NECMETTIN ERBAKAN UNIVERSITY

DENTAL JOURNAL

Vol: 6 Issue: 1 Year: 2024

e-ISSN: 2687-5535

NEU PRESS

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Necmettin Erbakan University Dental Journal

Volume: 6, Issue: 1 (April 2024)
International Peer Reviewed Journal

Owner
Necmettin Erbakan University

Editor-in-Chief
Assoc. Prof. Makbule Bilge Akbulut

Publication Type
National Periodical

Publication Period
Published third-annual

Published Date
April 2024

Correspondence Address
NEU PRESS Yaka Mah. Yeni Meram Cad. Kasım Halife Sok. No: 11 B Blok Zemin Kat
Posta Kodu: 42090 Meram / KONYA

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Web: dergipark.org.tr/en/pub/neudhfdergisi

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Necmettin Erbakan University Dental Journal - NEUDentJ - is an international peer reviewed third-annual journal

E- ISSN: 2687-5535

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Diş Hekimliği Dergisi

Vol: 6 No: 1 Year: 2024 | Research Article | e-ISSN: 2687-5535

https://doi.org/10.51122/neudentj.2024.83

Evaluating Content, Quality, and Adequacy of Maxillofacial Trauma Videos on YouTube

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Article Info

Article History

Received: 06.06.2023
Accepted: 16.11.2023
Published: 30.04.2024

Keywords:
Maxillofacial Trauma,
Patient Information,
YouTube,
GQS,
VIQI.

ABSTRACT

Aim: This study aimed to evaluate the content, quality, and adequacy of YouTube videos on maxillofacial trauma.

Methods: A search for "Maxillofacial trauma" was conducted on YouTube with, a selection of two hundred videos. Out of these, 108 videos were considered eligible for the assessment of quality and adequacy. These videos were then evaluated for quality and adequacy using established assessment tools: the Information Quality Index (VIQI) and the Global Quality Scale (GQS). Subsequently, the videos were classified into low or high-content groups, based on a 16-point scoring system.

Results: Most videos (55.6%) were uploaded by healthcare professionals. 81.5% were classified as low content and 18.5% as high content. The main topics covered included anatomical structures (43.5%), trauma area (40.7%), treatment procedure (32.4%), intraoral complications (31.5%), and maxillofacial trauma definition (30.6%). Fewer videos discussed post-operative prognosis and survival (13.9% and 17.6%, respectively). High-content videos had significantly higher GQS and VIQI scores, with strong correlations between content scores, VIQI, and GQS.

Conclusions: The study shows a need for higher quality, accurate YouTube content on maxillofacial trauma, especially for non-medical audiences. Collaboration between healthcare professionals, commercial entities, laypersons, and YouTube could enhance reliable educational content, making YouTube a more valuable resource for patient education and awareness.

YouTube'daki Maksillofasiyal Travma Videolarının İçeriğinin, Kalitesinin ve Yeterliliğinin Değerlendirilmesi

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 06.06.2023
Kabul Tarihi: 16.11.2023
Yayın Tarihi: 30.04.2024

Keywords:
Maksillofasiyal Travma,
Hasta Bilgilendirmesi,
YouTube,
GQS,
VIQI.

ÖZET

Amaç: Bu çalışma, YouTube'daki "Maksillofasiyal travma" videolarının içeriğini, kalitesini ve yeterliliğini değerlendirmeyi amaçlamaktadır.

Gereç ve Yöntemler: YouTube'da "Maksillofasiyal travma" araması yapıldı ve 200 video seçildi. Bu videolardan 108'i, kalite ve yeterlilik değerlendirmesi için uygun bulundu. Videolar, Bilgi Kalite İndeksi (VIQI) ve Global Kalite Ölçeği (GQS) kullanılarak kalite ve yeterlilik açısından değerlendirildi. Daha sonra, videolar, 16 puanlık bir değerlendirme sistemi temel alınarak düşük veya yüksek içerikli gruplara ayrıldı.

Bulgular: Videoların çoğu (%55,6) sağlık profesyonelleri tarafından yüklenmiştir. Videoların %81,5'i düşük içerikli ve %18,5'i yüksek içerikli olarak sınıflandırıldı. En çok ele alınan konular arasında anatomik yapılar (%43,5), travma alanı (%40,7), tedavi prosedürü (%32,4), intraoral komplikasyonlar (%31,5) ve maksillofasiyal travma tanımı (%30,6) bulunuyor. Daha az video, post-operatif prognoz ve hayatta kalma oranlarını (%13,9 ve %17,6, sırasıyla) tartıştı. Yüksek içerikli videoların GQS ve VIQI puanları anlamlı derecede yüksekti ve içerik puanları, VIQI ve GQS arasında güçlü korelasyonlar bulundu.

Sonuçlar: Çalışma, özellikle profesyonel olmayan izleyiciler için YouTube'daki maksillofasiyal travma içeriklerinin kalitesinin ve doğruluğunun arttırılması gerektiğini göstermektedir. Sağlık profesyonelleri, ticari kuruluşlar, meslek ile alakası olmayan kişiler ve YouTube arasındaki iş birliği, güvenilir eğitim içeriğinin geliştirilmesine yardımcı olabilir, böylece YouTube, hastaların eğitimi ve maksillofasiyal travma yönetimi ve tedavisi hakkındaki farkındalığı için daha değerli bir kaynak haline gelebilir.

To cite this article:
Tekin A., Temel AN., Erdem Hepsenoğlu Y. Evaluating Content, Quality, and Adequacy of Maxillofacial Trauma Videos on YouTube. NEU Dent J. 2024;6:1-12. https://doi.org/10.51122/neudentj.2024.83

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INTRODUCTION

Accident-related injuries represent a significant public health concern, being a leading cause of mortality and morbidity. Between 5 to 33% of severe trauma patients sustain facial injuries[1,2]. Facial injuries result from various incidents, including falls, car accidents, assaults, alcohol-related events, workplace incidents, and everyday activities.[3] They can happen alone or in conjunction with other severe injuries, such as cranial, spinal, upper, and lower body injuries.[4]

Maxillofacial injuries can be particularly incapacitating. It is the location of critical functions like breathing, mastication, speech, vision, hearing, and olfaction. The psychological impact of disfigurement may also increase the level of resulting morbidity because of the proximity of significant vascular and neural structures.[5] These injuries are likely to have a significant financial impact as well. Young adults are the age group most frequently affected.[6]

In maxillofacial traumas, there are many sub-headings such as trauma site, affected areas, type of trauma, cause of trauma, treatment procedures, intraoral and extraoral complications, symptoms, effects on quality of life, prognosis, survival rate, imaging methods used, first aid and status after surgical treatment.[7]

With the widespread use of the internet and smartphones globally, a significant number of people now rely on online sources for medical information. Currently, approximately 65.6% of the global population has access to the internet, and of these, over 70% use it to seek health-related information.[8] With 122 million people accessing YouTube daily and a total of 2.6 billion users, its widespread popularity and easy accessibility have made it a unique source of medical information.[9] Information obtained from the "2018 Health Information National Trends Survey" shows that more than a third of patients watch health-related videos on YouTube.[10] Due to its accessible platform, individuals and groups can easily upload misleading content. The level of accuracy, whether there is bias, or whether the quality is adequate is a factor unknown to the viewer. Therefore, uploaders need to be particularly careful about the quality of the uploaded content to avoid misleading the viewer.

Health-related misinformation on social media is gradually turning into a mounting public health concern that may affect patient-provider communication due to the popularity of social media and the relative ease with which information can be posted online.[11]

Even though many health-related videos on YouTube are considered educationally valuable and of high quality.[12,13] Some studies indicate that health-related videos on YouTube often lack quality, can be misleading, or contain commercial content designed to sell products or services all of which may have serious implications for consumer attitudes and medical decisions. [14,15]

Recent studies have evaluated the quality of information on disc herniation, cervical cancer, and many other surgical topics on YouTube.[16–119]

However, to date, no study has evaluated the quality of maxillofacial trauma patient videos on YouTube. This study aimed to investigate the content, quality, and adequacy of maxillofacial trauma-related videos on YouTube.

MATERIAL AND METHODS

For this study, approval has been obtained from the ethics committee with the number E-10840098-772.02-810. This study cross-sectionally evaluated the Internet-based video environment. A YouTube (www.youtube.com; Google, San Bruno,

Calif) search using the keyword "Maxillofacial Trauma" was performed on 15 January 2023. According to the Google Trends Website (2022), “maxillofacial trauma” was the most frequently used search term for accidental injuries in the head and neck region in the English language.

All history and cookies of the computer were cleared to prevent restrictions based on user history. The search setting was configured worldwide to broaden the scope of the results. During the search, no filters were applied to the upload date, duration, or feature sections. The content type was set to 'video', and relevance-based ranking was selected as the sorting criterion. The resulting videos were playlisted on YouTube on a set date to ensure consistency in ranking. In a study, it was observed that only 17% of users looked beyond the first three pages of search results, while another reported that merely 8% of users did.[20] Therefore, search results were restricted to the first 200 videos. To guarantee consistency in ranking, the resulting videos were playlisted on YouTube on a set date because the outcomes of the searches might vary from day to day.

The exclusion criteria for our study included videos in a language other than English, no audio, longer than 30 minutes, duplicate videos, and videos not related to maxillofacial trauma. In these cases, only video properties were noted. Basic attributes of these videos, including the upload date, the number of minutes, the country from which they were uploaded, and the total number of comments and likes were recorded.

The source of the videos was classified into four categories: professionals, hospitals/universities, commercial entities, and laypersons. The intended audience was divided into three groups: professional, layperson, and both.

Upon analyzing the video content, the examiners determined whether the target audience consisted of professionals, laypersons, or both. This was based on the level of technical and scientific information presented in the videos. According to the study by Hassona *et al*. [21] the interaction level of the viewers was evaluated using the interaction index and viewing rate formulas based on the number of likes, total views, and days since the upload date.

The research team consists of A.T, an oral and maxillofacial radiology specialist, and Y.E.H, an endodontics specialist, both of whom have more than seven years of practice in their corresponding areas. Two researchers evaluated the videos based on 16 criteria, which included the definition of maxillofacial trauma, anatomical structures, trauma area and types, causes, treatment procedures, intraoral and extraoral complications, case presentation, symptoms, psychological and psychosocial impact, prognosis and survival, imaging of trauma, initial actions, secondary survey, and post-operative care. The calculation was made over a total of 16 points, 1 point for each of the videos that meet each of these criteria similar to the study by Lena et al.[22] videos earning a cumulative score of 9-16 were classified as high-content, while those scoring under 8 were categorized as low-content.

The Video Information and Quality Index (VIQI) was employed to gauge the comprehensive audio-visual quality of the videos, using a 5-point Likert scale that ranged from 1 (low quality) to 5 (excellent quality). This index assesses video characteristics such as information flow, accuracy, quality (attributing one point each for incorporating still images, animations, community interviews, captions, and a summary), and precision (the coherence between the video's title and its content). The educational quality was assessed based on the Global Quality Scale (GQS), a 5-point scale that evaluates flow, patient

usefulness, and overall quality (Table 1).

To estimate intraobserver reliability, the same researcher reevaluated all of the videos after 30 days. Additionally, a second examiner reevaluated all videos to determine interobserver reliability. Intraobserver and interobserver agreements were determined using intraclass correlation coefficients (ICCs). In case of uncertainty, the first researcher consulted the second researcher, and they reached a consensus by viewing the video together.

Table 1: Global Quality Scale (GQS)

Score Description	Score
Poor quality, poor flow of the video, most information missing, not at all useful for patients	1
Generally poor quality and poor flow, some information listed but many important topics missing, of very limited use to patients	2
Moderate quality, suboptimal flow, some important information is adequately discussed but others poorly discussed, somewhat useful for patients	3
Good quality and generally good flow. Most of the relevant information is listed, but some topics are not covered, useful for patients	4
Excellent quality and flow, very useful for patients	5

Statistical Analyses

In this study, IBM SPSS Statistics 22 software served as the tool for interpreting the results and conducting statistical examinations. The Shapiro-Wilks test was applied to analyze the distribution normality of the parameters, establishing that the parameters did not conform to a normal distribution. Descriptive statistical approaches (mean, standard deviation, median, frequency) were used to assess the data gathered in the study, alongside the Kruskal Wallis Test (post hoc Dunn's test) for drawing comparisons among more than two sets of quantitative data. The Mann Whitney U Test was used for comparisons between two sets of quantitative data. Spearman's rho correlation analysis was used to evaluate the correlations between parameters. To compare qualitative data, techniques like the Chi-Square test, Fisher's Exact Chi-Square test, Fisher Freeman Halton Exact Test, and Continuity (Yates) Correction were employed. The threshold for significance was set at the $p<0.05$ level.

RESULTS

A total of 200 videos were examined in the study. However, 92 videos were excluded from the study for various reasons, including 21 videos (22.8%) with lacked audio, 17 videos (18.5%) were not in English, 2 videos (2.2%) were duplicates, 6 videos (6.5%) were not related to the subject and 46 videos (50%) with a duration of 30 minutes or longer. All evaluations were made on the remaining 108 videos.

The intraobserver reliability between the two raters was excellent for total content, with ICC values of 0.933. Additionally, intraobserver reliability was good for both GQS and VIQI, with ICC values of 0.875 and 0.844 respectively. Good interobserver reliability was seen across all three scoring systems, with ICC values of 0.883 for total content, 0.831 for GQS, and 0.804 for VIQI.

In searches using the keyword "maxillofacial trauma" among the 108 videos that met the inclusion criteria for the study, 61 (56.5%) were uploaded from the United States, 28 (25.9%) from India, and 19 (17.6%) from other countries.

The descriptive statistics, such as the number of views, likes, and days since the videos were uploaded. The average duration of the YouTube videos on maxillofacial trauma was 6.33 minutes, with a mean total view count was 6097.73 and a viewing rate was 604.83. The mean like count was 104.27, ranging from 0 to 2400. The videos had been uploaded, on average, 1414.05 days ago, with a range of 95 to 4491 days (Table 2).

Table 2: Descriptive Statistics of the YouTube Videos

Variables	Minimum	Maximum	Mean	Std. Dev.	Median
Video Characteristics					
Number of Views	1	137917	6097,73	17646,33	393,5
Duration in Minutes	2 sec	29,21 min	6,33	7,52	2,76
Days Since Upload	95	4491	1414,05	901,41	1212
Number of Comments	0	207	8,53	28,16	0
Number of Likes	0	2400	104,27	323,38	3,5
Viewing Rate	0,04	13243,95	604,83	1768,78	35,67
Interaction Index	0	11,05	1,46	1,97	0,75
Total Content Score	0	16	4,25	4,55	3
GQS Score	1	5	2,08	1,12	2
VIQI Content Assessment					
Flow of Information	1	5	2,31	1,26	2
Information Accuracy	1	5	3,33	1,34	3
Quality	1	4	1,87	0,96	2
Precision	1	5	2,40	1,35	2
VIQI Total Score	4	19	9,91	4,53	10

Table 3: Distrubition of Youtube Videos Source of Upload, Target Audience, Video Contents

		n	%
Source of Upload	Healthcare Professionals	60	55,6
	Hospital/University	5	4,6
	Commercial Entities	41	38
	Layperson	2	1,9
Target Audience	Professional	39	36,1
	Layperson	53	49,1
	Both	16	14,8
Total Content Score	Low-Content (0-8)	88	81,5
	High-Content (9-16)	20	18,5
Video Contents	Definition of Maxillafacial Trauma	33	30,6
	Anatomic Structures	47	43,5
	Trauma Area	44	40,7
	Trauma Types	32	29,6
	Trauma Causes	28	25,9
	Treatment Procedure	35	32,4
	Intraoral Complications	34	31,5
	Extraoral Complications	27	25
	Case Presentation	28	25,9
	Symptoms	30	27,8
	Psychological and Psychosocial Impact	20	18,5
	Prognosis and Survival	19	17,6
	Imaging of Trauma	24	22,2
	Initial Action	23	21,3
	Secondary Survey	20	18,5
	Post-Operative	15	13,9

In this study, the most frequently covered topics were anatomic structures (43.5%), trauma areas (40.7%), and treatment procedures (32.4%), However, post-operative information was discussed the least discussed topic (13.9%) (Table 3). Table 3 presents additional video demographics, such as the uploader's identity, the target audience, and content. Most of the videos (55.6%, n=60) were uploaded by healthcare professionals, followed by commercial entities (38%, n=41), while the rest were from laypersons and hospital/university sources. The videos were predominantly aimed at laypersons (49.1%), with only 36.1% targeting dental professionals (Table 3).

Of the 108 videos, 88 videos (81.5%) and 20 videos (18.5%) were included in the low-content and high-content groups, respectively (Table 3).

No statistically significant difference was found between the low and high-content video groups regarding video view counts, the time elapsed since the video upload, number of comments, number of likes, number, and viewing rate (p>0.05) (Table 4).

Table 4: Comparison of Variables Low-Content and High-Content Videos

	Low -Content			High-Content			
Variables	**Min**	**Max**	**Mean±SD (median)**	**Min**	**Max**	**Mean±SD (median)**	**p**
Video Characteristics							
Number of Views	1	137917	5452,86±17410,61 (372,5)	30	75951	8935,15±18847,26 (892)	0,371
Duration in Minutes	0,02	29,21	4,94±7,11 (2,1)	2,15	25,46	12,23±6,35 (10,5)	0,001*
Days Since Upload	95	4491	1413,07±909,77 (1202)	246	3453	1418,35±886,54 (1239)	0,899
Number of Comments	0	207	8,15±29,59 (0)	0	86	10,22±21,11 (2)	0,051
Number of Likes	0	2400	97,68±329,5 (3)	0	1300	133,25±301,19 (19,5)	0,056
Viewing Rate	0,04	13243,95	591,15±1835,89 (29,7)	1,9	5938,31	665,01±1476,8 (103,2)	0,438
Interaction Index	0	11,05	1,33±1,92 (0,6)	0	7,68	2,04±2,1 (1,4)	0,049*
GQS	1	4	1,77±0,97 (1)	3	5	3,45±0,6 (3)	0,001*
VIQI Content Assessment							
Flow of Information	1	5	2,05±1,2 (2)	2	5	3,45±0,83 (3)	0,001*
Information Accuracy	1	5	3,06±1,32 (2,5)	4	5	4,55±0,51 (5)	0,001*
Quality	1	4	1,65±0,83 (1)	1	4	2,85±0,88 (3)	0,001*
Precision	1	5	2,07±1,24 (2)	3	5	3,85±0,75 (4)	0,001*
VIQI Total Score	4	19	8,82±4,21 (8)	10	19	14,7±2,23 (15)	0,001*

Mann Whitney U Test **p<0,05*

The average interaction index of high-content videos is statistically significantly higher than that of low-content videos (p=0.049). Compared with the low-content group, the high-content video group had a higher median value of GQS score (4.00 vs 2.00; P<0.001) and more in VIQI score (16.00 vs 12.00; P<0.001). The flow of information, information accuracy, quality, and precision of high-content videos are statistically significantly higher than those of low-content videos (p=0.001) (Table 4).

The correlations between the total content, GQS and VIQI scores were analyzed. Pearson correlation analysis revealed a strong correlation between the total content and VIQI scores (r=0.792; P=0.001) as well as between GQS and total

content scores (r=0.778; P=0.001). Furthermore, a strong correlation was observed between GQS and VIQI scores (r=0.93; p=0.001) (Table 5).

There are statistically significant and high-level positive correlations in the relationship between the overall content score and the duration of the video. (r = 0.704), VIQI score and video duration (r = 0.782), VIQI score and like count (r = 0.652), GQS score and video duration (r = 0.809), as well as GQS score and like count (r = 0.621; p=0.001) (Table 5).

Table 5: Correlations Between Total Content Score, VIQI, GQS And Youtube Demographics

		Total Content Score	VIQI	GQS
Total Content Score	r	1,000		
	p	,		
VIQI	r	0,792	1,000	
	p	0,001*	,	
GQS	r	0,778	0,930	1,000
	p	0,001*	0,001*	,
Number of Views	r	0,323	0,454	0,421
	p	0,001*	0,001*	0,001*
Duration in Minutes	r	0,704	0,782	0,809
	p	0,001*	0,001*	0,001*
Days since Upload	r	-0,228	-0,310	-0,292
	p	0,017*	0,001*	0,002*
Number of Comments	r	0,449	0,581	0,572
	p	0,001*	0,001*	0,001*
Number of Likes	r	0,466	0,652	0,621
	p	0,001*	0,001*	0,001*
Viewing Rate	r	0,384	0,550	0,507
	p	0,001*	0,001*	0,001*
Interaction Index	r	0,458	0,558	0,553
	p	0,001*	0,001*	0,001*

Spearman's Rho Correlations *p<0,05

Regarding the source of upload, statistically significant differences were found between the low and high-content groups (p=0.001). Videos uploaded by healthcare professionals were significantly high-content (%85) compared to low-content (%48.9). Videos sourced by commercial entities had a significantly higher incidence of low-content videos (%46.6) compared to high-content (%0) (Table 6).

Statistically significant differences were found in total content (p=0.001), VIQI (p=0.001), and GQS (p=0.001) based on the target audience, with videos targeting non-professionals having significantly lower scores in all three metrics compared to videos targeting professionals and both groups combined (p1=0.001; p2=0.001) (Table 7).

DISCUSSION

YouTube is often used as a resource for health-related information.[23] People from all age groups have been consulting the internet for information about their health ranging from older adults [24] to younger patients who are mostly affected by maxillofacial trauma.[25] and their parents or guardians.[26] YouTube videos constitute a potent source of knowledge that is readily available to a diverse spectrum of individuals.[27]

Table 6: Comparison of Variables Low-Content and High-Content Videos

		Low-Content	High-Content	
		n (%)	**n (%)**	**p**
Source of Upload	Healthcare Professionals	43 (%48,9)	17 (%85)	[1]0,001*
	Hospital/University	2 (%2,3)	3 (%15)	
	Commercial Entities	41 (%46,6)	0 (%0)	
	Layperson	2 (%2,3)	0 (%0)	
Target audience	Professional	27 (%30,7)	12 (%60)	[2]0,001*
	Layperson	51 (%58)	2 (%10)	
	Both	10 (%11,4)	6 (%30)	
Video Contents	Definition of Maxillofacial Trauma	18 (%20,5)	15 (%75)	[3]0,001*
	Anatomical Structures	28 (%31,8)	19 (%95)	[3]0,001*
	Trauma Area	24 (%27,3)	20 (%100)	[3]0,001*
	Trauma Types	16 (%18,2)	16 (%80)	[3]0,001*
	Trauma Causes	17 (%19,3)	11 (%55)	[3]0,001*
	Treatment Procedure	17 (%19,3)	18 (%90)	[3]0,001*
	Intraoral Complications	18 (%20,5)	16 (%80)	[3]0,001*
	Extraoral Complications	12 (%13,6)	15 (%75)	[3]0,001*
	Case Presentation	14 (%15,9)	14 (%70)	[3]0,001*
	Symptoms	12 (%13,6)	18 (%90)	[3]0,001*
	Psychological and Psychosocial Impact	9 (%10,2)	11 (%55)	[4]0,001*
	Prognosis and Survival	5 (%5,7)	14 (%70)	[4]0,001*
	Imaging of Trauma	11 (%12,5)	13 (%65)	[4]0,001*
	Initial Action	9 (%10,2)	14 (%70)	[4]0,001*
	Secondary Survey	7 (%8)	13 (%65)	[4]0,001*
	Post-Operative	4 (%4,5)	11 (%55)	[4]0,001*

[1]Fisher Freeman Halton Exact Test [2]2Chi-square test [3]Continuity (yates) fix. [4]Fisher's Exact test

**p<0,05*

Table 7: Comparison of Scores According to Source of Upload and Target Audience

		Total Score	VIQI	GQS
		Mean±SD (median)	**Mean±SD (median)**	**Mean±SD (median)**
Source of Upload	Healthcare Professionals	0,28±0,45 (0)	12,6±3,65 (13)	2,7±0,98 (3)
	Hospital/University	0,6±0,55 (1)	12,2±4,97 (15)	2,8±1,3 (3)
	Commercial	0±0 (0)	5,78±1,8 (5)	1,12±0,4 (1)
	Layperson	0±0 (0)	8±4,24 (8)	1,5±0,71 (1,5)
	p	0,001*	0,001*	0,001*
Target Audience	Professional	0,31±0,47 (0)	12,92±3,9 (14)	2,77±0,99 (3)
	Layperson	0,04±0,19 (0)	6,58±2,76 (5)	1,32±0,73 (1)
	Both	0,38±0,50 (0)	13,56±2,22 (14)	2,94±0,77 (3)
	p	0,001*	0,001*	0,001*

Kruskal Wallis Test **p<0,05*

Numerous studies have been performed on the quality and adequacy of YouTube videos on different topics but there hasn't been any concerning maxillofacial trauma. [28] In this study, we have aimed to investigate the contents and quality of the videos related to maxillofacial trauma.

The average daily time spent by a user on YouTube including all platforms and devices is 19 minutes and 39 seconds and the average mobile viewing session is approximately 40 minutes.[9] This study found that the average duration of low-content and high-content videos was 4.94±7.11 and 12.23±6.35 minutes respectively. Even though a positive correlation has been found between video duration and content ratings, there's a demand for shorter videos. A study has shown that short-length videos are more popular than long-length videos.[29] YouTube Shorts has been recently introduced and it grew by %135 between 2021 and 2022, reaching 30 billion daily views in 2022.[9] Patients should be directed to longer videos for more accurate information.

[30] In this study, videos were classified into two categories as high and low-content based on their inclusion of 16 criteria. These criteria were determined by their frequent appearance in book chapters and reviews on the subject.[30–33] Videos were also graded using VIQI and GQS which are used in similar articles.[22,34,35] Total content score, VIQI and GQS scores were found to be correlated. There was also a correlation between VIQI and GQS scores.

As of November 2021, YouTube has removed the public dislike count from all of the videos.[36] Research about the accuracy of YouTube videos commonly included dislike counts in their statistical analysis.[20,37] In this study, dislike counts were not investigated since the findings suggest that hiding the number of dislikes from viewers has altered the user interactions for the like/dislike features, which may affect the reliability of the parameter.[38]

Although socioeconomic deterioration as a result of psychological damage after maxillofacial trauma is widely recognized, this study found very few videos of posttraumatic postoperative psychological impairment and social difficulties.[31,33] In addition to psychological and social effects, unfavorable outcomes such as infections, nonunion and malunion that can result in malocclusion and deformities may occur during the post-operative healing period in case of patient noncompliance.[39]

Early and sensitive assessment and management of maxillofacial trauma is of utmost importance because the most favorable outcomes are only possible with early intervention.[41] The videos evaluated failed to provide accurate and sufficient information on issues vital for treatment planning and prognosis.[40-42]

Based on the target audience, statistically significant differences were found in total content scores, VIQI scores, and GQS scores, with videos targeting non-professionals having significantly lower scores in all three scales compared to videos targeting professionals and both groups combined. This indicates that videos aimed at professionals generally have higher quality and more accurate information.

Given the ever-changing nature of YouTube content, search results are prone to fluctuation as user interests and video viewing patterns shift over time. However, extending the research time might result in an unwieldy volume of social media data, complicating the analysis process. Furthermore, even though the Google Trends tool identified the most prevalent keywords for maxillofacial trauma, using different keywords might lead to different videos. Other limitations of this study include the use of only "maxillofacial trauma" as a keyword. In addition, the fact that the

number of laypersons who know the term "maxillofacial trauma" does not constitute a very large part of the population can also be seen as a limitation of the study. This situation statistically affects the homogeneous distribution between the groups.

CONCLUSION

The results of this research emphasize the necessity for enhanced content quality and accuracy of YouTube videos on maxillofacial trauma, especially for layperson viewers. Achieving this requires collaboration among healthcare professionals, commercial entities, laypersons, and YouTube to create, review, and promote reliable educational content. By doing so, YouTube can become a more valuable resource for patient education and awareness regarding maxillofacial trauma management and treatment.

Ethical Approval

The necessary ethical approval for this study was received from Istanbul Medipol University Non-Interventional Scientific Research Ethics Committee. (E- 10840098-772.02-810)

Financial Support

The authors declare that this study received no financial support.

Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Design: AT, YEH, ANT, Data collection and processing: AT, Analysis and interpretation: AT, YEH, Literature review: AT, ANT, Writing: AT, ANT

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NEU PRESS

Diş Hekimliği Dergisi

Vol: 6 No: 1 Year: 2024 | Research Article | e-ISSN: 2687-5535

https://doi.org/10.51122/neudentj.2024.84

Evaluation of the Effect of Different Bonding Systems and Restorative Materials on Shear Bond Strength in the Repair of High-Viscosity Glass Ionomer Cement

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Article Info

Article History

Received: 22.08.2023
Accepted: 23.01.2024
Published: 30.04.2024

Keywords:
Glass Ionomer,
Composite Resin,
Adhesive System,
Shear Bond Strength,
Thermal Cycle.

ABSTRACT

Aim: High viscosity glass ionomer cements have been produced to increase the mechanical properties of glass ionomer cements. The aim of this study is to determine the appropriate adhesive system and restorative material that can be used in fracture repair of high viscosity glass ionomer cements.
Material and Methods: A total of 140 standard size acrylic blocks were used in the study. 14 groups were formed from randomly selected acrylic blocks, with 10 samples in each group. High viscosity glass iomomer cement was placed in the first 13 groups, and resin-modified glass ionomer cement was placed in the last group. After the thermal cycle aging process was applied to all samples, repair restorations were performed with 4 different adhesive systems, 2 different composite resins and 2 different restorative types of glass ionomer cement. After the repair restorations, thermal cycle aging was applied again and the shear bond strengths were evaluated. One-way analysis of variance and Duncan multiple comparison test were used for statistical analysis.
Results: The highest shear bond strength values were obtained by the total etch adhesive system ($p<0.001$). The lowest shear bond strength values were obtained when high-viscosity glass-iomomer cement without adhesive system was restored with high-viscosity glass iomomer cement ($p<0.001$).
Conclusion: For higher shear bond strength values in the repair of high-viscosity glass ionomer cements should use to total etch adhesive systems and composite resin.

Yüksek Viskoziteli Cam İyonomer Siman Tamirinde Farklı Bonding Sistemlerinin ve Restoratif Materyallerin Makaslama Bağlantı Dayanımı Üzerine Etkisinin Değerlendirilmesi

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 22.08.2023
Kabul Tarihi: 23.01.2024
Yayın Tarihi: 30.04.2024

Anahtar Kelimeler:
Cam Iyonomer,
Kompozit Rezin,
Adeziv Sistem,
Makaslama Bağlanma Dayanımı,
Termal Siklus.

ÖZET

Amaç: Cam iyonomer simanların mekanik özelliklerini arttırmak amacıyla yüksek viskoziteli cam iyonomer simanlar üretilmiştir. Bu çalışmanın amacı yüksek viskoziteli cam iyonomer simanların kırık tamirinde kullanılabilecek uygun adeziv sistem ve restoratif materyali belirlemektir.
Gereç ve Yöntemler: Çalışmada standart boyutta toplam 140 akrilik blok kullanıldı. Rastgele seçilen akrilik bloklardan her grupta 10'ar örnek olacak şekilde 14 grup oluşturuldu. İlk 13 gruba yüksek viskoziteli cam iyomomer siman, son gruba ise rezin-modifiye cam iyonomer siman yerleştirildi. Tüm örneklere termal siklus ile yaşlandırma işlemi uygulandıktan sonra 4 farklı adeziv sistem, 2 farklı kompozit rezin ve 2 farklı restoratif tipte cam iyonomer siman ile tamir restorayonları yapıldı. Tamir restorasyonlarının ardından tekrar termal siklus ile yaşlandırma işlemi uygulandı ve bağlantı yüzeylerindeki makaslama bağlantı dayanım kuvvetleri değerlendirildi. İstatistiksel analizler için Tek yönlü varyans analizi ve Duncan çoklu karşılaştırma testi kullanıldı.
Bulgular: En yüksek makaslama bağlanma dayanımı değerleri total etch adeziv sistem ile elde edildi ($p<0,001$). En düşük makaslama bağlanma dayanımı değerleri adeziv sistem kullanılmayan yüksek viskoziteli cam iyomomer simanın yüksek viskoziteli cam iyomomer siman ile restore edildiğinde elde edildi($p<0,001$).
Sonuç: Yüksek viskoziteli cam iyonomerler simanların tamirinde, yüksek makaslama bağlanma dayanımı değerleri için, total etch sistemler ile kompozit rezin restorasyonların kullanımı önerilir.
Anahtar kelimeler: Cam iyonomer, kompozit rezin, adeziv sistem, makaslama bağlanma dayanımı, termal siklus

To cite this article:
Özmen B., Mutlu B., Elgörmüş A.M. Evaluation of the Effect of Different Boning Systems and Restorative Materials on Shear Bond Strength in the Repair of High-Viscosity Glass Ionomer Cement. NEU Dent J. 2024;6:13-21. https://doi.org/10.51122/neudentj.2024.84

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INTRODUCTION

In today's dentistry practices, with the advances in adhesive techniques, protective and preventive treatments have begun to be preferred and the principle of protecting healthy dental tissues has become more important. Instead of multi-session restorations, the use of single-session direct restoration techniques has been developed.[1]

As permanent direct restorative materials, amalgam, composite resins and glass ionomer cements (GICs) are generally used in routine applications.[2] Amalgam contains 42-45% mercury by weight. The use of amalgam has decreased due to the fact that mercury vapor negatively affects human health, rarely causes allergic reactions, amalgam waste can cause environmental pollution and is not aesthetic.[3] Although composite restorations are highly aesthetic and color compatible, they require technical precision during application. In addition, composite resins may cause problems such as polymerization shrinkage, as a result of the stress occurring within the material, it can lead to microleakage, post-operative sensitivity, discoloration and secondary caries.[4] For this reason, the studies for a durable restorative material that can be used safely in the field of dentistry continues. Glass ionomer cements are among the filling materials routinely used today; It has advantages such as chemical bonding to the tooth, ability to release fluoride, biocompatibility, and a thermal expansion coefficient similar to dental hard tissues.[5,6] In order to improve the mechanical properties of GICs, high viscosity GICs were produced by reducing the filler particle sizes. Moreover, powder-liquid ratio, particle sizes and distributions in high viscosity GICs have been changed.[7,8]

A high viscosity restorative system that can be condensed similar to amalgam (EQUIA; GC Europe, Tokyo, Japan), designed for use in the permanent restoration of Class I, II and V cavities, was introduced to the market in 2007.[9,10] The hardening mechanisms of these newly developed high viscosity cements are the same as traditional GICs, but according to traditional GICs; wear resistance, surface hardness, bending and compression resistance are increased. Studies have reported that, unlike other GICs, early exposure to water does not adversely affect the physical properties of these materials, as the hardening reaction in high viscosity GICs is completed faster.[11,12]

Adhesion is the coming together of two different surfaces by physical or chemical. In restorative applications, adhesion occurs between mineralized tooth structures and filling materials.[13] Many dental adhesive systems have been developed to achieve sufficient bonding strength in enamel and dentin.[14] Today, routinely used systems can be classified depending on the way they are used as three-stage etch and rinse, two-stage etch and rinse, two-stage self-etch and single-stage self-etch adhesive. In etch and rinse systems, the smear layer is removed with orthophosphoric acid and the collagens on the dentin surface are revealed. On the other hand, self-etch adhesives, do not require acid application or washing, and they modify the smear layer by demineralizing the dentin with the acid.[15] Researchers have focused on inventing the ideal adhesive system and adhesive technique for perfect adaptation in dental restorative materials.[16]

In permanent restorations, it is possible for fractures to occur over time for various reasons. In such a case, the necessity of repairing the fracture or completely removing the restoration and making a new restoration is controversial. In this study, it was aimed to determine the appropriate adhesive system and restorative material that can be used in the repair of fractures of high viscosity GICs, which are stated to be used in permanent restorations.

MATERIAL AND METHOD

Preparation of Acrylic Blocks

A total of 140 acrylic blocks of standard size were used in the study. Cylinder-shaped

blocks were prepared from cold acrylic (SC Cold Acrylic, Imicryl Kimya, Konya, Turkey) by using silicone molds, 2 cm diameter and 2 cm height. There was a standard slot with a diameter of 6 mm and a depth of 2.5 mm in the middle of each acrylic block (Figure 1). After the acrylic blocks were removed from the molds, the surfaces of them were sanded with 100 and 320 grit silicon carbide sandpaper for standardization.

Figure 1: Preparation of acrylic blocks

Creating Groups

14 groups were created from randomly selected acrylic blocks, with 10 samples in each group (Figure 2). The groups are shown in Table 2. High viscosity GIC (Equia forte fil capsule, GC, Japan) was placed in 13 groups according to the manufacturer's instructions. Resin-modified GIC (Fuji II LC capsule, GC, Japan) was placed in the last group. Glass ionomers in capsule form were mixed in an amalgamator (SYG-200, China). According to the manufacturer's instructions, Equia Coat was applied on Equia forte fil glass ionomers, which may be affected by moisture in the early period, and polymerized for 20 seconds with an LED light device (Woodpecker G, China). The samples were kept in an oven at 37˚C for 24 hours in a 100% humidity environment. All GIC surfaces were polished with 100 and 320 grit silicon carbide sandpaper to obtain standard surfaces.

Figure 2: Creation of the samples

Table 2. Formation of the groups

Groups	Repaired surface	Bonding system	Feature of bonding system	Restorative material
Group 1	Equia forte fil	Adper single bond 2	Total etch	Gradia direct posterior
Group 2	Equia forte fil	Clearfil S3 bond	One-stage self etch	Gradia direct posterior
Group 3	Equia forte fil	Futura bond NR	Two-stage self etch	Gradia direct posterior
Group 4	Equia forte fil	All-bond universal	Universal bond	Gradia direct posterior
Group 5	Equia forte fil	Adper single bond 2	Total etch	Filtek P60 posterior
Group 6	Equia forte fil	Clearfil S3 bond	One-stage self etch	Filtek P60 posterior
Group 7	Equia forte fil	Futura bond NR	Two-stage self etch	Filtek P60 posterior
Group 8	Equia forte fil	All-bond universal	Universal bond	Filtek P60 posterior
Group 9	Equia forte fil	Adper single bond 2	Total etch	Fuji II LC
Group 10	Equia forte fil	Clearfil S3 bond	One-stage self etch	Fuji II LC
Group 11	Equia forte fil	Futura bond NR	Two-stage self etch	Fuji II LC
Group 12	Equia forte fil	All-bond universal	Universal bond	Fuji II LC
Group 13	Equia forte fil	-	-	Equia forte fil
Group 14	Fuji II LC	-	-	Fuji II LC

Preparation of Repair Restorations

In this study, 4 different adhesive systems, 2 different composite resins and 2 different restorative types of GIC were used. The materials used are shown in Table 1. As repair material, Gradia direct Posterior (GC, Japan) was used in 4 groups of samples, Filtek P60 posterior (3M ESPE, USA) was used in 4 groups, and resin–modified GIC was used in 4 groups. Four adhesives system was a total etch adhesive system (Adper single bond 2, 3M ESPE, USA), a single-stage self-etch adhesive system (Clearfil S3 bond, Kuraray, Japan), a two-stage self-etch adhesive system (Futura bond NR, Voco, Germany). and a universal adhesive system (All-bond universal, Bisco, USA). They were applied according to the manufacturer's instructions. The same LED light device was used for polymerizations. In another group, high viscosity GIC was placed directly (without applying adhesive agent). Resin-modified GIC was placed on the last group where resin-modified GIC base was used (without applying adhesive agent). All repair materials placed were prepared to be 2.5 mm high and 2.5 mm diameter. The samples were kept in an oven at 37˚C for 24 hours in a 100% humidity environment.

Table 1. Materials used in the study

Materials	Materials Description	Content	Colour	Producer	Lot number
Equia Forte Fil	Bulk Fil glass hybrid restorative system	Powder:Floro-alumino-silicate glass, Polyacrylic acid, oxidised ferric Liquid: polybazic carboxylic acid, distiled water	A2	GC Dental, Tokyo, Japan	1610251
Fuji II LC	Resin-reinforced glass ionomer restorative cement in capsule form	Powder: Floro-alumino-silikat glass Liquid: poliakrilik acid, HEMA, 2,2,4, trimetil heksametilen dikarbonat, TEGDMA	A2	GC Dental, Tokyo, Japan	1611246
Adper single bond 2	Total etch adhesive system	BIS-GMA, HEMA, dimethacrylate, amines, methacrylic copolymer of polyacrylic and polyitaconic, acids, ethanol, water, photoinitiator	-	3M ESPE	N961805
Clearfil S3 bond	One-stage self etch adhesive system	10-MDP, Bisfenol A diglisidmetakrilat, HEMA, etanol, hidrofilik alifatik metakrilat, koloidal silika, kamforokinon, silan, akselatör, iniatör, water	-	Kuraray, Japan	700028
Futura bond NR	Two-stage self etch adhesive system	Bis-GMA, hyroyethyl-methacrylate, BHT, ethanol, organic asit, fluorides	-	Voco, Germany	1719524
All-bond universal	Universal adhesive system	MDP, bis-GMA, ethanol		Bisco, USA	1700001591
Gradia direct posterior	Microfil hybrid composite	Urethane dimethacrylate co-monomer matrix, silica, prepolymerised fillers, fluoroalumino-silicate glass (vol %65)	A2	GC Dental, Tokyo, Japan	1701272
Filtek P60 posterior	Microhybrid	Bisglycidyl ether dimethacrylate (bis-GMA) Urethane dimethacrylate (UDMA), 2,2-bis(4-(2-Methacryl-oxyethoxy)phenyl)propane (BIS-EMA), zirconia/silica filler % 61	A3	3M ESPE, USA	NA13766
EQUIA Forte Coat	Low viscosity nanofilament surface capping resin	50% Metil metakrilat, 0.09% kamforokinon	-	GC Dental, Tokyo, Japan	1608051
K-Etchant syringe	35% phosphoric acid	35% phosphoric acid, kollaida silica	-	Kuraray, Japan	3S0102

Bis-GMA, bisphenol diglycidyl methacrylate; MDP, 10-methacryloyloxydecyl dihydrogen phosphate;

Thermal Cycle Application

Thermal cycling process was carried out using 2 separate water baths at temperatures between 5 °C and 55 °C, in the form of 5000 cycles each (Figure 3). Thermal cycle aging process was applied both before the repair restoration application and after the repair restoration was completed. Dwell time was set as 30s and transfer time was set as 5s in each water bath. After the thermal cycle aging process, the shear bond strengths of the samples were evaluated.

Figure 3: Thermal cycling

Measuring Shear Bond Strength

For shear bond strength testing, each acrylic block was placed in a universal testing machine (LRX 5K Universal Testing Machine, LLOYD Instruments, LRX) (Figure 4). A mechanism with a screw clamping system was used to place the samples. Shear bond strength was measured by subjecting the samples to shear force with a knife-edge tip at a transverse speed of 1.0 mm/min. Force was applied until fracture occurred. These values, where the fracture occurred, determined in Newton, were converted to Megapascals by dividing by the connection surface area.

Figure 4: Shear connection strength test

Fracture Types Analysis

Post-fracture surfaces were classified as adhesive, cohesive and mixed fracture types under a stereomicroscope (Olympus SZ61, Munster, Germany) at x30 magnification.

Statistical Analysis

SPSS program (SPSS 17 for Windows, SPSS Inc., Chicago, IL, USA) was used to analyze the data. The normality assumption of the data was examined with the Shapiro Wilk test and it was determined that the data showed normal distribution (P>0.05). With the Levene test, it was determined that the variances of the data were homogeneous (P>0.05). For this reason, one-way analysis of variance was used for group comparisons. Duncan multiple comparison test was used for multiple comparisons within groups. Chi-square test for independence was used to examine fracture types.

RESULTS

The shear bond strength values obtained from each group of 4 were compared with the 13th and 14th groups without adhesive system and significant statistical differences were determined ($p<0.001$). In the 10th group, statistical evaluations were performed on 9 specimens in this group due to the failure of one specimen after the thermal cycle. The mean shear bond strength values and standard error obtained from the groups were given in Tables 3-5. In addition, adhesive systems were statistically evaluated within themselves and significant statistical differences were found between different groups with the same adhesive system ($p<0.001$) (Tables 6-9). When the results were evaluated as a whole, the highest shear bond strength value was found in group 5 and the lowest value was found in group 13. Significant statistical differences were found in terms of fracture types. The most common fracture type was cohesive fracture ($p<0.001$) (Graph 1).

Graph 1: Groups in terms of fracture types

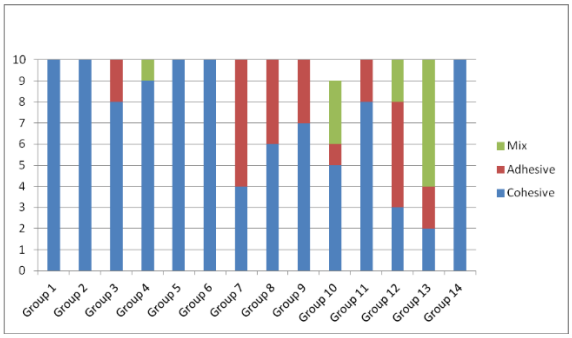

Table 3. Shear connection strength values of the Gradia direct posterior composite applied groups

Groups	n	Mean ± SD
Group 1	10	16,31 ± 1,07a
Group 2	10	13,73 ± 0,74b
Group 3	10	14,89 ± 0,69ab
Group 4	10	11,64 ± 0,42c
Group 13	10	7,17 ± 0,37d
Group 14	10	12,91 ± 0,6bc
P value		<0,001

Table 4. Shear connection strength values of the group applied with Filtek P60 posterior composite

Groups	n	Mean ± SD
Group 5	10	20,64 ± 1,28a
Group 6	10	18,5 ± 1,04a
Group 7	10	15,6 ± 0,75b
Group 8	10	11,71 ± 0,54c
Group 13	10	7,17 ± 0,37d
Group 14	10	12,91 ± 0,6c
P value		<0,001

Table 5. Shear bond strength values of the resin-modified glass ionomer cemented group

Groups	n	Mean ± SD
Group 9	10	12,07 ± 0,41ab
Group 10	9	10,66 ± 0,72b
Group 11	10	11,98 ± 0,72ab
Group 12	10	7,52 ± 0,81c
Group 13	10	7,17 ± 0,37c
Group 14	10	12,91 ± 0,6a
P value		<0,001

Table 6. Shear bond strength values of the group using total etch adhesive system

Groups	n	Mean ± SD
Group 1	10	16,31 ± 1,07b
Group 5	10	20,64 ± 1,28a
Group 9	10	12,07 ± 0,41c
P value		<0,001

Table 7. Shear bond strength values of the group using one-stage self etch adhesive system

Groups	n	Mean ± SD
Group 2	10	13,73 ± 0,74b
Group 6	10	18,50 ± 1,04a
Group 10	9	10,66 ± 0,72c
P value		<0,001

Table 8. Shear bond strength values of the group using two-stage self etch adhesive system

Groups	n	Mean ± SD
Group 3	10	14,89 ± 0,69a
Group 9	10	15,60 ± 0,75a
Group 11	10	11,98 ± 0,72b
P value		<0,001

Table 9. Shear connection strength values of groupsın using universal adhesive system

Groups	n	Mean ± SD
Group 4	10	11,64 ± 0,42a
Group 10	10	11,71 ± 0,54a
Group 12	10	7,52 ± 0,81b
P value		<0,001

DISCUSSION

High viscosity glass ionomers have been developed in order to strengthen the mechanical properties of conventional glass ionomers and increase their wear resistance. High viscosity glass ionomers have the same curing mechanism as conventional glass ionomers, and their solubility is reduced and their surface hardness, abrasion resistance and flexural compression strength are increased. Conventional glass ionomers, high viscosity glass ionomers, resin-modified glass ionomers, composite resins can be used in fracture repair of high viscosity glass ionomers.[17] In our study, different bonding systems and restorative materials that can be used in the repair of fractures and as a permanent restoration option, were investigated.[18]

Adhesive systems play an important role in the bond strength of restorations. Adhesive systems can be classified as etch & rinse adhesives and self-etch adhesives. Etch & rinse adhesive systems remove the smear layer and demineralise the dentin tissue to a depth of several micrometres, exposing the collagen-rich hydroxyapatite structure. Thus, hydrophilic monomers infiltrate collagen fibres.[19] However, it has been reported that the acid roughening step may cause postoperative sensitivity. This step was removed and self-etch adhesives were developed to ensure ease of application and to reduce the possibility of recontamination with blood and saliva during washing and drying of the cavity.[20] Perdigao et al.[21] compared different adhesive systems and found that there was no difference between the systems in terms of shear strength, but marginal leakage was observed more in self-etch systems than in total etch systems. In our study, similar to the results of the study by Barutçugil et al.[22] , it was observed that the bond strength was higher when total etch systems were used. In our study, in the comparison of the use of one-stage self etch adhesive system and two-stage self etch adhesive system in the repair of high viscosity glass ionomer, statistically similar results were found in the groups using Gradia direct posterior and Resin-modified glass ionomer. In the groups using Filtek P60 posterior composite, the shear bond strength values of one-stage self-etch adhesive system and total etch adhesive system were statistically similar. This may be due to the differences in the content of the adhesive systems. Dental restorative materials are affected by temperature and pH changes in the oral environment.[23] Therefore, In our study, aging was done by thermal cycle in order to comply with in-vivo studies. This method mimics the effect of hot and cold substances on teeth.[24] In this study, materials and bonding systems that can be used in the repair of high-viscosity glass ionomer aged by thermal cycling were investigated. A review of the literature revealed no studies in which different materials were used with different adhesive systems for the repair of high-viscosity glass ionomers. Previous studies were generally performed between tooth and restorative materials.[25,26,27]

Shear bond strength tests are one of the frequently preferred methods for the evaluation of dental materials and techniques under in vitro conditions.[27] In this study, shear bond strength test was preferred because it is a practical and common method. Fractures observed in restorative materials cause failure in dental treatment. Fracture types were analysed and classified as adhesive, cohesive or mixed fracture in our study.[28] While adhesive fractures occur between the tooth surface and the restoration, cohesive fractures occur in the restoration. Poitevin et al.[29] suggested that adhesive type fracture may reflect the bond strength values more accurately, but cohesive fractures were more common in the samples in study.

In our study, high viscosity glass ionomer, resin-modified glass ionomer and two different brands of composite resins with microfillers (Gradia direct Posterior, Filtek P60 posterior restorative) were used to repair high viscosity glass ionomer. Shear bond strength was found to be higher in composite resins in all different adhesive techniques. When composite resins were compared, "Filtek P60 posterior" was found to be more durable than Gradia direct posterior in all groups. The reason for this may be the content differences between the brands. In addition, the presence of "zirconia" in the content of Filtek P60 posterior and its absence in Gradia direct posterior may also lead to this difference. When resin-modified glass ionomer was used in the repair of high viscosity glass ionomer, it was observed that the bond strength was lower than composite resins. Summers et al.[30] compared resin-modified glass ionomer and composite resins in the bonding of orthodontic brackets and found that the bond strength of composite resins was higher. Similarly, in our study, values of the shear bond strengths of composite resins (groups 1-8) were quite high.

In all groups, the lowest connection strength was observed in group 13, that is, when high-viscosity glass ionomer was used without any adhesive system in the repair of high-viscosity glass ionomer. When resin-modified glass ionomer was used without any adhesive system in resin-modified glass ionomer repair, the shear bond strength was statistically significantly higher than in group 13.

CONCLUSION

Based on these findings, it can be concluded that an adhesive system should be used in the repair of high viscosity glass ionomers and it would be beneficial to use a total etch system and the type of composite used is also important. It was concluded that resin modified glass ionomers used with an adhesive system were not as successful as composite resins in the repair of high viscosity glass ionomers.

Ethical Approval

Ethics committee approval was not required in this study.

Financial Support

No financial support was received from any institution or organization for this study

Conflict of Interest

The authors declare that they have no competing interests.

Author Contributions

Design: BÖ, Data collection and processing: AE, Analysis and interpretation: BÖ, AE, Literature Review: BM, Writing: BM, BÖ.

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NEU PRESS

Diş Hekimliği Dergisi

Vol: 1 No: 1 Year: 2024 | Research Article | e-ISSN: 2687-5535

https://doi.org/10.51122/neudentj.2024.85

Evaluation of The Relationship Between Dental and Cervical Vertebrae Maturation in Terms of Age Determination

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Article Info

Article History

Received: 19.01.2024
Accepted: 11.03.2024
Published: 30.04.2024

Keywords:
3. Molar,
Tooth Calcification,
Cervical Vertebra,
Maturation,
Age Determination.

ABSTRACT

Aim: Age determination is a very important issue in anthropology, forensic science, and dentistry. Today, the most commonly used methods for age determination are the methods in which tooth and bone development are evaluated. This study aims to evaluate the relationship between gender, chronological age, dental maturation, and cervical vertebral maturation in individuals aged 8-25 years.

Material and Method: Digital panoramic, lateral cephalometric radiographs of 500 patients aged 8-25 years were used in this study. Cervical vertebra maturation was evaluated using the dental maturation-modified Demirjian classification system of Baccetti et al. Means, minimum, maximum, and standard deviations were calculated and analyzed as descriptive statistics. Kolmogorov-Smirnov, Kappa, Kruskal-Wallis, Chi-Square, Linear Regression, and Spearman Correlation tests were used for statistical analysis.

Results: There was a statistically significant difference between chronological age and dental maturation and cervical vertebral maturation levels ($p < 0.01$). While dental maturation levels did not differ significantly according to gender ($p > 0.05$), cervical vertebra maturation was statistically different ($p < 0.01$). There was a positive correlation between chronological age and dental maturation, and cervical vertebral maturation levels ($p < 0.01$). There was a strong correlation between dental maturation and cervical vertebral maturation levels ($p < 0.01$).

Conclusion: The findings of this study showed that skeletal maturity increased with the increase in chronological and dental age for both genders. The earlier formation was consistently observed for each stage of skeletal maturation in females. All correlations between skeletal and dental maturations were statistically significant.

Dental ve Servikal Vertebra Olgunlaşması Arasındaki İlişkinin Yaş Tayini Açısından Değerlendirilmesi

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 19.01.2024
Kabul Tarihi: 11.03.2024
Yayın Tarihi: 30.04.2024

Anahtar Kelimeler:
3. Molar,
Diş Kalsifikasyonu,
Servikal Vertebra,
Olgunlaşma,
Yaş Tayini.

ÖZET

Amaç: Yaş tayini antropoloji, adli bilimler ve diş hekimliğinde çok önemli bir konudur. Günümüzde yaş tayini için en sık kullanılan yöntemler diş ve kemik gelişiminin değerlendirildiği yöntemlerdir. Bu çalışmada 8-25 yaş arası bireylerde cinsiyet, kronolojik yaş, dental maturasyon ve servikal vertebral maturasyon arasındaki ilişkinin değerlendirilmesi amaçlanmıştır.

Gereç ve Yöntem: Bu çalışmada 8-25 yaş arası 500 hastanın dijital panoramik, lateral sefalometrik radyografileri kullanıldı. Servikal vertebra maturasyonu Baccetti ve arkadaşlarının dental maturasyon-modifiye Demirjian sınıflandırma sistemi kullanılarak değerlendirildi. Ortalama, minimum, maksimum ve standart sapmalar hesaplandı ve tanımlayıcı istatistikler olarak analiz edildi. İstatistiksel analiz için Kolmogorov-Smirnov, Kappa, Kruskal-Wallis, Ki-Kare, Lineer Regresyon ve Spearman Korelasyon testleri kullanıldı.

Bulgular: Kronolojik yaş ile dental olgunlaşma ve servikal vertebral olgunlaşma seviyeleri arasında istatistiksel olarak anlamlı bir fark vardı ($p<0,01$). Dental olgunlaşma düzeyleri cinsiyete göre anlamlı farklılık göstermezken ($p>0,05$), servikal vertebra olgunlaşması istatistiksel olarak farklıydı ($p<0,01$). Kronolojik yaş ile dental olgunlaşma ve servikal vertebral olgunlaşma seviyeleri arasında pozitif bir korelasyon vardı ($p <0,01$). Dental olgunlaşma ile servikal vertebral olgunlaşma seviyeleri arasında güçlü bir korelasyon vardı ($p <0,01$).

Sonuç: Bu çalışmanın bulguları, iskelet olgunluğunun her iki cinsiyet için de kronolojik ve dental yaşın artmasıyla birlikte arttığını göstermiştir. Kadınlarda iskelet olgunlaşmasının her aşaması için tutarlı bir şekilde daha erken oluşum gözlenmiştir. İskelet ve diş olgunlaşmaları arasındaki tüm korelasyonlar istatistiksel olarak anlamlıydı.

To cite this article:
Mağat G. Evaluation of The Relationship Between Dental and Cervical Vertebrae Maturation in Terms of Age Determination. NEU DENT J. 2024;6:22-30. https://doi.org/10.51122/neudentj.2024.85

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INTRODUCTION

The human growth and development trend is often expressed in chronological age. However, studies have shown that individuals of the same chronological age show developmental differences. In particular, the growth and development stages of individuals are important in orthodontic diagnosis and treatment planning and forensic sciences. For this reason, it has become increasingly popular to determine growth and development according to the maturation stage of the body's hard tissues and organs.[1,2]

Age determination according to bone development is one of the most commonly used methods. Many factors such as endocrine disorders, congenital disorders, nutritional disorders, congenital syndromes, systemic disorders such as growth retardation, and environmental and geographical factors affect bone development. Due to their hard structure and low metabolic rate, teeth are less affected by these factors than other structures in the organism.[3] For this reason, data from teeth can give more accurate results compared to other tissues.[3]

Radiological examination plays a crucial role in the diagnosis of dental or forensic issues in dentistry.[4] The radiological methods used to determine the growth and development period are classified as panoramic, cephalometric, and hand-wrist radiographs.[5] Since the changes in teeth and bones belonging to each period can be easily observed in radiological images, this method is preferred more than other growth, development, and age determination applications[6]. In addition, radiological examinations are superior to biochemical and histological examinations because they are not invasive and do not damage the integrity of the material.[7] Recently, cone-beam computed tomography (CBCT) has allowed for the acquisition of sagittal, coronal, and axial images, furnishing dentists with valuable insights into the anatomical structure and developmental stages.[8-10] However, considering the radiation dose, it has been stated that 2-dimensional diagnostic radiographs can also provide necessary information.[11-13]

Studies have shown that growth and development differ according to ethnic groups. For this reason, researchers emphasized the importance of using data according to populations in age determination.[14] Therefore, this study aims to reveal the relationship between dental age and skeletal age using panoramic radiography. The goal is to determine the optimal timing for initiating orthodontic treatment, to assist in age determination in forensic sciences, to minimize time loss, and to avoid additional radiation exposure from procedures like cephalometric radiography.

MATERIAL AND METHOD

Ethical approval was obtained for this study from the Necmettin Erbakan University Faculty of Dentistry Review Board (2022/190) and the study was conducted according to the criteria specified by the Helsinki Declaration.[15]

In this retrospective investigation, lateral cephalometric and panoramic radiographs from the radiology archive of Necmettin Erbakan University Faculty of Dentistry, Department of Oral and Maxillofacial Radiology in Konya, Türkiye, were utilized. The study involved a total of 500 patients, comprising 304 females and 196 males, within the age range of 8 to 25 years, who were selected randomly.

The inclusion criteria for the study were as follows: participants should not have any systemic diseases, conditions affecting bone development, or malnutrition, and should exhibit normal growth and development, as evidenced by quality radiographs. Radiographs of individuals who had orthodontic treatment before and any anatomical deformation in their cephalometric radiographs were not included in the study. Birth dates, radiography and sex of all selected lateral cephalograms were recorded. The chronological age of each individual was obtained by subtracting the date of birth from the date the image was taken.

Lateral cephalometric and panoramic x-rays were consistently captured using a uniform method on the same device (Morita Veraviewepocs 3D R100-P, J Morita MFG Corp., Kyoto, Japan), operating at settings of 65 kVp, 7mA, and a duration of 7.4 seconds. These images were saved in the TIFF format, and anonymized to obscure the subjects' age and gender from evaluators. An experienced observer (G.M.), with a background of twelve years in the field, reviewed a set of 50 radiographs twice, spaced one month apart, using a computer equipped with an Intel® Xeon® i5 processor, 2.5 GHz; NVIDIA Quadro 2000; a display resolution of 1366 x 768 pixels, 4 GB of RAM, and running on Microsoft Windows 10.

The CVM stages 1 to 6 on cephalometric X-rays, based on Baccetti et al.'s [16] system. This focuses on the shape and concavity of the lower borders of the second to fourth cervical vertebrae (C2-C4). Briefly, stages 1 and 2 feature flat and concave lower borders in C2-C4 with trapezoidal C3 and C4. In stages 3 and 4, concavities appear in C2-C4, with varying shapes from trapezoidal to rectangular. Stages 5 and 6 show concavities in all vertebrae, with C3 or C4 being either square or rectangular.

In the evaluation of radiographs, based on the classical method published by Demirjian et al.[17] in 1973, which is divided into 8 stages from A to H (stages A-D, crown development, E-H root development, stages 0 and 1 are added. The modified Demirjian method was used.[18]

For the statistical evaluation, various methods were employed, including Descriptive Statistics, Cohen's Kappa, the Kolmogorov-Smirnov test, the Chi-square test, the Mann-Whitney U test, and Linear Regression analysis. The analyses were conducted using SPSS version 22.0 by IBM, located in Armonk, NY, USA. A significance threshold was established at a p-value of 0.05.

RESULTS

Table I presents the average chronological and dental ages of patients at each stage of CVM, broken down by gender. Additionally, this table includes the distribution frequency of patients across the various CVM stages. Notably, the largest concentration of patients was observed in stages CVM5 and CVM6.

While DM levels did not differ statistically by gender ($p>0.05$) (Figure 1), CVM was statistically different ($p<0.01$) (Figure 2). The frequency of CVM 3, 5, and 6 was more predominant in females (Figure 2).

Figure 1. The distribution of Demirjian dental maturation levels according to gender and age.

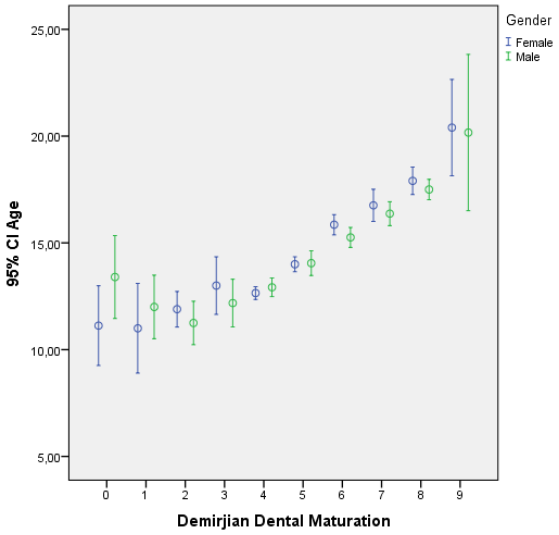

Figure 2. The distribution of cervical vertebrae maturation levels according to gender and age

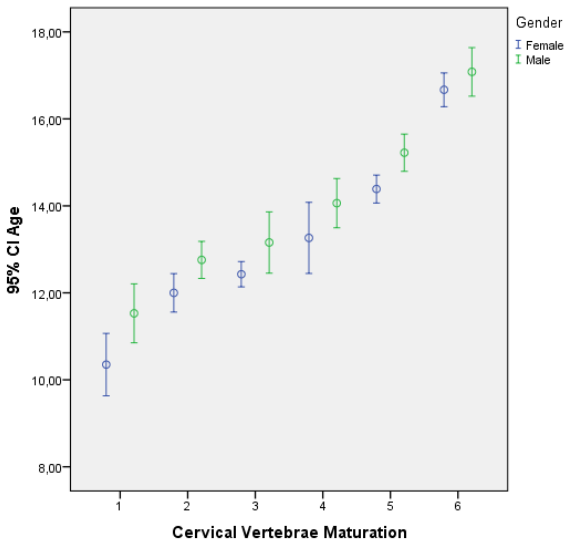

Table 1. The mean chronological age and dental age of patients at each cervical vertebra maturation (CVM) stage separately for females and males

CVM		Female		Male		Total	
		Number	Mean	Number	Mean	Number	Mean
CVM1	Chronological age	20(37.0%)	10.35±1.53	34(63.0%)	11.52±1.94	54(100.0%)	11.09±1.87
	Dental age		12.00±1.69		12.35±1.47		12.22±1.55
	Difference of chronological and dental age		0.14±0.051		0.13±0.044		0.13±0.047
CVM2	Chronological age	29(46.8%)	12.00±1.16	33(53.2%)	12.76±1.20	62(100.0%)	12.40±1.23
	Dental age		13.46±1.22		13.44±1.18		13.44±1.19
	Difference of chronological and dental age		0.101±0.02		0.10±0.02		0.101±0.02
CVM3	Chronological age	35(64.8%)	12.42±0.85	19(35.2%)	13.15±1.46	54(100.0%)	12.68±1.14
	Dental age		13.33±1.25		13.81±1.22		13.50±1.25
	Difference of chronological and dental age		0.10±0.038		0.09±0.023		0.10±0.033
CVM4	Chronological age	19(54.3%)	13.26±1.69	16(45.7%)	14.06±1.06	35(100.0%)	13.62±1.47
	Dental age		14.05±1.11		13.63±1.89		13.86±1.51
	Difference of chronological and dental age		0.09±0.017		0.11±0.048		0.10±0.035
CVM5	Chronological age	98(68.5%)	14.38±1.60	45(31.5%)	15.22±1.42	143(100.0%)	14.65±1.59
	Dental age		14.36±1.29		14.85±1.66		14.52±1.43
	Difference of chronological and dental age		0.09±0.024		0.10±0.036		0.09±0.029
CVM6	Chronological age	103(67.8%)	16.66±1.98	49(32.2%)	17.08±1.94	152(100.0%)	16.80±1.97
	Dental age		15.62±1.29		16.00±1.75		15.74±1.46
	Difference of chronological and dental age		0.11±0.031		0.12±0.037		0.11±0.034
Total	Chronological age	304(60.8%)	14.37±2.56	196(39.2%)	14.33±2.56	500(100.0%)	14.35±2.56
	Dental age		14.41±1.66		14.27±2.00		14.35±1.80
	Difference of chronological and dental age		0.10±0.033		0.11±0.039		0.10±0.035

As shown in Table I, dental age was higher than chronological age between CVM 1 and 4 in females, while CVM was higher between 1 and 3 in males. The largest difference between chronological age and dental age in males and females was recorded in CVM1.

Table 2 shows the relationship between age, CVM, and DM levels as assessed by the Spearman correlation test. According to this test, correlations between all parameters were statistically significant ($p<0.01$). As shown in Table II, the highest correlation was found between CVM and chronological age. The correlation coefficient between CVM and DM was also found to be 0.659. In addition, the correlation coefficient of the relationship between chronological age and DM was 0.744. While there was a very high correlation (0.814) between CVM and chronological age in males, this value was 0.794 in females. Correlations between CVM and dental age were high in both genders (Table 2).

Table 2. The relationship between age, cervical vertebra maturation (CVM), and dental maturation (DM) levels as assessed by the Spearman correlation test

CVM		CVM	Dental Age	Chronological age
Spearman's rho	Correlation coefficient	1,000	0.659**	0.786**
	Number	500	500	500
Female	Correlation coefficient	1,000	0.636**	0.794**
	Number	304	304	304
Male	Correlation coefficient	1,000	0.695**	0.814**
	Number	196	196	196

The correlations between dental age and chronological age according to CVM stages for males and females separately are shown in Table 3. Accordingly, the strongest correlation was seen in the CVM2 stage (0.617) in males. In females, the strongest correlation was in CVM 4 stage (0.633). The correlation between dental age and chronological age in males was weakest (0.115) at CVM4, while it was weakest at CVM3 (0.097) in females.

Table 3. The correlations between dental age and chronological age according to cervical vertebra maturation (CVM) stages for males and females separately

				Dental Age
Female	CVM1	Chronological age	Spearman's correlation	0.503*
			Number	20
	CVM2	Chronological age	Spearman's correlation	0,252
			Number	29
	CVM3	Chronological age	Spearman's correlation	0,097
			Number	35
	CVM4	Chronological age	Spearman's correlation	0.633**
			Number	19
	CVM5	Chronological age	Spearman's correlation	0.580**
			Number	98
	CVM6	Chronological age	Spearman's correlation	0.629**
			Number	103
Male	CVM1	Chronological age	Spearman's correlation	0,252
			Number	34
	CVM2	Chronological age	Spearman's correlation	0.617**
			Number	33
	CVM3	Chronological age	Spearman's correlation	0.476*
			Number	19
	CVM4	Chronological age	Spearman's correlation	0,115
			Number	16
	CVM5	Chronological age	Spearman's correlation	0.471**
			Number	45
	CVM6	Chronological age	Spearman's correlation	0.574**
			Number	49

DISCUSSION

Various research has been carried out globally to identify growth, development, and age estimation. A significant correlation has been observed between skeletal, sexual, and somatic growth stages. However, there is a lack of studies that link dental maturity (DM) with skeletal development.[17] This prompted our investigation into the connection between CVM and DM stages within the Turkish population.

Panoramic radiographs are a common tool in dental practices. The DM assessment technique, as proposed by Demirjian[17], focuses on the teeth's calcification stages, examining the shape and proportion of the teeth's root length. This approach minimizes the impact of radiographic projection. On the other hand, cephalometric radiographs, essential for CVM assessment, are not typically used due to the additional radiation exposure they entail. Thus, understanding the relationship between CVM and DM becomes crucial. Should a positive correlation be established, patients could potentially use a single, routinely conducted panoramic radiograph for predicting skeletal

maturation stages. This would serve as a safer alternative to other methods that involve higher radiation exposure.

According to the CVM method, it was stated that the pubertal growth spurt occurred between CVM3 and CVM4.[16] At the CVM3 stage in this study, the mean chronological age was 12.42 ± 0.85 in girls and 13.15 ± 1.46 in boys. These findings were consistent with the age of onset of pubertal growth spurt for adolescents in the literature.[19-21] The mean chronological age in girls was lower at each CVM stage. This indicates that, within the measured age range and the preferred vertebral framework, girls are more mature than boys. These findings are consistent with previous studies that found differences in skeletal maturation by gender.[19,21] Consistent with our previous study[22], no significant difference was found between DM and gender in this study ($p<0.05$).

In the present study, we observed significant correlation coefficients between CVM and chronological age, with values of 0.814 for males and 0.794 for females. These findings suggest a potential variance between skeletal maturity and chronological age. Notably, in females, the link between skeletal and chronological ages was more pronounced than the correlation between skeletal age and dental age. Literature typically reports positive correlations among chronological age, dental age, and skeletal age. In a study which conducted in 2006[23] conducted on a similar population to ours indicated a lower correlation coefficient of 0.720 between chronological age and CVM, compared to our finding of 0.786. Contrastingly, the study by Al-Balbeesi et al.[24] highlighted a stronger relationship between chronological age and CVM, especially in females. However, current study found a more significant correlation in males.

The literature contains few studies that examine the connection between the maturation of third molars and skeletal development stages. Cho and Hwang[25] observed a marginally stronger association between skeletal maturation and the Demirjian index (with a correlation coefficient of 0.640) compared to the correlation between CVM and DM, which was 0.590. This is in line with the findings of Chertkow and Fatti[26], Engstrom et al.[27], and Krailassiri et al.[28]. However, this differs from the results of Uysal et al.[23], who identified a weak link between the development of the third molar and skeletal maturation. In a 2016 study involving Indian individuals aged 9 to 14, researchers found correlations of 0.683 in males and 0.704 in females between dental and skeletal ages.[29] In agreement with these findings, our study also recorded a high correlation between CVM and DM, with a correlation coefficient of 0.659.

In present study, a stronger relationship was observed between dental age and chronological age at the CVM2 stage for males and at the CVM4 stage for females. Rozylo-Kalinowska et al.[19] identified the highest correlation between dental and chronological ages at the CVM1 stage for both genders. Litsas and Lucchese[30], in 2016, noted the strongest link between chronological and dental ages for both males and females at the CVM4 stage. Conversely, Mollabashi et al.[31]. discovered a more pronounced correlation at the CVM5 stage for males and the CVM4 stage for females. The variability in these results across different studies could potentially be attributed to ethnic variations.

Consistent with our results, the literature shows a strong correlation between DM and CA.[32-35] The correlation coefficient was 0.744. In a study that included Hispanic individuals aged 4-13 in 2020, a very high correlation was found between dental age and chronological age ($r = 0.86$).[36] In a study evaluating the third molar teeth of 832 Turkish individuals aged 6-16 years in 2013 [37], a correlation coefficient of 0.63 and 0.61 was found between DM and age in males and females, respectively. In another study conducted in a Turkish population[38], a correlation coefficient of 0.77 in males and 0.69 in females was found between age and DM.

The limitations of the study are that factors such as climate, environment, ethnic diversity, socioeconomic status, genetics, and hormones, which are effective on the growth of children, were not evaluated in this study. Another limitation is that this study was conducted in only one subpopulation of Türkiye. Therefore, further research on a larger sample with new population groups is needed. Additionally, a limitation that can be added is that the radiographic images included in the study were obtained from a single brand of device.

CONCLUSION

The findings of this study showed that skeletal maturity increased with the increase in chronological and dental age for both genders. Earlier formation was consistently observed for each stage of skeletal maturation in females. All correlations between skeletal and dental maturations were statistically significant. Although a strong relationship between skeletal and dental age has been reported, it cannot be considered the only reliable indicator for evaluating growth. However, dental calcification stages can be useful in addition to skeletal maturity in assessing an individual's growth. More research is needed to reach stronger results.

Acknowledgment

This study was presented as an oral presentation at the 4th International Congress of Oral Diagnosis and Maxillofacial Radiology in Izmir, Türkiye, October 19-22, 2022.

Ethical Approval

The required ethical approval for this study was received by Necmettin Erbakan University Non-Pharmaceutical and Medical Device ethics committee (2022/190).

Financial Support

No financial support was received from any institution or organization for this study.

Conflict of Interest

The authors declare that they have no competing interests.

Author Contributions

Design: GM, Data collection or data entry: GM, Analyzing and interpreting: GM, Literature review: GM, Writing: GM.

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NEU PRESS

Diş Hekimliği Dergisi

Vol: 1 No: 1 Year: 2024 | Research Article | e-ISSN: 2687-5535

https://doi.org/10.51122/neudentj.2024.86

The Effect of Temporomandibular Joint Disc Displacement Type on Jaw Function Limitation

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Article Info

Article History

Received: 17.05.2023
Accepted: 16.11.2023
Published: 30.04.2024

Keywords:
Functional Status,
Jaw Abnormalities,
Temporomandibular Joint

ABSTRACT

Aim: Temporomandibular joint disorder (TMD) present symptoms such as pain, swelling, clicking or crepitating sounds, limitations or blockages in jaw movements, and may even affect simple functions such as eating and speaking. This study aims to evaluate the impact of disc displacement type on jaw function in patients with TMD who suffer from disc displacement.

Material and Methods: This cohort study was conducted on patients with temporomandibular joint (TMJ) disc displacement. The independent variable was the type of disc displacement. The outcome variable was the scores on the Jaw Functional Limitation Scale-20 (JFLS-20). The covariates included the patient's age and pain score. Data collection methods were carried out using the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) guidelines and the JFLS-20 questionnaire, with pain levels also assessed using a visual analog scale. Data analysis was performed using ANOVA and Pearson Correlation tests, with a significance level set at 0.05.

Results: The study groups were formed by including 72 patients with disc displacement, while the control group was formed by including 28 healthy volunteers. The control group had lower JFLS-20 scores than the disc displacement groups($p<0.05$). Although there was no statistically significant difference in JLFS-20 scores between the disc displacement groups, disc displacement with reduction group had significantly lower pain scores than both disc displacement without reduction groups($p<0.05$).

Conclusion: It was observed that individuals with disc displacement experience restricted jaw functions, and this limitation is not affected differently by the various subtypes of disc displacement.

Temporomandibular Eklem Disk Deplasman Türünün Çene Fonksiyon Kısıtlılığı Üzerine Etkisi

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 17.05.2023
Kabul Tarihi: 16.11.2023
Yayın Tarihi: 30.04.2024

Anahtar Kelimeler:
Çene Bozuklukları,
Fonksiyonel Durum,
Temporomandibular Eklem.

ÖZET

Amaç: Temporomandibular eklem bozukluğu (TMB), ağrı, şişlik, klik veya krepitasyon sesleri, çene hareketlerinde kısıtlılık veya blokaj gibi semptomlar gösterir ve hatta yemek yeme ve konuşma gibi basit işlevleri etkileyebilir. Bu çalışma, disk deplasmanı olan TMB hastalarında disk deplasman tipinin çene işlevi üzerindeki etkisini değerlendirmeyi amaçlamaktadır.

Gereç ve Yöntem: Bu kohort çalışması, temporomandibular eklemde (TME) disk deplasmanı olan hastalar üzerinden yapıldı. Bağımsız değişken, disk deplasmanının tipiydi. Sonuç değişkeni, Çene Fonksiyonel Kısıtlama Ölçeği-20 (JFLS-20) puanlarıydı. Ortak değişkenler hastanın yaşı ve ağrı skoruydu. Veri toplama yöntemleri, Temporomandibular Disfonksiyon/ Tanı Kriterleri (TMD/TK) talimatları ve JFLS-20 anketi kullanılarak gerçekleştirilmiş, ayrıca ağrı seviyeleri görsel analog ölçeği ile değerlendirilmiştir. Veri analizi, ANOVA testi ve Pearson Korelasyon testi kullanılarak gerçekleştirilmiş ve anlamlılık düzeyi 0.05 olarak kabul edilmiştir.

Bulgular: Disk deplasmanı olan 72 hasta ile çalışma grupları, 28 sağlıklı gönüllü ile kontrol grubu oluşturuldu. Kontrol grubu, disk deplasman gruplarına göre daha düşük JFLS-20 puanlarına sahipti ($p<0,05$). Disk deplasmanlı gruplar arasında JLFS-20 skorları açısından istatistiksel olarak anlamlı bir fark bulunmamakla birlikte, redüksiyonlu disk deplasmanlı grup, redüksiyonsuz disk deplasmanlı gruplara göre anlamlı derecede daha düşük ağrı skorlarına sahipti ($p<0,05$).

Sonuç: Disk deplasmanı olan bireylerin çene fonksiyonlarında kısıtlılık yaşadıkları ve bu kısıtlılığın disk deplasmanının çeşitli alt tiplerinden farklı şekilde etkilenmediği görülmüştür.

To cite this article:
Balel Y. The Effect of Temporomandibular Joint Disc Displacement Type on Jaw Function Limitation. NEU Dent J. 2024;6:31-8. https://doi.org/10.51122/neudentj.2024.86

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INTRODUCTION

Temporomandibular joint disorder (TMD) is characterized by abnormal functioning or disease of the two joints that control the movements of the jaw and face, as well as the muscles, tendons, and other tissues surrounding these joints.[1,2] These disorders present symptoms such as pain, swelling, clicking or crepitating sounds, limitations or blockages in jaw movements, and may even affect simple functions such as eating and speaking.[3–5]

For the clinical classification of TMDs, numerous disciplines, particularly surgeons, dentists, orthodontists, prosthodontists, radiologists, and physiotherapists have conducted studies. While Peck et al. [6] classification is one of the most important outcomes of these efforts, Schiffman et al. [7] Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) is the most current clinical diagnostic criteria. Both publications evaluate the displacements of the temporomandibular joint (TMJ) disc under four main headings: disc displacement with reduction (DDwR), DDwR with intermittent locking, disc displacement without reduction (DDwoR) with limited opening, and DDwoR without limited opening. Although the literature has generally examined the effects of TMJ disc displacement on the amount of maximal mouth opening, there is limited information on the degree to which different types of disc displacement affect jaw functions.

This study aims to evaluate the impact of disc displacement type on jaw function in patients with TMD who suffer from disc displacement. The first hypothesis of the study posits that individuals with disc displacement will have more limited jaw functions compared to those without TMD. The second hypothesis suggests that the various types of disc displacement will have differing degrees of impact on jaw functions.

MATERIAL AND METHODS

Study sample and design

This study was approved by local ethics committee on 02.03.2023 with the number 23-KAEK-037 and was conducted in accordance with the Declaration of Helsinki. After obtaining written and verbal consent from all participants who agreed to participate in the study, they were included in the study. It is a retrospective cohort study that involves clinical examination protocols administered to patients seeking treatment for TMJ pain at the Tokat Gaziosmanpaşa University Faculty of Dentistry Oral and Maxillofacial Surgery Clinic, as well as to volunteers without TMD. This cohort study was conducted and reported in accordance with the CONSORT guidelines.The inclusion criteria for this study were as follows: (I) between the ages of 18 and 65, (II) for the study group, having the same type of disc displacement on both sides, and (III) for the control group, patients without TMD or any pain in the head and neck region. The exclusion criteria were: (I) patients with asymmetrically affected TMJs, (such as right TMJ DDwR and left TMJ DDwoR with limited opening), (II) patients with Degenerative Joint Disease, (III) patients with subluxation, and (IV) patients with muscle pain only.

Study variables

The independent variable was the type of disc displacement. The type of disc displacement was determined by applying the DC/TMD criteria. DC/TMD was published in 2014 by Schiffman et al. [7] This assessment tool consists of internal parts, namely Axis-I and Axis-II. Axis-I usually includes physical examination tools to determine the type of TMD, while Axis-II includes pain scales, health questionnaires, and psychosocial questionnaires. The study group, consisting of patients with TMD, underwent DC/TMD instructions and were subsequently divided into 4 groups: DDwoR with limited opening,

DDwoR without limited opening, DDwR, and DDwR with intermittent locking. Additionally, the DC/TMD instructions were administered to healthy volunteers who did not report any TMD complaints. After confirming that they did not have TMD, a control group was formed.

The outcome variable was the Jaw Functional Limitation Scale-20 (JFLS-20) scores. The validation studies for the JFLS-20 were completed and published by Ohrbach et al.[8] in 2008. The JFLS-20 is a TMJ-specific tool that assesses limitations in chewing, jaw mobility, and verbal and emotional expression. It consists of three constructs and uses a 0 (No Restriction) to 10 (Serious Restriction) VAS with a total of 20 questions. This tool was used to evaluate the jaw function of patients with TMD in this study. Scoring is based on the average score of the first 6 questions for *mastication*, the average score of 7-10 questions for *mobility*, the average score of 13-20 questions for *communication*, and the average score of all questions for *global*. Additionally, a visual analog scale (VAS) scale from 0 to 10 was used to determine the patient's pain level. The covariates were the patient's age and pain score.

Data collection methods

DC/TMD instructions were applied twice to both the study and control groups by a researcher who was an oral and maxillofacial surgeon, and the type of disc displacement was determined. The JFLS-20 questionnaire and VAS for pain were completed by the patient.

Power analysis

A pilot study was conducted with 5 patients in each group to calculate the sample size. In the analysis using the G-Power program based on the average scores of the Global JFLS-20 for the groups, with a significance level (α) of 0.05 and power (1-β) of 0.95, an effect size of 0.7483315 was observed, and the minimum required sample size was calculated to be 20 per group, totaling 40. Considering potential data losses, the sample size was kept larger than the calculated value.

Data analysis

The n (%) format was used to represent categorical variables, and the ± standard deviation format for continuous variables. The ANOVA test was used to compare multiple groups because the data were normally distributed and homogenous. Post hoc analyses were performed using the Bonferroni test. To assess the correlation between two continuous variables, a Pearson Correlation test was utilized, and significance was defined as a p-value lower than 0,05.

RESULTS

Following the application of the inclusion and exclusion criteria, 72 out of 128 patients with TMD were included in the study as the study group. Furthermore, after applying the DC/TMD to 30 volunteers, it was observed that 2 individuals had unilateral DDwR, and they were subsequently removed, resulting in the formation of a control group consisting of 28 individuals. The Table 1 shows the disc displacement types, JFLS-20 scores, and pain scores.

Table 2 shows that there was no statistically significant difference between the groups in terms of age ($p=0,492$). However, there was a significant difference between the groups in terms of JFLS-20 scores and VAS scores ($p<0,05$).

Post hoc analyzes as shown in Table 3 were used to identify the differentiated group. The control group had lower scores than the disc displacement groups ($p<0,05$). Although there was no statistically significant difference in JLFS-20 scores between the disc displacement groups, DDwR group had significantly lower pain scores than both DDwoR groups (with and without limited mouth opening) ($p<0,05$).

Table 1. Distribution of disc displacement status, Jaw Functional Limitation Scale -20 scores and VAS pain scores

		Age		JFLS-20 Mastication		JFLS-20 Mobility		JFLS-20 Communication		JFLS-20 Global		Pain VAS Score	
	n (%)	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Normal	28 (21.9)	28.79	9.02	0.55	0.31	0.69	0.41	0.28	0.10	0.51	0.27	0.39	0.49
DDwR	49 (38.3)	27.94	10.33	3.24	2.06	3.96	2.51	2.15	2.01	3.08	1.81	3.26	2.08
DDwR with intermittent locking	11 (8.6)	24.18	6.11	2.50	2.34	4.11	3.19	2.86	2.79	3.12	2.41	4.09	3.53
DDwoR with limited opening	28 (21.9)	26.61	7.52	3.93	2.08	5.37	2.41	2.78	2.03	3.74	1.72	5.82	2.51
DDwoR without limited opening	12 (9.4)	30.42	10.94	3.24	1.80	3.54	2.84	1.26	1.43	2.48	1.63	5.33	2.70
Total	100 (100.0)	27.74	9.23	2.74	2.18	3.52	2.79	1.86	2.02	2.61	1.98	3.46	2.88

Table 2. Results of Anova analysis

	Sum of Squares	df	Mean Square	F	Sig.
Age	293.730	4	73.432	0.857	0.492
JFLS-20 Mastication	190.291	4	47.573	14.087	0.000
JFLS-20 Mobility	332.898	4	83.224	15.583	0.000
JFLS-20 Communication	112.795	4	28.199	8.488	0.000
JFLS-20 Global	173.489	4	43.372	16.222	0.000
Pain VAS Score	467.892	4	116.973	24.307	0.000

Table 3. Results of Bonferroni post hoc analysis applied to examine the difference between groups

	(I) Type of Disk Disorder	(J) Type of Disk Disorder	Mean Difference (I-J)	Std, Error	Sig,	95% Confidence Interval	
						Lower Bound	Upper Bound
JFLS-20 Mastication	Normal	DDwR	-2.69133*	0.43536	**0.000**	-3.9358	-1.4468
		DDwR with intermittent locking	-1.95110*	0.65393	**0.034**	-3.8204	-0.0818
		DDwoR with limited opening	-3.38607*	0.49115	**0.000**	-4.7900	-1.9821
		DDwoR without limited opening	-2.69012*	0.63407	**0.000**	-4.5026	-0.8776
	DDwR	DDwR with intermittent locking	0.74022	0.61314	1.000	-1.0125	2.4929
		DDwoR with limited opening	-0.69474	0.43536	1.000	-1.9392	0.5497
		DDwoR without limited opening	0.00121	0.59191	1.000	-1.6908	1.6932
	DDwR with intermittent locking	DDwoR with limited opening	-1.43497	0.65393	0.301	-3.3043	0.4343
		DDwoR without limited opening	-0.73902	0.76710	1.000	-2.9318	1.4538
	DDwoR with limited opening	DDwoR without limited opening	0.69595	0.63407	1.000	-1.1166	2.5085
JFLS-20 Mobility	Normal	DDwR	-3.26439*	0.54748	**0.000**	-4.8294	-1.6994
		DDwR with intermittent locking	-3.41721*	0.82236	**0.001**	-5.7680	-1.0665
		DDwoR with limited opening	-4.67786*	0.61764	**0.000**	-6.4434	-2.9123
		DDwoR without limited opening	-2.84524*	0.79738	**0.005**	-5.1246	-0.5659
	DDwR	DDwR with intermittent locking	-0.15282	0.77105	1.000	-2.3569	2.0513
		DDwoR with limited opening	-1.41347	0.54748	0.110	-2.9785	0.1515
		DDwoR without limited opening	0.41915	0.74435	1.000	-1.7086	2.5469
	DDwR with intermittent locking	DDwoR with limited opening	-1.26065	0.82236	1.000	-3.6114	1.0901
		DDwoR without limited opening	0.57197	0.96467	1.000	-2.1856	3.3295
	DDwoR with limited opening	DDwoR without limited opening	1.83262	0.79738	0.232	-.4467	4.1120
JFLS-20 Communication	Normal	DDwR	-1.87388*	0.43180	**0.000**	-3.1082	-0.6396
		DDwR with intermittent locking	-2.57429*	0.64859	**0.001**	-4.4283	-0.7203
		DDwoR with limited opening	-2.49536*	0.48714	**0.000**	-3.8879	-1.1029
		DDwoR without limited opening	-0.97929	0.62889	1.000	-2.7770	0.8184
	DDwR	DDwR with intermittent locking	-0.70041	0.60813	1.000	-2.4388	1.0380

		DDwoR with limited opening	-0.62148	0.43180	1.000	-1.8558	0.6128
		DDwoR without limited opening	0.89459	0.58707	1.000	-0.7836	2.5728
	DDwR with intermittent locking	DDwoR with limited opening	0.07893	0.64859	1.000	-1.7751	1.9330
		DDwoR without limited opening	1.59500	0.76084	0.381	-0.5799	3.7699
	DDwoR with limited opening	DDwoR without limited opening	1.51607	0.62889	0.174	-0.2816	3.3138
JFLS-20 Global	Normal	DDwR	-2.56981*	0.38737	**0.000**	-3.6771	-1.4625
		DDwR with intermittent locking	-2.61070*	0.58185	**0.000**	-4.2739	-0.9475
		DDwoR with limited opening	-3.23583*	0.43701	**0.000**	-4.4850	-1.9866
		DDwoR without limited opening	-1.97048*	0.56417	**0.007**	-3.5832	-0.3578
	DDwR	DDwR with intermittent locking	-0.04089	0.54555	1.000	-1.6004	1.5186
		DDwoR with limited opening	-0.66602	0.38737	0.881	-1.7733	0.4413
		DDwoR without limited opening	0.59934	0.52666	1.000	-0.9061	2.1048
	DDwR with intermittent locking	DDwoR with limited opening	-0.62513	0.58185	1.000	-2.2884	1.0381
		DDwoR without limited opening	0.64023	0.68254	1.000	-1.3109	2.5913
	DDwoR with limited opening	DDwoR without limited opening	1.26536	0.56417	0.267	-0.3474	2.8781
Pain VAS Score	Normal	DDwR	-2.87245*	0.51969	**0.000**	-4.3580	-1.3869
		DDwR with intermittent locking	-3.69805*	0.78061	**0.000**	-5.9295	-1.4666
		DDwoR with limited opening	-5.42857*	0.58629	**0.000**	-7.1045	-3.7526
		DDwoR without limited opening	-4.94048*	0.75690	**0.000**	-7.1041	-2.7768
	DDwR	DDwR with intermittent locking	-0.82560	0.73191	1.000	-2.9178	1.2666
		DDwoR with limited opening	-2.55612*	0.51969	**0.000**	-4.0417	-1.0706
		DDwoR without limited opening	-2.06803*	0.70657	**0.041**	-4.0878	-0.0483
	DDwR with intermittent locking	DDwoR with limited opening	-1.73052	0.78061	0.285	-3.9619	0.5009
		DDwoR without limited opening	-1.24242	0.91570	1.000	-3.8600	1.3752
	DDwo with limited opening	DDwoR without limited opening	0.48810	0.75690	1.000	-1.6755	2.6517

The relationship between the parameters was evaluated with the Pearson Correlation test. A statistically significant positive correlation was observed between all parameters including JFLS-20 scores and pain scores (Table 4) (p<0,0001).

Table 4. Evaluation of the relationship between parameters with Pearson Correlation test

		JFLS-20 Mastication	JFLS-20 Mobility	JFLS-20 Communication	JFLS-20 Global	Pain VAS Score
JFLS-20 Mastication	r	1	0.658*	0.653*	0.843*	0.451*
	p		0.000	0.000	0.000	0.000
JFLS-20 Mobility	r	0.658*	1	0.553*	0.828*	0.530*
	p	0.000		0.000	0.000	0.000
JFLS-20 Communication	r	0.653*	0.553*	1	0.861*	0.466*
	p	0.000	0.000		0.000	0.000
JFLS-20 Global	r	0.843*	0.828*	0.861*	1	0.551*
	p	0.000	0.000	0.000		0.000
Pain VAS Score	r	0.451*	0.530*	0.466*	0.551*	1
	p	0.000	0.000	0.000	0.000	

*. Correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

Disc displacement, which is a common type of TMD, can lead to many jaw dysfunctions, such as joint sounds, pain, and limited movement.[7,9,10] This study aimed to investigate the impact of different types of disc displacement on jaw functions in patients suffering from TMD. The study had two hypotheses, the first of which stated that individuals with disc displacement would have more limited jaw functions than those without TMD, while the second hypothesis predicted that different types of disc displacement would affect jaw functions to

varying degrees. Although the results supported the first hypothesis, the second hypothesis was rejected.

Regarding limitations in jaw function (JFLS-20), there were statistically significant differences between the control group and the disc displacement groups. Participants in the control group had lower scores throughout the questionnaire, indicating no functional limitations in their jaw movements. Conversely, the disc displacement groups had scores over 4 times higher than the healthy control group, indicating a functional limitation, although they did not completely lose their vertical jaw movements. Analysis of the JFLS-20 chewing scores showed that chewing hard foods was challenging for these patients, while they reported less difficulty chewing soft foods. There was no significant difference in functional limitation between the disc displacement groups, regardless of the type of disc displacement, with or without reduction.

Regarding pain scores, which are one of the most important clinical findings in patients with TMD [11,12], patients with DDwR had significantly less pain than patients with DDwoR. However, pain in the 'DDwR with intermittent locking' group, which is a transitional phase from DDwR to DDwoR[6,7], did not differ from the other groups. It is important to investigate the intermittent locking status in patients with DDwR during clinical examination and, if present, evaluate the necessary treatment protocols to prevent the problem from progressing further.

In the literature, most studies on TMDs or disc displacements have typically assessed jaw function using quantitative parameters such as pain, maximal mouth opening, and lateral range of motion.[13–16] However, it is important to consider that jaw function involves more than just these quantitative parameters. Eating, drinking, laughing, and talking are all integral parts of social life that involve jaw movements. Therefore, it was considered important to evaluate the social aspect of jaw function using the questions in the JFLS-20 questionnaire in this study, as it is a suitable tool for this purpose. The questionnaire allowed us to evaluate the limitations in jaw function experienced by patients with TMDs in a more comprehensive manner.

Ohrbach et al. [8] and Lövgren et al. [17] reported higher JFLS-20 results and pain scores in the group with chronic TMD, similar to our study, in their study comparing the clinical findings of patients with chronic TMD with the control group. Kim and Kim [18] evaluated patients with TMD in three groups as patients with muscle, joint, and muscle-joint combined disorders and reported that there was no significant difference between the JFLS-20 scores of these patients. In other studies using the JFLS-20 scoring, it has been reported that patients with TMD have higher scores than healthy individuals.[19–21] In these studies, TMD was generally evaluated as a single disorder, and the analyses were not detailed by examining the subtypes of disc displacement. In their meta-analysis study, Dinsdale et al. [22] evaluated jaw range of motion, muscle function, and proprioception impairment in patients with permanent TMD and reported that these factors may be related to TMD, but there is uncertainty in subgroups of TMD and new studies are needed in this area.

This study has several limitations. The first limitation, the type of disc displacement, was determined using the DC/TMD instrument only. Magnetic resonance imaging could be used for definitive diagnosis, but no additional radiological diagnosis was made, as previous studies [1,3,7] have confirmed that DC/TMD is a rapid and reliable tool for the clinical diagnosis of disc displacements.[7] The second limitation was the limitation of jaw functions, which was determined by the patients' self-scores. This may have caused the patient to give more restraint or pain scores than their current condition. In order to

minimize this effect, the questionnaires were explained to the patient in detail and a long time frame was given for scoring without any time limit.

CONCLUSION

As a result, it was observed that individuals with disc displacement experience restricted jaw functions, and this limitation is not affected differently by the various subtypes of disc displacement. Furthermore, the pain status may vary depending on the type of disc displacement. To determine the level at which subtypes of temporomandibular disorders affect jaw functions and to identify potential differences between them, it is recommended to conduct large-scale studies that include all subtypes of temporomandibular disorders.

Ethical Approval

This study was approved by Tokat Gaziosmanpaşa University Clinical Research Ethics Committee on 02.03.2023 with ethics committee number 23-KAEK-037.

Financial Support

No financial support was received from any institution or organization for this study.

Conflict of Interest

The authors declare that they have no competing interests.

Author Contributions

Design: YB, Data collection or data entry: YB, Analysis and interpretation: YB, Literature review: YB, Writing: YB.

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NEU PRESS

Diş Hekimliği Dergisi

Vol: 1 No: 1 Year: 2024 | Research Article | e-ISSN: 2687-5535

https://doi.org/10.51122/neudentj.2024.87

An Evaluation of Oral Hygiene Habits of Children in the Post-Earthquake Period in Malatya Province

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Article Info

Article History

Received: 15.08.2023
Accepted: 15.01.2024
Published: 30.04.2024

Keywords:
Children,
Earthquake,
Brushing Teeth,
Oral Hygiene Habits.

ABSTRACT

Aim: This cross-sectional study aimed to evaluate the oral hygiene habits of children in the post-earthquake period in Malatya.

Material and Methods: Three hundred parents presented to Inonu University Department of Pediatric Dentistry for examination/treatment participated in this study. The survey consists of a total of 18 questions. Descriptive statistical methods were used when evaluating the study data. The Chi-square test was used to compare qualitative data. Significance was evaluated at $p<0.05$ level.

Results: 43.3% of the children participating in the study were brushing teeth once a day before the earthquake, 40.3% were brushing teeth rarely, 15% were brushing twice or more a day, and 1.3% were not brushing at all. After the earthquake, the rate of brushing teeth once a day was 31.3%, the rate of brushing teeth twice a day or more was 13%, the rate of rarely brushing teeth was 50%, and the rate of not brushing at all was 5.7%. The decrease in tooth brushing habits of children whose housing changed after the earthquake (30.8%) was statistically significantly higher than that of children whose housing did not change (20%) ($p:0.027$; $p< 0.05$).

Conclusion: As a result of this study, it was observed that children's oral hygiene habits unfortunately decreased or disappeared as their housing conditions changed. Appropriate living conditions should be provided for children as soon as possible after natural disasters, and oral hygiene habits should be restarted.

Malatya İlinde Deprem Sonrası Süreçte Çocukların Oral Hijyen Alışkanlıklarının Değerlendirilmesi

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 15.08.2023
Kabul Tarihi: 15.01.2024
Yayın Tarihi: 30.04.2024

Anahtar Kelimeler:
Çocuklar,
Deprem,
Diş Fırçalama,
Oral Hijyen Alışkanlıkları.

ÖZET

Amaç: Bu kesitsel çalışma, Malatya ilinde deprem sonrası süreçte çocukların oral hijyen alışkanlıklarını değerlendirmeyi amaçlamıştır.

Gereç ve Yöntemler: Bu çalışmaya İnönü Üniversitesi Çocuk Diş Hekimliği Anabilim Dalı'na muayene/ tedavi için başvuran 300 ebeveyn katılmıştır. Anket formları ebeveynlere elden verilmiştir. Anket toplam 18 sorudan oluşmaktadır. Çalışma verileri değerlendirilirken tanımlayıcı istatistiksel metodlar kullanılmıştır. Niteliksel verilerin karşılaştırılmasında ise Ki-Kare testi kullanılmıştır. Anlamlılık $p<0,05$ düzeyinde değerlendirilmiştir.

Bulgular: Çalışmaya katılan çocukların deprem öncesi %43,3'ü günde 1 kez, %40,3'ü nadiren, %15'i günde 2 ve üzeri kez dişlerini fırçalıyorken, %1,3'ü hiç fırçalamıyordu. Deprem sonrası günde 1 kez diş fırçalama oranı %31,3, günde 2 ve üzeri kez fırçalama oranı %13, nadiren fırçalama %50 ve hiç fırçalamama oranı %5,7'di. Deprem sonrası yaşam alanı değişen çocukların deprem sonrası diş fırçalama alışkanlığında azalma görülme oranı (%30,8), yaşam alanı değişmeyen çocuklardan (%20) istatistiksel olarak anlamlı düzeyde yüksek bulunmuştur. ($p:0,027$; $p<0,05$).

Sonuç: Bu çalışmanın sonucunda çocukların yaşam alanları ve koşulları değiştiği için oral hijyen alışkanlıklarının da maalesef azaldığı yada kaybolduğu görülmüştür. Doğal afetlerden sonra en yakın sürede çocuklar için uygun yaşam koşulları sağlanarak oral hijyen alışkanlıkları oluşturmaya tekrar başlanmalıdır.

To cite this article:
Gümüşboğa ZŞ. An Evaluation of Oral Hygiene Habits of Children in the Post-Earthquake Period in Malatya Province. NEU DENT J. 2024;6:39-47. https://doi.org/10.51122/neudentj.2024.87

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INTRODUCTION

An earthquake is a natural phenomenon causing loss of life and property and cannot be predicted in terms of the area it will affect and the magnitude of its impact.[1] Earthquakes are among the most common natural disasters.[2] The extent of the impact of earthquakes is more than we can imagine. Especially earthquakes experienced during childhood cause physical and psychological changes in children in various ways. Respiratory system problems, skeletal and muscular problems, digestive system disorders, and sleep-related problems have been observed in children affected by the earthquake.[3] In addition, difficulties in accessing sufficient food and clean water, inadequate hygiene conditions, increase in infectious diseases, difficult access to health services, shortage of temporary housing, and overcrowded shelters are among the problems experienced by both adults and children after the earthquake.[4]

On February 6, 2023, two major earthquakes occurred nine hours apart in Türkiye. As a result of these earthquakes, a significant amount of damage and destruction occurred in 11 provinces including Hatay, Gaziantep, Elazığ, Osmaniye, Şanlıurfa, Diyarbakır, Kilis, Kahramanmaraş, Adıyaman, Malatya, and Adana. Due to the severity of the earthquake, these provinces suffered from shelter shortages, inadequate hygiene conditions, difficulties in obtaining food and clean water, and overcrowded shelters for a certain period of time.

Today, all cleaning practices to protect health are called hygiene. The most important hygiene practices are personal hygiene practices.[5] One of the personal hygiene practices is oral hygiene habits.[6] Tooth brushing is one of the oral hygiene habits that significantly reduce the possibility of caries formation. It has been reported that individuals who acquire the habit of brushing teeth twice a day at an early age have fewer dental caries.[7] The adoption of these oral hygiene habits acquired in childhood starts with parents at home and continues for a lifetime.[8] In the literature, it has been observed that earthquakes have a negative effect on oral/dental health due to disruption of oral hygiene habits.[9-12]

Natural disasters cause many changes in the lives of individuals, especially children. Children may have difficulty in maintaining many habits they acquired before the earthquake (reading, tooth brushing, eating habits, change in sleeping hours, etc.), especially hygiene habits, after the earthquake or they may lose these existing habits.[13] Our study aimed to obtain information about the conditions under which children in Malatya province maintain their oral hygiene habits in the post-earthquake period and to evaluate the change in children's oral hygiene habits after the earthquake.

MATERIALS AND METHODS

Ethics committee approval for this study was obtained from Inonu University Non-Interventional Clinical Research Ethics Committee (Ethics number: 2023/4633).

Parents and their children presented to Inonu University Department of Pediatric Dentistry for examination/treatment between 09.05.2023 and 09.07.2023 and declared that they had experienced the earthquake were included in the study. A total of 300 parents participated in the study. With 95% confidence (1-α), 95% test power (1-β), and an effect size of g=-0.093, the minimum sample size was calculated as 153 people. Signed consent forms were obtained from the patients' parents before the study.

Earthquake-affected children and their parents who agreed to fill out the questionnaire and could read and write were included in the study. Earthquake-affected children and their illiterate parents who refused to fill in the questionnaire form, and children who were not affected by the earthquake and their parents were not included in this study.

The questionnaire form, which consisted of 18 questions in total, consisted of two parts. The first part of the questionnaire included 11

questions about the sociodemographic characteristics of the parent and child (gender, age, education level, income level, place of residence (before and after the earthquake), place of living (before and after the earthquake), number of people in the place of residence). The second part of the questionnaire included 7 questions about children's oral hygiene habits (whether they had toothbrush and toothpaste (before and after the earthquake), brushing habits (before and after the earthquake), reason for not brushing in the post-earthquake period). The questions in the questionnaire were prepared to evaluate the oral hygiene habits of children in the post-earthquake period.

The questionnaires were handed to the parents and they filled them in. Considering that the questions in the questionnaire form may remind children of the earthquake, the questionnaires were given to the parents in an environment where their children were not present.

Statistical Analysis

While evaluating the findings obtained in the study, IBM SPSS Statistics 22 program was used for statistical analysis. In addition to descriptive statistical methods (mean, standard deviation, frequency), the Kruskal Wallis test was used for comparisons of quantitative data between groups. The Chi-Square test was used for the comparison of qualitative data. Significance was evaluated at $p<0.05$ level.

RESULTS

The study was conducted in a total of 300 children aged between 2 and 14 years and their parents. The mean age of the children was 8.65±1.57 years.

Of the children, 50.7% were female and 49.3% were male. The majority of the parents were mothers (67.7%) and fathers (25.7%). The income and education levels of the parents are shown in detail in the table below (Table 1).

Table 1. Demographic information

		n	%
Sex	Female	152	50.7
	Male	148	49.3
Parent	Mother	203	67.7
	Father	77	25.7
	Other	20	6.6
Income Level	<8.500 TL	187	62.3
	8.500-17.000 TL	93	31.0
	>17.000 TL	20	6.7
Education Level	Primary School	103	34.3
	Middle School	74	24.7
	High School	76	25.3
	University	42	14
	Postgraduate	5	1.7
Number of people in the place of residence Min-Max. Mean±SD (median)		1-31	5.7±2.8 (5)

The number of people in the residence varied between 1 and 31, with a mean of 5.7±2.8 and a median of 5 (Table 1).

Pre- and post-earthquake housing places of the parents are presented in Table 2. Forty percent of the parents had to change their accommodation after the earthquake. (Table 2)

Information on children's toothbrush and toothpaste ownership and tooth brushing habits before and after the earthquake is shown in Table 3. After the earthquake, tooth brushing habits of 24.3% of the children decreased after the earthquake (Table 3).

Table 2. Information on housing

		n	%
Pre-earthquake housing	Flat	178	59.3
	Detached house/Garden house	122	40.7
Post-earthquake housing	Flat	117	39
	Detached house/Garden house	104	34.7
	Container	30	10
	Tent	33	11
	No permanent place of accommodation	16	5.3
Change of accommodation after the earthquake	Housing changed	120	40
	Housing not changed	180	60
Pre-earthquake residence	City	188	62.7
	Town	64	21.3
	Village	46	15.3
	Another city	2	0.7
Post-earthquake residence	City	155	51.7
	Town	66	22
	Village	77	25.7
	Another city	2	0.7

Table 3. Information on tooth brushing habits

		n	%
Whether the child had their own toothbrush and toothpaste before the earthquake	Yes	290	96.7
	No	10	3.3
Whether the child had their own toothbrush and toothpaste after the earthquake	Yes	274	91.3
	No	26	8.7
Receiving toothbrushes and toothpaste for children from anywhere after the earthquake	Yes	123	41
	No	167	55.7
	Does not think it is necessary	10	3.3
Obtaining a toothbrush and toothpaste for their child with their own means after the earthquake	Yes	240	80
	No	55	18.3
	Does not think it is necessary	5	1.7
Child's tooth brushing habits before the earthquake	Once a day	130	43.3
	Twice a day or more	45	15
	Seldom	121	40.3
	None	4	1.3
Child's tooth brushing habits after the earthquake	Once a day	94	31.3
	Twice a day or more	39	13
	Seldom	150	50
	None	17	5.7
Change in tooth brushing habits after the earthquake	Decreasing	73	24.3
	Already low	181	60.3
	Other	46	15.3
Reason for Change (n=254)	Lack of Access to clean water	55	21.7
	No toothbrush and paste	13	5.1
	The environment is not suitable	29	11.4
	No dental complaints	23	9.1
	Not required	5	2.0
	Couldn't make it a habit	44	17.3
	Other	85	33.5

There was no statistically significant difference between the change in the child's tooth brushing habits after the earthquake according to the type of residence ($p>0.05$). Tooth brushing habits of 21.4% of children living in flats, 19.2% of children living in detached houses, 26.7% of children living in containers, 42.4% of children living in tents, and 37.5% of children living without a permanent shelter decreased after the earthquake (Table 4).

Table 4. The relationship between post-earthquake living space and change in tooth brushing habits for children after the earthquake

		Place of residence after the earthquake					
		Flat	**Detached house/ Garden house**	**Container**	**Tent**	**No permanent accommodation**	
		n (%)	**n (%)**	**n (%)**	**n (%)**	**n (%)**	**p**
Change in tooth brushing habits after the earthquake	Declining	25 (%21.4)	20 (%19.2)	8 (%26.7)	14 (%42.4)	6 (%37.5)	
	Already low	70 (%59.8)	67 (%64.4)	17 (%56.7)	17 (%51.5)	10 (%62.5)	0.102
	Other	22 (%18.8)	17 (%16.3)	5 (%16.7)	2 (%6.1)	0 (%0)	

*Chi-square test *p<0.05*

The rate of decrease in tooth brushing habits of children whose living space changed after the earthquake (30.8%) was statistically significantly higher than that of children whose living space did not change (20%) (p:0.027; p<0.05). (Table 5)

Table 5. The relationship between the change in living space after the earthquake and the change in tooth brushing habits for children after the earthquake

		Living space after the earthquake		
		Change in housing	**No change in housing**	
		n (%)	**n (%)**	**p**
Change in tooth brushing habits after the earthquake	Declining	37 (%30.8)	36 (%20.0)	
	Already low	71 (%59.2)	110 (%61.1)	0.027*
	Other	12 (%10.0)	34 (%18.9)	

*Chi-square Test *p<0.05*

The rates of lack of access to clean water (42.5%) and unsuitable environment (21.9%) were significantly higher in children with decreased tooth brushing habits after the earthquake (p:0.001; p<0.05) compared to children with normal tooth brushing habits (Table 6).

There is a statistically significant difference between the type of residence and the reason for not brushing teeth after the earthquake (p:0.001; p<0.05). The rate of change in tooth brushing habits of those living in tents due to lack of access to clean water (32.3%) is significantly higher than those living in detached houses (14.9%). The rate of change in tooth brushing habits due to inappropriate environment among those living without a permanent shelter (31.3%) was significantly higher than those living in flats (3.2%) and detached houses (10.3%) (Table 7).

Table 6. Evaluation of the reasons according to the change in tooth brushing habits after the earthquake

	Tooth brushing habits after the earthquake		
	Declining	**Already low**	
Reason	**n (%)**	**n (%)**	**p**
Lack of access to clean water	31 (%42.5)	24 (%13.3)	
No toothbrush and paste	7 (%9.6)	6 (%3.3)	
The environment is not suitable	16 (%21.9)	13 (%7.2)	
No dental complaints	8 (%11)	15 (%8.3)	0.001*
Not required	2 (%2.7)	3 (%1.7)	
Couldn't make it a habit	6 (%8.2)	38 (%21)	
Other	3 (%4.1)	82 (%45.3)	

*Chi-square test *p<0.05*

Table 7. Evaluation of the causes by living area after the earthquake

REASON	Flat	Detached house/ Garden house	Container	Tent	No permanent housing	
	n (%)	n (%)	n (%)	n (%)	n (%)	p
Lack of access to clean water	23 (%24.2)	13 (%14.9)	5 (%20)	10 (%32.3)	4 (%25)	
No toothbrush and paste	3 (%3.2)	4 (%4.6)	2 (%8)	3 (%9.7)	1 (%6.3)	
The environment is not suitable	3 (%3.2)	9 (%10.3)	6 (%24)	6 (%19.4)	5 (%31.3)	0.001*
No dental complaints	6 (%6.3)	13 (%14.9)	2 (%8)	1 (%3.2)	1 (%6.3)	
Not required	0 (%0)	0 (%0)	1 (%4)	2 (%6.5)	2 (%12.5)	
Couldn't make it a habit	21 (%22.1)	20 (%23)	1 (%4)	2 (%6.5)	0 (%0)	
Other	39 (%41.1)	28 (%32.2)	8 (%32)	7 (%22.6)	3 (%18.8)	

Chi-square test *$p<0.05$

DISCUSSION

Our oral and dental health constitutes an important part of our general health. The importance given by parents to oral hygiene and their attitudes towards oral hygiene play a major role in children having better oral and dental health and acquiring oral hygiene habits. By creating an environment suitable for a healthy life for their children, parents increase the child's self-confidence and help to form oral hygiene habits.[14] The occurrence of unpredictable natural disasters (earthquakes, floods, hurricanes, fires, etc.) may cause people to change their living spaces, and parents may not be able to provide the appropriate environment for their children.[15]

Forty percent of the buildings in the 11 provinces affected by the Kahramanmaraş earthquakes of magnitude 7.8 and 7.5 Mw on February 6 were damaged or destroyed to varying degrees. Due to these damages and destructions, many people had to leave the province for a certain period of time for shelter and had to continue their lives in tents, containers, or dormitories.[15]

In studies examining the impact of natural disasters on oral and dental health, especially the shelter status of individuals after the earthquake has been questioned.[16] In this study, the shelter of the parents participating in the questionnaire was questioned and it was observed that 10% of the parents stayed in containers, 11% in tents, and 5.3% did not have a permanent shelter. It was calculated that the average number of people residing in the same residence was 5.7±2.8 people.

People living in tents, containers, dormitories, and public facilities may suffer from poor oral and dental health due to the change of living environment. Worsening economic conditions as a result of natural disasters, water shortages, lack of clean water, interrupted access to preventive and emergency dental care, increased consumption of high-carbohydrate and processed packaged foods that can lead to caries development in children and adults, periodontitis due to infection, and poor oral hygiene can lead to dental caries, toothache, and even tooth loss. As a result, natural disasters can directly or indirectly affect people's oral and dental health-related quality of life (OHRQoL) by severely damaging their social relationships.[9]

The basic principle of prevention of dental caries and gingival diseases, which are common in children, is regular tooth brushing habits.[17] Tseveenjav et al. reported that adequate tooth brushing habits significantly reduce the formation of new caries and that a daily brushing frequency of less than twice a day is risky for the protection of oral health.[18] In a study examining the oral and dental health of children aged 7-14 years in Malatya province, it was found that children did not comply with the recommended brushing frequency, the rate of those who brushed their teeth twice a day or more was as low as 31%, and the rate of children who reported brushing their teeth once a day was 24.2%. The rate of children who reported never brushing their teeth was 7.9%.[19] In another study conducted in Malatya province, it was found that the frequency of tooth brushing of children was

12.8% who brushed their teeth twice a day or more, 36.8% who brushed their teeth once a day, 40.8% who rarely brushed their teeth, and 9.6% who never brushed their teeth.[20] In this study, it was determined that only 15% of the children brushed their teeth twice a day or more before the earthquake, and the remaining children brushed their teeth once a day (43.3%), rarely (40.3%), or never (1.3%). The results of this study and previous studies conducted in Malatya show that the tooth brushing habits of children in Malatya are inadequate and that parents do not give enough importance to oral and dental health.

Although there is limited evidence in studies examining the impact of natural disasters on oral and dental health, it has been suggested that earthquakes, one of the natural disasters, have a negative impact on oral and dental health.[9-12] In a study conducted 4 months after the 7.8 magnitude earthquake in Nepal in 2015, it was reported that people's tooth decay and gum condition was poor and worsened to varying degrees and that 4% of people never brushed their teeth after the earthquake and 28.4% rarely brushed their teeth.[12] In this study, it was found that 5.7% of the children never brushed their teeth after the earthquake and 50% rarely brushed their teeth. At the same time, 24.3% of the children had a decrease in brushing habits after the earthquake. There is no study in the literature comparing tooth brushing habits of individuals and/or children before and after natural disasters. The rate of decrease in tooth brushing habits of children whose housing state changed after the earthquake was found to be statistically significantly higher than children whose housing state did not change ($p<0.05$). This result showed that oral hygiene habits of children whose housing state changed decreased.

After the October 23, 2011 Van earthquake, Kalanlar (2016) published a study titled "Lessons Learned from the Van Earthquake in the Context of Urban Environment and Health" and stated that the health and hygiene conditions of the Van earthquake disaster victims were not supported very well and this issue was neglected. It was observed that women, the elderly, and children were the groups that suffered the most in this regard. It was stated that disaster managers were insufficient in meeting the needs of women and children.[21] One study reported that after the earthquakes in Haiti in 2010 and Japan in 2011, oral care products such as toothbrushes, toothpaste, denture cleaners, etc. were provided to disaster victims and oral health outcomes were reported in the immediate aftermath.[10] In this study, 41% of the parents reported that toothpaste and toothbrushes were provided for themselves or for their children after the earthquake.

Clean water is one of the most important issues to be addressed immediately after earthquakes. The water source should be thoroughly inspected and treated before supplying water to the network in affected housings. It is especially important to make sure that the water supply is not contaminated with chemical waste. After an earthquake, it is useful to chlorinate the water in the system.[22]

After the 2011 Great East Japan Earthquake, Hosokawa et al. reported that elderly people were reluctant to wash their dentures due to insufficient water supply, but the authors did not report any quantitative data on this issue.[10] In this study, 21.7% of the parents stated that the reason for their children not brushing or hesitating to brush their teeth was lack of access to clean water. It was observed that especially those living in tents had more difficult access to clean water. Twenty-nine (11.4%) parents stated that the place of shelter was not suitable for their children to brush their teeth, and 44 (17.3%) parents stated that their children did not have regular tooth brushing habits before the earthquake.

Due to the unpredictability of the timing and magnitude of earthquakes and limited data on their aftermath, it is difficult to study and analyze their direct impact on oral and dental health. Despite the limited evidence, this study suggests that earthquakes tend to negatively affect oral and dental health.

When the literature on the subject was examined, no study examining oral hygiene habits after the earthquake was found in Türkiye. When the studies conducted outside Türkiye were examined, it was seen that there exist few studies on this subject.[9-12]

In conclusion, in this study, it was determined that the living spaces and oral hygiene habits of most of the children living in Malatya changed after the earthquake.

CONCLUSION

To maintain and improve oral and dental health status after natural disasters, it is important to reintroduce dental clinic visits and for dentists to encourage their patients to re-establish oral hygiene habits after natural disasters. For the health of individuals, access to clean water should be ensured as soon as possible. At the same time, children and adults should be helped to establish oral hygiene habits by creating a healthy living environment. Care should be taken to include materials for oral hygiene (toothbrush, toothpaste, dental floss, denture cleaner, mouthwash, etc.) in aid packages.

There is a need for more research with robust evidence that contributes to the protection and improvement of oral and dental health after disasters in Türkiye as well as the rest of the world.

Acknowledgment

We would like to thank all participants for their contribution to this research.

Ethical Approval

Ethics committee approval for this study was obtained from Inonu University Non-Interventional Clinical Research Ethics Committee (Ethics number: 2023/4633).

Financial Support

No financial support was received from any institution or organization for this study.

Conflict of Interest

There is no conflict of interest in this study.

Author Contributions

Design: ZŞG Data collection and data entry: ZŞG Analysis and interpretation: ZŞG Literature review: ZŞG, Writing: ZŞG

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NEU PRESS

Diş Hekimliği Dergisi

Vol: 1 No: 1 Year: 2024 | Research Article | e-ISSN: 2687-5535

https://doi.org/10.51122/neudentj.2024.88

Perceptions and Surgical Approaches of Periodontists and Residency Students for Bone Augmentation Procedures

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Article Info

Article History

Received: 30.08.2023
Accepted: 05.02.2024
Published: 30.04.2024

Keywords:
Biomaterial,
Bone Regeneration,
Defect,
Implant.

ABSTRACT

Aim: Bone deficiency due to various systemic and periodontal diseases, trauma, and tumors remains a major challenge for osseointegration in implant therapies. To provide implant survival, sufficient bone volume is mandatory. The purpose of the present study is to assess the techniques used by periodontists in implant applications, treatment plans, and solutions to the complications they experience.

Material and Methods: 126 periodontists and/or residency students participated in this study. A questionnaire consisting of 20 questions was used. The knowledge and treatment methods about the technique, materials, and planning they use in bone regeneration and the management of complications were questioned. Descriptive statistics and the Pearson Chi-square test were used to analyze the data.

Results: All participants needed bone regeneration in implant cases. The most used material for regeneration by the participants was xenograft, with 43.5%. The most preferred application in bone regeneration is guided bone regeneration (GBR) using the collagen membrane, with a rate of 78.3%. The most common complication was membrane exposure. In order to prevent complications, 77.3% of the participants performed adequate soft tissue release, while 63.6% controlled periodontitis. The most commonly used treatment option for complications was the use of postoperative antibiotics/antiseptics. 82.6% of the participants received support in the management of complications.

Conclusion: In our study, it was observed that periodontists frequently chose different planning methods and treatment options when performing bone reconstruction/regeneration. It will be beneficial for periodontists to include the latest treatment models applied in the current literature in periodontology residency education.

Periodontoloji Uzmanlarının ve Uzmanlık Öğrencilerinin Kemik Ogmentasyonu Açısından Algıları ve Cerrahi Yaklaşımları

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 30.08.2023
Kabul Tarihi: 05.02.2024
Yayın Tarihi: 30.04.2024

Anahtar Kelimeler:
Biyomateryal,
Defekt,
Implant,
Kemik
Rejenerasyonu.

ÖZET

Amaç: Sistemik ve periodontal hastalıklar, travma ve tümörlerden dolayı oluşan kemik kaybı veya yetersizliği, dental implantların osseointegrasyonu için büyük bir zorluk yaratmaktadır. İmplant sağkalımını sağlamak için yapılan bölgelerde yeterli kemik hacmi bulunmalıdır. Çalışmamızın amacı; periodontoloji uzmanlarının, implant uygulamalarında kullandıkları teknikleri, tedavi planlarını ve yaşadıkları komplikasyonlar karşısındaki çözüm yollarını değerlendirmektir.

Gereç ve Yöntemler: Çalışmaya, 126 periodontoloji uzmanı ve/veya uzmanlık öğrencisi katılmıştır. İmplant uygulamaları ve kemik rejenerasyonu ile ilgili 20 sorudan oluşan anket uygulanmıştır. Kemik rejenerasyonunda ve oluşan komplikasyonların yönetilmesi için kullanılan teknikler, malzemeler ve planlama hakkındaki bilgi ve yöntemler sorgulanmıştır. Veriler tanımlayıcı istatistik ve Pearson Ki kare testi ile analiz edilmiştir.

Bulgular: Tüm katılımcıların dental implant uygulamalarında kemik rejenerasyonuna ihtiyacı olmaktadır. Rejenerasyon için en çok kullandığı materyal ksenogrefttir (%43,5). Kemik rejenerasyonunda en çok tercih edilen uygulama, kollajen membran ile yönlendirilmiş kemik rejenerasyonudur (YKR) (%78,3). En sık karşılaşılan komplikasyon, membran ekspozürüdür. Komplikasyonları önlemek adına, katılımcıların %77,3'ü yeterli yumuşak doku serbestleştirmesini yaparken, %63,6'sı periodontitis kontrolü yapmaktadır. Komplikasyon yaşandığında en çok kullanılan tedavi seçeneği postoperatif antibiyotik/antiseptik kullanımıdır. Oluşan komplikasyon yönetiminde, katılımcıların %82,6'sı destek almaktadır.

Sonuç: Çalışmamızda periodontoloji uzmanlarının sıkça kemik rekonstrüksiyonu/ rejenerasyonu uygularken farklı planlama şekli ve tedavi seçeneklerini seçtikleri görülmüştür. Tedavi yaklaşımları vakaya göre değişebileceğinden, periodontoloji uzmanlık eğitiminde güncel literatürde uygulanan en son tedavi modellerinin yer alması periodontoloji uzmanları için faydalı olacaktır

To cite this article:
Lektemur-Alpan A. & Torumtay-Cin G. Perceptions and Surgical Approaches of Periodontists and Residency Students for Bone Augmentation Procedures. NEU Dent J. 2024;6:48-59. https://doi.org/10.51122/neudentj.2024.88

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INTRODUCTION

Osseointegrated dental implants are an important tool in dentistry and are used to support many different configurations, from single missing teeth to complete dentures. Periodontal destruction, traumatic tooth extractions, and bone loss due to the long-term use of removable dentures are the most important reasons that prevent implants from being placed in the ideal position.[1] One problem frequently experienced in implant dentistry is the lack of bone required for implant installation according to standard procedures. To solve bone insufficiency, various clinical techniques have been established.[2] The treatment protocol applied to restore the lost bone tissue volume is called bone augmentation. Bone grafts and/or membranes are used in most of these methods. Selecting an appropriate graft material for augmentation requires knowledge of the material used in terms of biocompatibility, biodegradability, structural stability, availability, ease of use, and cost.[3]

Various complications can occur during or after bone augmentation procedures.[4] To minimize poor outcomes and failure, it is important to both understand and manage bone graft-related complications. The complications can either originate at the site where the bone graft was harvested or develop as secondary complications at the site of the graft. They can include injury to local anatomical structures such as the teeth, the nerves, the muscles, the vasculature, and possible sinus complications.[5, 6] In addition, graft exposure, resorption, and infection at the recipient site are also complications.[5, 6] In order to prevent such complications, the experience of the physician performing the technique, the systemic condition of the patient, and clinical and radiographic examination of the augmentation site are important. In Turkiye, there are two departments where implant application is given as a specialty course obligation. The first one is oral and maxillofacial surgery and the other is periodontology. Since the periodontology department includes operative procedures related to the gingiva, some specialists do not prefer advanced bone surgery applications and residents may be deficient in advanced bone surgery and complication management. With all this information, the aim of our study is to evaluate the methods used by periodontists and periodontology residents in planning bone augmentation, graft selection, causes of complications, and methods used to prevent them.

MATERIALS AND METHODS

The protocol of our study was approved by the Pamukkale University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee. The number of participants was determined with 95% confidence and 99.9% test power.[7] The duration of professional experience of the physicians was taken into account for power analysis. In our study, a total of 20 questions were asked to 126 periodontist/periodontology residency students about the number of years they have been practicing implants, the biomaterials they prefer in regenerative treatment, the bone augmentation methods they apply, and the diagnosis and treatment of complications they encounter. The questionnaire form is given in Table 1.

Table 1: Survey questions administered to physicians

Age?
23-29
30-39
40-49
50-59
Over 60 years old
Gender?
Female
Male
How many years have you been practicing in dentistry?
0-5 years
5-10 years

More than 10 years
In which institution do you work?
Dental Polyclinic
Private Dental Clinic
Oral and Dental Health Center/Government Hospital
University Hospital
Do you use dental implants?
Yes
No.
Do you need bone reconstruction and/or regeneration?
Yes
No.
How often do you perform bone reconstruction?
Every day
Every week
Every month
Several times a year
Never
What is the material you use most for regeneration?
Autogenous graft
Allograft
Xenograft
Alloplastic graft
Composite graft
What is your reason for choosing this material?
For clinical success
Because of its cost
Due to hand habit and ease of implementation
Because of the opinions of other physicians
Due to ease of transportation
Do you perform socket preservation procedures after tooth extraction?
Frequently
Rarely
Always
Do you perform procedures other than standard implant surgery?
Yes
No.
If no, why?
I did not need
I do not have enough practice
Avoiding complications
Due to the cost
I choose more minimally invasive methods (short implant, closed lift)
Which augmentation procedures do you prefer? (You can choose more than one)
Ramus/symphysis block
GBR collagen membrane
t/e/d-PTFE reconstruction
Tent screw
Bone ring
Sandwich technique
Khoury technique
Sausage technique
Lateral window sinus elevation
Titanium mesh
Split crest
Distraction osteogenesis
What is the most common complication you experience in the early period after bone augmentation? (You can choose more than one)
Soft tissue dehiscence
Implant failure
Infection
Bone fractures
Membrane exposure
Nerve damage
Sinus membrane perforation
Graft resorption
No complications

What is your preferred option to prevent such complications? (You can choose more than one option)
Systemic disease control
Periodontitis control
Smoking cessation
Choice of surgical method
3d radiography
Adequate soft tissue release
Preop soft tissue augmentation
Platelet-derived biological products
Preop antibiotic use
What are the procedures you have performed to overcome complications? (You can choose more than one)
Postop antibiotic/antiseptic use
Removal of the exposed portion of the graft
Autologous soft tissue graft
Complete removal of the graft/membrane
Re-suture the area
Irrigation with Chx
Do you get support when you face complications?
Yes
No.
Where/whom do you get support?
YouTube
Instagram
Experts/faculty members
Courses
Colleagues
Implant representative
Do you think periodontology specialty training is sufficient to perform advanced bone surgery?
Yes
No.
Do you follow developments in bone augmentation? Which resources do you benefit? (You can choose more than one)
No, I do not
Current literature
Training seminars
Hands-on courses
YouTube videos
Social media

Statistical Analysis

All data were analyzed using SPSS 21 (Statistical Package for the Social Sciences Inc., Chicago, IL, USA). Although descriptive statistical methods were used for the data analysis (frequency distributions, percentage distributions), the comparison of qualitative data was performed with the Pearson chi-square test. The significance value was taken as $p < 0.05$.

RESULTS

A total of 126 periodontists/ periodontology residents participated in our study. 52.2% of the participants were between the ages of 30-39, 21.7% between the ages of 40-49, and 13% between the ages of 23-29. 56.5% of the participants were male and 43.5% were female. 69.9% of the participants have been practicing dentistry for more than 10 years. More than half of the periodontists work in university hospitals (56.5%) and 26.1% work in private polyclinics. All participants stated to practice dental implant treatment and all of them need bone regeneration. 34.8% of periodontists reported performing bone regenerative procedures every week, 26.1% every month and 39.1% several times a year. The most commonly used materials for regeneration were xenograft (43.5%), autogenous graft (26.1%), allograft (13%), and alloplastic graft (8.7%) (Figure 1). The two most important reasons for periodontists to choose the graft material they used were the clinical success of the material with a rate of 30.4% and the ease of application with hand skill. The cost of the graft material was the reason for preference with a rate of 21.7%. The accessibility of the material was the reason for

preferring this material with a rate of 13%. When the regeneration materials used by participants and the reasons for choosing them were compared., the clinical success of the material was found to be significantly higher than the other reasons for preference in terms of autogenous graft use, while ease of application was significantly more preferred in allograft and xenograft use ($p < 0.05$) (Table 2).

Figure 1. Answers to the question of materials used for regeneration

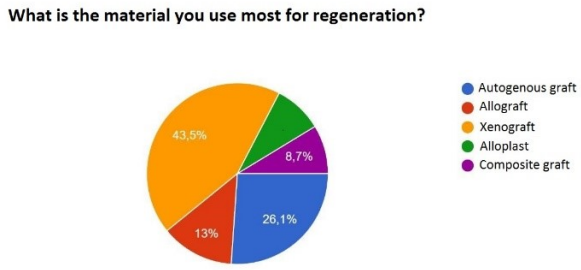


Table 2: Reasons for physicians' preference according to the regeneration material used

	Clinical success	Cost	Ease of application	Advice from other colleagues	Accessibility	Total
Autogenous graft	27(81.8%)[a]	0(0)[b]	3(9.1%)[b]	3(9.1%) [b]	0(0)[b]	33(100%)
Allograft	1(6.3%)[a]	3(18.8%) [a]	12(75.0%)[b]	0(0)[a,b]	0(0)[a]	16(100%)
Xenograft	6(10.9%)[a]	10(18.2%)[a]	30(54.5%)[b]	6(10.9%)[b]	3(5.5%)[a]	55(100%)
Alloplastic graft	1(9.1%)[a]	2(18,2%) [a]	1(9.1%)[a]	0(0)[a.b]	7(63.6%)[b]	11(100%)
Composite graft	2(18.2%)	2(18.2%)	1(9.1%)	0(0)	6(54.5%)	11(100%)

Data are presented as numbers and percentages (%). For data with different superscripts, $P < 0.05$ is statistically significant

Table 3: Comparison of the methods used by participants for bone augmentation according to their professional experience

	Ramus/ symphysis block	GBR/ collagen membrane	t/e/d PTFE	Tent screw	Bone ring	Sandwich technique	Khoury technical	Sausage technique	Lateral window Sinus elevation	Titanium mesh	Split crest	DO	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
0-5 years	13 (29.5%)	13 (13,1%)	0 (0)	13 (48.1%)	0 (0)	0 (0)	13 (34.2%)	0 (0)	13 (15.9%)	0 (0)	13 (%19,7)	0 (0)	13 (%10,3)
5-10 years	25 (56,8%)	25 (25,3%)	0 (0)	14 (51.9%)	0 (0)	11 (40.7%)	24 (65.8%)	0 (0)	25 (30.5%)	0 (0)	25 (%37,9)	0 (0)	25 (%19,8)
>10	6 (13,6%)	61 (61,6%)	33 (100%)	0 (0)	11 (100%)	16 (59.3%)	0 (0)	27 (100%)	44 (53.7%)	33 (100%)	28 (%42,4)	0 (0)	88 (%69,8)
Total	44 (34.9%)	99 (78.6%)	33 (26.2%)	27 (21.4%)	11 (8.7%)	27 (21.4%)	38 (30.2%)	27 (21.4%)	82 (65.1%)	33 (26.2%)	66 (%52,4)	0 (0)	126 (%100)

Data are presented as numbers and percentages (%)

Table 4: Preferred methods by the participants in terms of bone augmentation according to the institution they work.

	Ramus/ symphysis block	GBR collagen membrane	t/e/d-PTFE	Tent screw	Bone ring	Sandwich technique	Khoury technical	Sausage technique	Lateral window sinus elevation	Titanium mesh	Split crest	DO	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n(%)
Dental Polyclinic	2 (4.5%)	25 (25.3%)	8 (24.2%)	2 (7.4%)	7 (63.6%)	0 (0)	2 (5.3%)	22 (81.5%)	25 (30.5%)	7 (21.2%)	10 (15.2%)	0 (0)	33 (26.2%)
Private Dental Clinic	1 (2.3%)	5 (5.1%)	9 (27.3%)	1 (3.7%)	3 (27.3%)	0 (0)	1 (2.6%)	3 (11.1%)	4 (4.9%)	5 (15.2%)	4 (6.1%)	0 (0)	13 (10.3%)
ODHC/ State Hospital	2 (4.5%)	8 (8.1%)	4 (12.1%)	2 (7.4%)	0 (0)	3 (11.1%)	2 (5.3%)	0 (0)	5 (6.1%)	3 (9.1%)	5 (7.6%)	0 (0)	9 (7.1%)
University Hospital	39 (88.6%)	61 (61.6%)	12 (36.4%)	22 (81.5%)	1 (9.1%)	24 (88.9%)	33 (86.8%)	2 (7.4%)	48 (58.5%)	18 (54.5%)	47 (71.2%)	0 (0)	71 (56.3%)
Total	44 (34.9%)	99 (78.6%)	33 (26.2%)	27 (21.4%)	11 (8.7%)	27 (21.4%)	38 (30.2%)	27 (21,4%)	82 (65.1%)	33 (26.2%)	66 (52.4%)	0 (0)	126 (100%)

Data are presented as numbers and percentages (%). (%) values within all applied procedures are given

While 43.5% of the participants frequently performed socket preservation procedures, 43.5% stated that they rarely performed, and 13% did not perform socket preservation procedures. The proportion of periodontists who do not perform advanced surgical procedures other than standard implant surgery procedures was 8.7%. The main reason was that 66.7% did not feel competent in this field and 33.3% avoided complications. The most preferred method of advanced bone surgery was guided bone regeneration (GBR) with a collagen membrane (78.3%) followed by lateral window sinus elevation (65.2%). The bone ring method was the least preferred operation with a rate of 8.7% (Figure 2). Tables 3 and 4 show which methods are preferred by the participants in terms of bone augmentation according to their professional experience and the institution they work. As the duration of professional experience increases, the practices of participants in advanced bone surgery also increase. While periodontist/periodontology residency students working in university hospitals applied most of the different bone augmentation methods at similar rates, periodontists working in private clinics reported that they most frequently preferred GBR with a collagen membrane, sausage technique, and lateral window sinus elevation. When the preferred materials for regeneration were evaluated according to the demographic characteristics of the participants such as gender, duration of professional experience, and the institution, no significant relationship was found (Table 5).

Figure 2. Answers to the question on preferred methods of regeneration

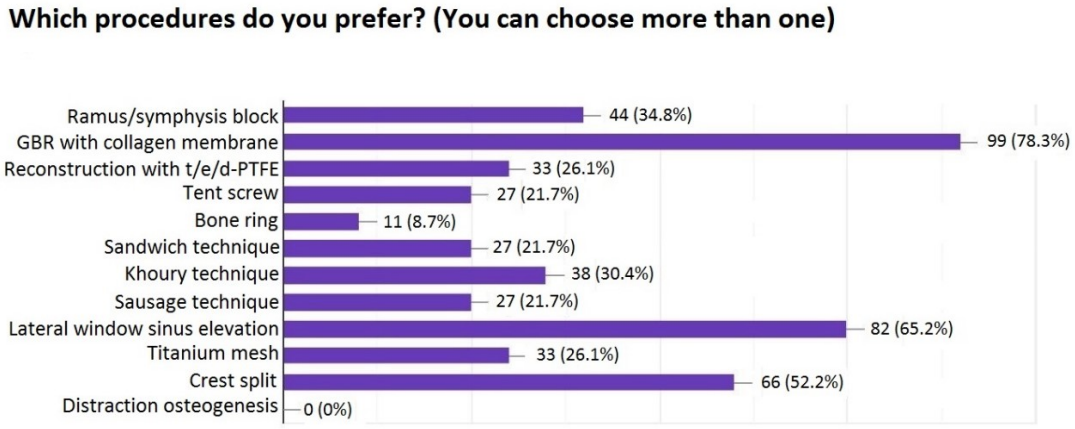


Table 5. The relationship between demographic characteristics of physicians and material selection

	Autogenous graft	Allograft	Xenograft	Alloplastic graft	Composite graft	Total	P value
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
Gender							
Woman	15 (27.3)	6 (10.9)	24 (43.6)	5 (9.1)	5 (9.1)	55 (100)	0.989
Male	18 (25.4)	10 (14.1)	31 (43.7)	6 (8.5)	8 (8.5)	71 (100)	
Duration of professional experience							
0-5 years	5 (38.5)	1 (7,7)	5 (38.5)	1 (7.7)	1 (7.7)	13 (100)	0.993
5-10 years	7 (28)	3 (12)	11 (44)	2 (8)	2 (8)	25 (100)	
> 10 years	21 (23.9)	12 (13,6)	39 (44.3)	8 (9.1)	8 (9.1)	88 (100)	
Institution							
Dental Polyclinic	7 (21.1)	6 (18.2)	16 (48.5)	2 (6.1)	2 (6.1)	33 (100)	
Private dental clinic	6 (46.2)	4 (30.8)	0	0	3 (23.1)	13 (100)	0.108
ODHC/Government hospital	1 (11.1)	0	4 (44.4)	3 (33.3)	1 (11.1)	9 (100)	
University Hospital	19 (26.2)	6 (8.5)	35 (49.3)	6 (8.5)	5 (7)	71 (100)	

Data are presented as numbers and percentages (%).

The most common complications encountered by periodontists after bone augmentation procedures were membrane exposure (52.2%) and graft resorption (43.5%). Soft tissue dehiscence (34.8%), sinus membrane perforation (30.4%), and infection (17.4%) were also among the complications (Figure 3). The most important interventions to prevent complications were adequate soft tissue release (77.3%), periodontitis control (63.6%), and preoperative soft tissue augmentation (59.1%). Systemic disease control, motivation for smoking cessation, and choice of the most appropriate surgical method were among the options preferred by participants at the same rate. 3D imaging options and preoperative antibiotic use were preferred by almost half of all periodontists (Figure 4). Postoperative antibiotic/antiseptic use was the most common procedure to overcome the complications (91.3%). The preference rate for re-suturing the operation site was 65.2%. Removal of the exposed part of the graft is preferred by 34.8%, and autologous soft tissue graft or complete removal of the graft/membrane is preferred by 21.7%. Irrigation of the wound site with chlorhexidine was the least preferred procedure with 4.3% (Figure 5). 82.6% of the participants received support when faced with complications. The most frequently requested support were faculty members, followed by colleagues. 47.8% of periodontists thought that periodontology residency training was insufficient to perform advanced bone surgery. Participants regularly follow current developments in bone regeneration. The most followed sources were current literature (78.3%), educational seminars (65.2%), and social media (52.2%).

Figure 3. Answers to the question about complications encountered in bone augmentation

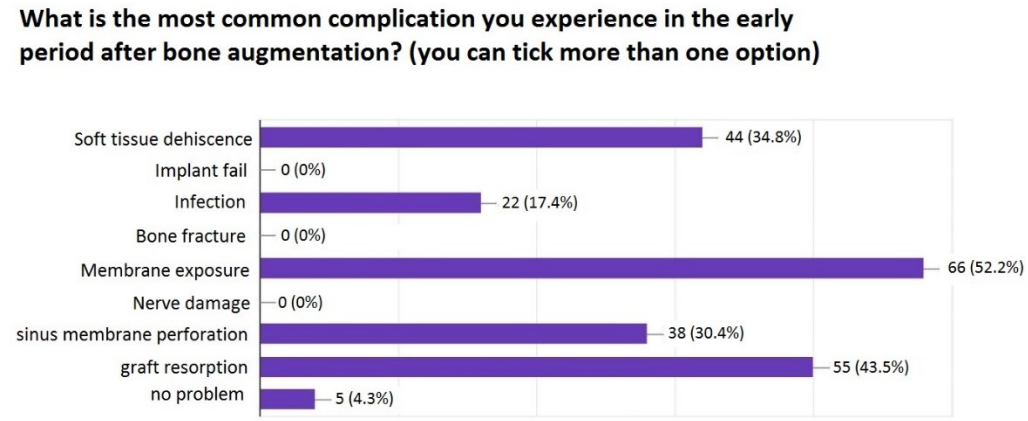


Figure 4. Responses for actions taken to prevent complications

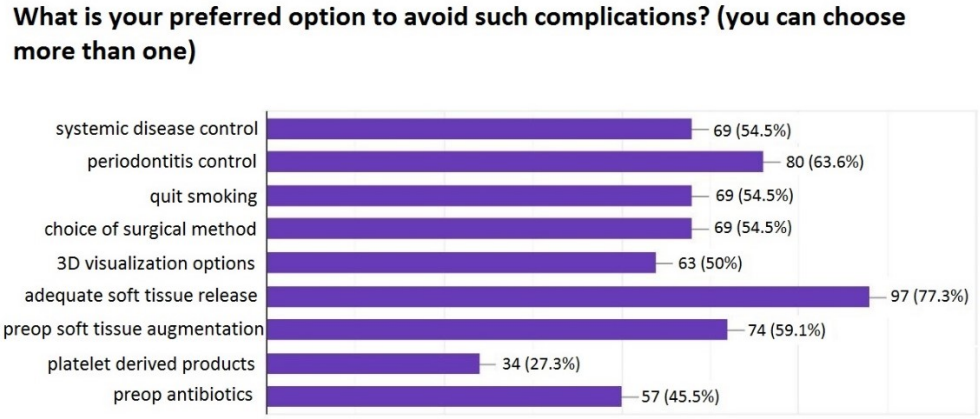
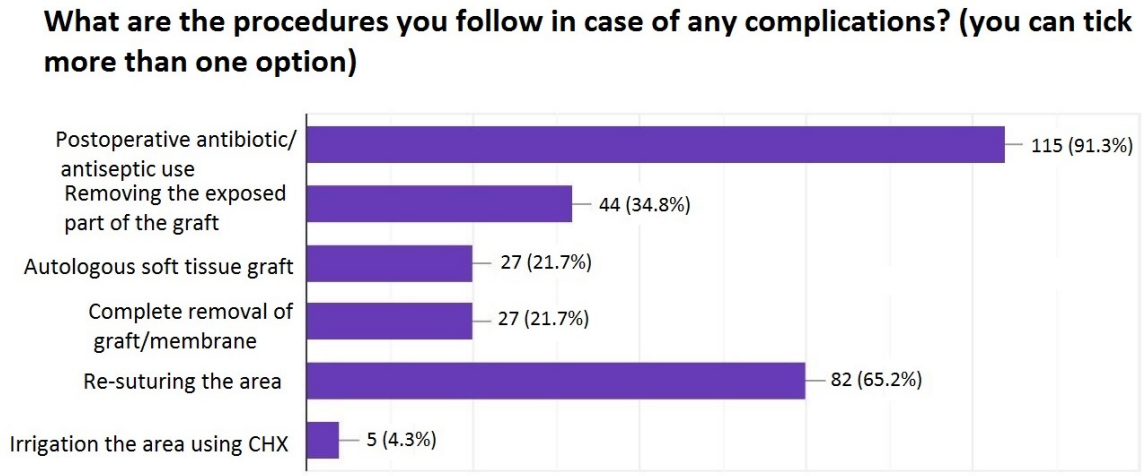


Figure 5: Responses to the procedures applied when faced with complications



DISCUSSION

Nowadays, implant applications are frequently performed to compensate for tooth deficiencies. Bone augmentation is a frequently required procedure in implant therapies.[8] In our study, the treatment approaches and complication management preferences of periodontist/periodontology residency students trained and specialized in periodontology were evaluated in terms of bone augmentation. The results were found to show that participants frequently underwent bone regeneration procedures, preferred xenografts as the most common regeneration material, and the most common method was GBR with collagen membrane. In terms of complications and management, it was observed that participants frequently encountered membrane exposure and graft resorption and preferred antibiotic/antiseptic use as the first treatment option in such a case. In terms of the methods and treatments applied, it was understood that periodontists used many treatment options in accordance with the literature.

While autogenous grafts remain the gold standard in bone regeneration, other graft materials can also provide satisfactory results. In our study, autogenous graft utilization was found to be 26.1%. There is a risk of morbidity and mortality in autogenous graft harvesting methods and the technical skill requirement is higher. For these reasons, the use of autogenous grafts by periodontists seems to be limited. The reason for autogenous graft preference was stated as high clinical success with a rate of 81.8%. Bovine xenograft materials have been used with great success in alveolar crest augmentation procedures.[9, 10] In our study, xenograft was the most commonly used graft type with 43.5%. More than half of the physicians preferred xenograft because of its ease of application. The choice of graft material is based on the condition of the augmentation needed, the amount of graft material required, the cost, and the patient's medical condition and wishes. Although some studies have reported that there is no difference between different graft materials in terms of regeneration capacity[11] There are also studies indicating that alloplastic materials are less successful in regeneration than others.[12] In our study, it was found that alloplasts were the least used graft type.

The membranes are routinely used as part of the GBR technique and help prevent the passage of non-osteogenic tissues. In our study, 78.3% of periodontists preferred the GBR procedure with a collagen membrane. 26.1% prefer the use of PTFE membrane or titanium mesh. PTFE membrane is a good barrier compared to resorbable membranes, but its use becomes disadvantageous due to soft tissue defects, membrane exposure, and the need for a secondary operation for removal.[13] Using

absorbable membranes provides various benefits over non-absorbable ones. These are no secondary operation to remove the membrane; simplification of procedures; no re-exposure of regenerated bone during membrane removal; a wider range of surgical techniques for abutment attachment; and reduced cost and patient morbidity. In conclusion, resorbable membranes are preferable in the treatment of horizontal bone defects whenever practically possible.[14]

The most common complication encountered by participants with horizontal and vertical bone augmentation procedures using bone grafts was membrane exposure (52.2%), followed by graft resorption (43.5%) and soft tissue dehiscence (34.8%). The most common complication seen in the literature is loss of the bone graft with impairment of regenerative results and the formation of soft tissue dehiscence which leads to exposure of the graft and subsequently contamination of the bone graft and/or membrane. [15-17] Risk factors associated with the incidence of these complications include age (> 40 years), smoking, history of periodontitis, and bone defects requiring multiple implants.[15, 16] The optimal management of complications with block bone grafts is prevention through meticulous preoperative evaluation of anatomical structures using three-dimensional imaging techniques and assurance of safety margins during surgery. Despite this, only 50% of the participants surveyed prefer 3D imaging methods. 2-dimensional visualization of the operation area will increase the complication rate. The most common complication in the lateral window sinus elevation procedure is perforation of the Schneiderian membrane. In our study, 30.4% of participants experienced sinus membrane perforation.

Systemic diseases can affect the patient's wound healing capacity, especially in patients with diabetes and osteoporosis.[18] In periodontology training, the relationship between systemic disease and periodontal disease is explained in detail. Of the participants, 54.5% tried to control systemic disease, but this rate was lower than expected compared to the training received. Smoking has also been shown to be detrimental to bone healing and osseointegration.[19] The negative impact of smoking can affect not only bone but also the healing of soft tissues. Experimental research has also shown that smoking cessation can partially reverse the previously described negative effects on bone healing.[20] More than half of physicians have attempted to get a patient to quit smoking. It is necessary for periodontists to be more aware of smoking and systemic disease control and to guide the patient in terms of the success of the procedures to be performed and to prevent complications. Karoussis et al. [21] applied implants to patients with and without a history of periodontitis. While the 10-year incidence of peri-implantitis was 6% in the group without periodontitis, this rate was 29% in those with a history of periodontitis. Roccuzzo et al. followed 101 patients who received dental implants after being categorized as 1) periodontally healthy, 2) moderate periodontal problems, and 3) severe periodontal problems. The authors reported that the frequency of implant sites showing ≥6 mm probing depth (2%, 16%, 27%, respectively), and≥3 mm bone loss (5%, 11%, 15%, respectively) differed significantly between the groups. [22, 23]. In addition, the intraoral microbial load from periodontitis may affect the success of the GBR procedure. The overall risk of membrane exposure is higher in patients with severe periodontal pockets compared to edentulous or periodontally healthy patients, so it is important to remember that all patients undergoing a surgical procedure should first be checked on a periodontal level.[24] In our study, 63.6% of the participants stated that they achieved periodontitis control. Considering that the study was conducted in the field of periodontology, this rate is expected to be higher.

Prevention of postoperative infection after bone surgery is often the basis for antibiotic use. Despite limited information

regarding the benefit of the systemic use of antibiotics in minimizing complications subsequent to bone regeneration, post-operative antibiotics are generally prescribed on an empiric basis due to the probability of contamination of the biomaterials used. Given the emergence of antibiotic resistance, antibiotic-associated hypersensitivity, ineffectiveness, and superinfections, it is left to the personal experience of practitioners to determine the need for antibiotics. Payer et al. [25] A study by the ITI Antibiotic Study Group led by the ITI Antibiotic Study Group examined the effect of giving 2 g of amoxicillin one hour before surgery and then 500 mg of amoxicillin every 8 hours for 3 days following surgery on the occurrence of postoperative complications and morbidity, compared with placebo. In both groups, the patients received paracetamol every 8 h for two postoperative days. The authors concluded that no improvement in the patient's perception of postoperative discomfort was achieved by systemic antibiotics. There were no significant differences in postoperative complications in either group. However, suppuration was higher in the control group. In a meta-analysis, there was insufficient evidence to support or reject antibiotic prophylaxis for the prevention of perioperative infection in intraoral bone grafting procedures. [26] Nevertheless, removal of the barrier membrane, curettage of the area, and systemic antibiotic treatment are recommended when abscess formation and membrane exposure are detected at the operation site. [27] In our study, 91.3% of the participants preferred the use of antibiotics. Although it is controversial whether the use of antibiotics, which is preferred at a very high rate, is sufficient to prevent postoperative complications, it should be applied in the presence of any complication.

The results of our study showed that periodontists performed advanced surgical procedures more frequently in university hospitals. Possible reasons for this include the availability of the necessary equipment and experienced assistive personnel for advanced surgical procedures or the presence of experienced faculty members who can be consulted in case of any complications.

CONCLUSION

Bone augmentation procedures have been shown to achieve highly predictable results in terms of bone recovery, regardless of the material used or the surgical method. The reduction of surgical complications is also related to the choice of surgical procedure because the incidence of complications is directly related to the condition of the bone defect. Many local and systemic factors such as systemic status, history of periodontitis, flap design, and soft tissue management affect the success of the procedure. Since regeneration-related procedures are technique-sensitive, they should only be performed by clinicians with appropriate training and experience. Expanding the residency training in periodontology to include more advanced bone surgery procedures would be beneficial for physicians in terms of complication management and procedural success.

Acknowledgment

Thank you to all our colleagues who participated in the survey.

Ethical Approval

The ethical approval for this study was obtained by Pamukkale University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee (2022/07-11).

Financial Support

No financial support was received from any institution or organization for this study.

Conflict of Interest

The authors declare that they have no competing interests.

Author Contributions

Design: ALA Data collection and data analysis: ALA, GTC Analysis and interpretation: ALA, GTC Literature review: ALA, GTC Article preparation: ALA, GTC.

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Diş Hekimliği Dergisi

Vol: 6 No: 1 Year: 2024 | Research Article | e-ISSN: 2687-5535

https://doi.org/10.51122/neudentj.2024.89

Comparison of the Efficacy of Tricalcium Phosphate and Mineralized Plasmatic Matrix Graft for the Bone Defect in the Distal Second Molar Tooth After Surgery of the Lower Impacted Third Molar Tooth

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Article Info

Article History

Received: 29.08.2023
Accepted: 20.02.2024
Published: 30.04.2024

Keywords:
Tricalcium Phosphate,
Platelet Rich Fibrin,
Third Molar,
Extraction of Tooth,
Bone.

ABSTRACT

Aim: After the extraction of mandibular horizontal and mesioangular teeth, a defect occurs in the distal part of the second molar. In this study, the effect of MPM on these defects was evaluated.

Materials and methods: 36 patients randomly divided into 3 groups. The first group included MPM and PRF. The second group included B-tcp and PRF. In the 3rd group, the extraction socket was left empty.

At preoperative and postoperative 6th months, periodontal pocket depth, gingival index and plaque index, and the distance between the enamel junction and crestal bone at the distal of the 2nd molar were measured by CBCT. 8 patients were removed for various reasons. 28 patients were evaluated.

Results: Preoperative and postoperative periodontal pocket depths at the sixth month were 7.67 ± 1.58 mm and 4.67 ± 1.23 mm in the MPM group (p<0.001); 6.60±1.96 mm and 4.70±1.34 mm in the β-TCP group (p<0.001); 6.78±1.48 mm and 5.56±1.01 mm in the control group (p<0.023).

Bone defects preoperatively and at six months postoperatively were 7.97 ± 1.04 mm and 3.59 ± 0.66 mm in the MPM group (p<0,001); 6.23 ± 1.37 mm and 2.90 ± 1.04 mm in the β-TCP group (p<0.001); 6.92±0.82 mm and 4.30±0.68 mm in the control group (p<0.001).

Conclusion: MPM is an effective graft material to restore the periodontal health of the distal part of the second molar after impacted lower third molar surgery

Alt Gömülü Üçüncü Molar Dişin Çekimi Sonrası İkinci Moların Distalinde Oluşan Kemik Defektinde Trikalsiyum Fosfat ve Mineralize Plazmatik Matriks Greftin Etkinliğinin Karşılaştırılması

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 29.08.2023
Kabul Tarihi: 20.02.2024
Yayın Tarihi: 30.04.2024

Anahtar Kelimeler:
Trikalsiyum Fosfat,
Trombositten Zengin Fibrin,
Üçüncü Molar,
Diş Çekimi,
Kemik.

ÖZET

Amaç: Mandibular mesioangular ve horizontal dişlerin çekiminden sonra ikinci molar dişin distalinde defekt oluşmaktadır. Bu çalışmada bu defektlere MPM' in etkisi değerlendirildi.

Materyal ve metot: 36 hasta rastgele 3 gruba ayrıldı. İlk grup MPM ve PRF içermekteydi. İkinci grup B-TCP ve PRF içermekteydi. Üçüncü grupta çekim soketi boş bırakıldı.

Preoperatif ve postoperatif 6. ayda periodontal cep derinliği, dişeti indeksi, plak indeksi ve 2. moların distalindeki kemik ile mine bileşimi arasındaki mesafe KIBT ile ölçüldü. 8 hasta çeşitli sebeplerle çıkarıldı. 28 hasta değerlendirildi.

Bulgular: Ameliyat öncesi ve sonrası altıncı ayda periodontal cep derinlikleri MPM grubunda 7,67 ± 1,58 mm ve 4,67 ± 1,23 mm (p<0,001); β-TCP grubunda 6,60±1,96 mm ve 4,70±1,34 mm (p<0,001); Kontrol grubunda 6,78±1,48 mm ve 5,56±1,01 mm (p<0,023).

MPM grubunda ameliyat öncesi ve ameliyat sonrası altı ayda kemik defektleri 7,97 ± 1,04 mm ve 3,59 ± 0,66 mm idi (p<0,001); β-TCP grubunda 6,23 ± 1,37 mm ve 2,90 ± 1,04 mm(p<0,001); Kontrol grubunda 6,92±0,82 mm ve 4,30±0,68 mm (p<0,001) idi.

Sonuç: MPM, gömülü alt üçüncü molar cerrahisi sonrasında ikinci molar dişin distal kısmının periodontal sağlığını yeniden sağlamada etkili bir greft materyalidir.

To cite this article:
Kılınç A., Işık BK., Duygulu Ş. Comparison of the Efficacy of Tricalcium Phosphate and Mineralized Plasmatic Matrix Graft for the Bone Defect in the Distal Second Molar Tooth After Surgery of the Lower Impacted Third Molar Tooth. NEU Dent J. 2024;6:60-9. https://doi.org/10.51122/neudentj.2024.89

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INTRODUCTION

There are several indications for the removal of impacted lower third molars, and one of them is the possibility that the impacted tooth may cause a bony defect on the distal aspect of the adjacent lower second molar.[1] This periodontal defect can develop due to the presence of the impacted third molar itself, as well as after its removal. [2] Especially people over the age of 26 with mesioangular or horizontally positioned third molars are more susceptible to such defects. [3]

To prevent periodontal problems caused by impacted third molars, various techniques such as different flap designs, guided tissue regeneration techniques, autografts, allografts and the use of platelet-rich fibrin (PRF) have been tried. [4–7] Also some alloplasts including tricalcium phosphate (TCP), porous hydroxyapatite, bioactive glass or a combination of them have been used.[4]

One of the disadvantages of particulate grafts is that they cannot remain stable under masticatory forces.[8] Recently, a biomaterial called mineralised plasmatic matrix (MPM) has been introduced. MPM is produced by mixing a plasma phase and a mineral phase. After centrifugation of the autologous blood, white blood cells (plasma phase) are removed and mixed with an autologous, alloplastic, allogeneic or xenogeneic bone graft (mineral phase). This produces a homogeneous, compact, stable, dense fibrin network and malleable graft material.[9]

Although there have been studies on the use of MPM in various oral surgical procedures, to our knowledge, there have not been sufficient studies on its efficacy after removal of impacted lower third molars. The aim of our study was to compare the efficacy of MPM and β-TCP on the defect that occurs on the distal aspect of the second molar after removal of the impacted lower third molars.

MATERIALS AND METHODS

This study received support from the Necmettin Erbakan University Scientific Research Projects. Ethical approval was obtained from the Ethics Committee of the Faculty of Dentistry at Necmettin Erbakan University.

Patient selection and study groups

Patients who applied for the removal of impacted lower molars between January 2018 and September 2018 were scanned. The inclusion criterias were:

- The patient was over 18 years old
- Systemic status was ASA I or II
- The tooth was fully impacted
- The tooth was in a mesioangular or horizontal position
- Removal of the impacted third molar appeared to cause a severe periodontal defect on the distal aspect of the adjacent lower second molar (Figure 1).

Figure 1: Mesioangular and fully impacted lower third molars. The right tooth is fully impacted and its presence has already caused a severe defect on the distal aspect of the second molar.

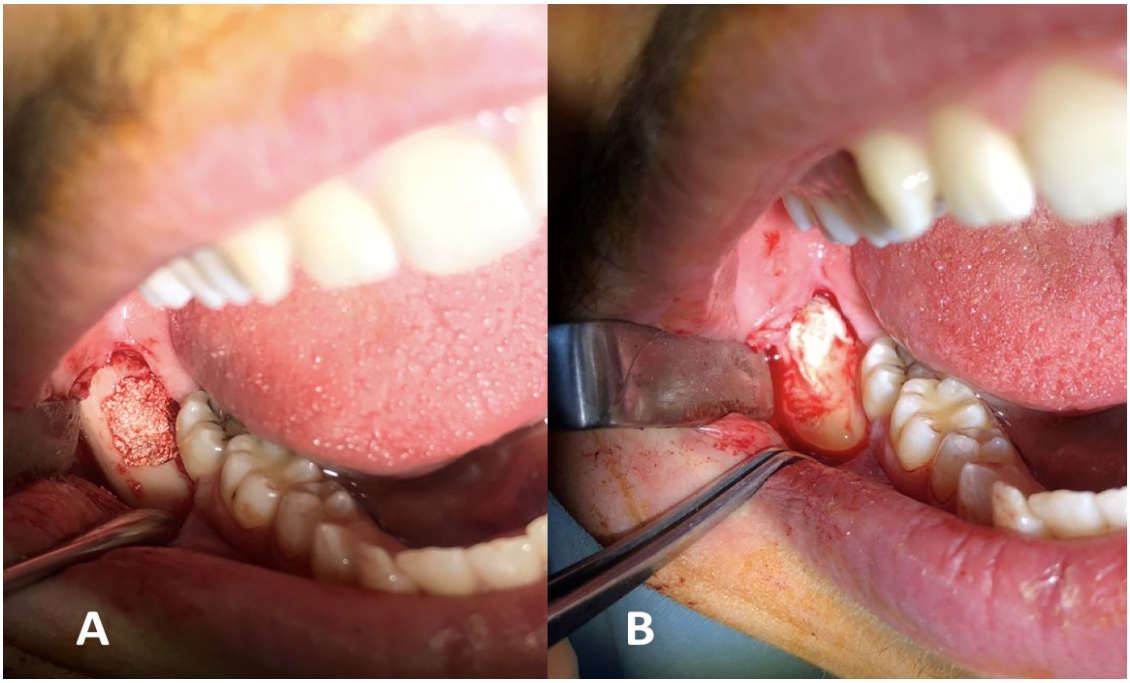
Exclusion criterias were:

- The adjacent second molar had a crown restoration
- Poor oral hygiene
- Pregnant or breastfeeding women
- The patient has had or is having orthodontic treatment
- Smoking habit

A total of 36 patients (14 males and 22 females) aged between 18 and 38 years (mean age 24.39 ± 5.09 years) were eligible. Each patient had one impacted third molar included in the study. The patients were randomly divided into three groups:

- The MPM group (n=12): The extraction socket was filled with MPM containing β-TCP as the mineral phase and covered with a PRF membrane (Figure 2).
- The β-TCP group (n=12): The extraction socket was filled with β-TCP Alloplast only and covered with a PRF membrane.
- The control group (n=12): The aspiration port was left empty and allowed to fill with blood clot.

Figure 2. A: Packing the MPM material into the aspiration port. B: Placement of the PRF membrane.

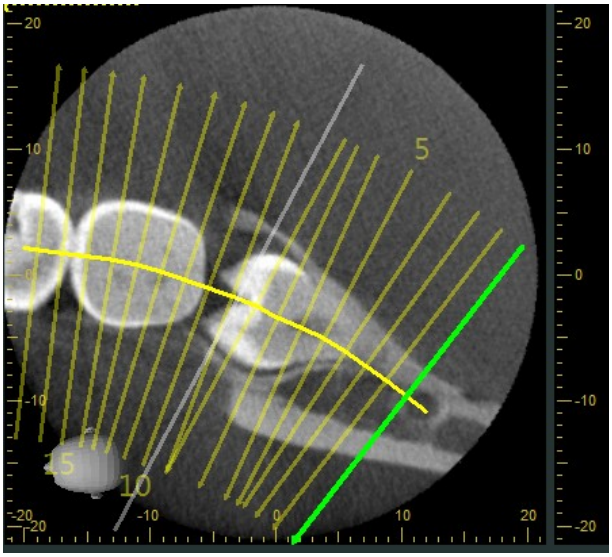


The following parameters were planned to be measured preoperatively (T_0) and in the sixth postoperative month (T_1):

- Periodontal parameters on the distal aspect of the adjacent second molar:
  - A Williams periodontal probe was used to measure the pocket depth on the distal aspect of the second molar, close to the central sulcus.
  - Gingival index.[10]
  - Plaque index.[11]
- Measurement using cone beam computed tomography (CBCT) involves determining the distance between the enamel-cement junction and the crestal bone level on the distal side of the lower second molar. This measurement is taken in a tomographic slice that passes through the central sulcus of the tooth (Figure 3).

The null hypothesis was "There is no significant difference in the healing of the distal aspect of the adjacent lower second molar between grafting the extraction socket with β-TCP, MPM or leaving the socket to heal spontaneously".

Figure 3. Preoperative measurement of the bony defect on the distal aspect of the left lower second molar CBCT.



Preparation of the MPM

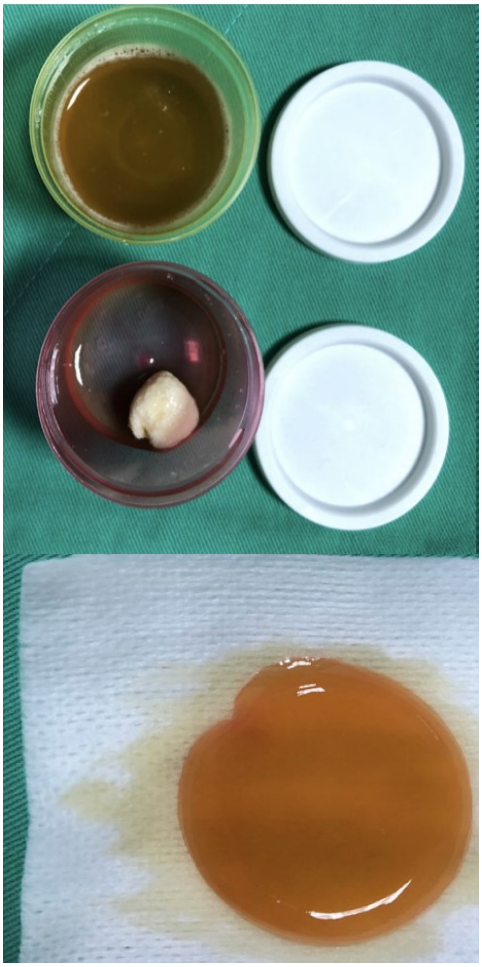
A dedicated MPM disposable kit (Matrices Plasmatiques Minéralisées, Kits de préparation, Atoll Implant, Toulouse, France) was used. It contained:

- Blood collection kit
- A 15mL syringe with a needle
- Four vacuette blood collection tubes
- Isotonic saline
- A special MPM tube
- Two graft containers: pink and yellow cups.

Before the surgery, we collected venous blood using four 9 mL Vacuette tubes that did not have any anticoagulant. After collection, the tubes were promptly placed in a centrifuge. (Ample Scientific Champion F-33, Norcross, Georgia, USA) and run at 2300 rpm for 15 minutes. This process separated the blood into two compartments: yellow plasma fluid at the top of the tube and red blood cells at the bottom. The yellow portion of each supernatant also contained platelets, which were withdrawn with a syringe and separated from the red blood cells. This plasma of about 2.5 mL was placed in a special MPM tube containing a clot activator and shaken by hand. It was then added to a sterile pink beaker containing 1 cc of wet β-TCP bone graft (Suprabone Powder, BMT calsis, Ankara, Türkiye) with a particle size of 0.5-1 mm and immediately mixed with a curette for a few minutes or until the mineral phase began to aggregate in clumps. This produced a mouldable MPM graft material.

The yellow portions of the other two tubes, reserved for the production of the PRF membrane, were removed and added to the yellow beaker. The remaining liquid from the pink beaker was also added to the yellow beaker to speed up the formation of the PRF membrane. Within approximately five minutes, membrane-like PRF was formed with the conversion of fibrinogen to fibrin (Figure 4).

Figure 4. Mouldable MPM graft (left) and PRF membrane (right).



Surgical procedure

The impacted lower third molars were treated in the usual way under local anaesthetic. The tooth was extracted and the extraction

socket was irrigated with saline. Then, in the MPM group, the MPM graft was placed in the socket and covered with PRF membrane. In the β-TCP group, only the β-TCP particulate graft was placed and covered again with PRF membrane. In the control group, the extraction socket was left empty and allowed to fill with blood.

The surgical wound was closed with 3-0 silk sutures. Postoperative oral amoxicillin (500 mg, 3×1), flurbiprofen (100 mg, 2×1) and 0.12% chlorhexidine gluconate mouthwash were prescribed. Sutures were removed after one week.

Statistical analyses

SigmaPlot 12.5 (Systat Software Inc, San José, CA, USA) was used for statistical analyses. First, the Shapiro-Wilk test was performed to determine whether the data followed a normal distribution, and parametric or non-parametric tests were selected accordingly. Paired t-test was used for within-group comparisons and one-way ANOVA or Kruskal-Wallis test for between-group comparisons. When multiple comparisons revealed significant differences, the Tukey test was used after ANOVA and the Dunn test after Kruskal-Wallis. The Fisher exact test was used to compare infection rates between groups. The level of statistical significance was accepted as $p < .05$.

RESULTS

Eight patients were excluded from the study: One patient in the MPM group, two patients in the β-TCP group and three controls did not attend the follow-up visits. Two patients in the MPM group had a postoperative infection in the surgical area.

The remaining 28 patients were 18 women and 10 men. The mean age was 22.78 ± 2.28 in the MPM group, 23.1 ± 4.68 in the β-TCP group and 25.56 ± 5.08 in the control group (p=.338). T_0 values of periodontal pocket depth, periodontal and gingival indices were similar in all groups, but the alveolar bone defect was significantly deeper in the MPM group (Table 1).

Table 2 shows that pocket depth and bone defects decreased in all groups at six months.

Table 3 compares periodontal pocket depth and bone defect changes at six months.

At the six-month mark, there was a notable disparity in the periodontal pocket depth between the MPM group and the control group. However, there was no significant distinction observed between the MPM group and the β-TCP group, nor between the β-TCP group and the control group. There was a significant difference in the changes in bone defects between the MPM and control groups and between the MPM and β-TCP groups. The difference between the TCP and control groups was not significant (Table 4).

Table 1. Intergroup comparison of T_0 values.

	β-TCP Group (n=10)				Control group (n=9)				MPM Group (n=9)				
	Mean	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**P**
PPD	6.60	1.96	4.00	10.0	6.78	1.48	5.00	9.00	7.67	1.58	5.00	10.0	.365
BD	6.23	1.37	3.90	8.60	6.92	0.82	6.10	8.50	7.97	1.04	5.80	9.00	.009*
PI	1.00	0.67	0.00	2.00	0.89	0.60	0.00	2.00	0.67	0.71	0.00	2.00	.510
GI	1.40	0.69	0.00	2.00	1.22	0.67	0.00	2.00	1.33	0.50	1.00	2.00	.794

*PPD: Periodontal pocket depth, BD: Bone defect, PI: Plaque index, GI: Gingival index *: Statistically significant difference*

Table 2. Intragroup test results of periodontal pocket depth and bone defects.

		T_0			T_1			
		Mean	**Min**	**Max**	**Mean**	**Min**	**Max**	**P**
β-TCP Group	**PPD**	6.60	4.00	10.0	4.70	3.00	7.00	<.001*
	BD	6.23	3.90	8.60	2.90	1.10	4.20	<.001*
MPM Group	**PPD**	7.67	5.00	10.0	4.67	3.00	6.00	<.001*
	BD	7.97	5.80	9.00	3.58	2.60	4.30	<.001*
Control group	**PPD**	6.78	5.00	9.00	5.56	4.00	7.00	.023*
	BD	6.92	6.10	8.50	4.30	3.00	5.30	<.001*

*PPD: Periodontal pocket depth, BD: Bone defect *: Statistically significant difference*

Table 3. Intergroup comparison of the periodontal pocket depth and bone defect changes between T_0 and T_1.

	β-TCP group				**Control group**				**MPM group**				
	Mean	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**Mean**	**SD**	**Min**	**Max**	**P**
PPD	1.90	0.74	1.00	3.00	1.22	1.30	0.00	4.00	3.00	1.12	1.00	4.00	.011*
BD	3.33	0.90	1.60	4.40	2.62	0.77	1.90	4.20	4.38	0.73	3.20	5.20	<.001*

*PPD: Periodontal pocket depth, BD: Bone defect *: Statistically significant difference*

Table 4. Amount of change in periodontal pocket depth and bone defect between T_0 and T_1.

	MPM vs Control		**MPM vs β-TCP**		**β-TCP vs Control**	
	Difference	**P**	**Difference**	**P**	**Difference**	**P**
PPD	1.78	<.05*	1.10	>.05	0.68	>.05
BD	1.76	<.001*	1.05	.024*	0.71	.158

*PPD: Periodontal pocket depth, BD: Bone defect. *: Statistically significant difference*

Postoperative infection was not observed in the β-TCP and control groups, but two patients in the MPM group had postoperative infection. The differences between the MPM and control groups and the MPM and β-TCP groups were not significant (p=.471 and p=.211 respectively).

DISCUSSION

After the removal of impacted lower third molars, there is a risk of experiencing crestal bone loss and developing deep periodontal pockets on the distal side of the neighboring second molar. Studies have shown that even two years post-surgery, 43.3% of patients may still have periodontal defects measuring 7mm or more on the second molar.[12,13] Patient age, angulation of the third molar, and extent of preoperative bone defect determine the risk.[14] In our study, we excluded the factors that could influence the results, such as systemic diseases,[15] prosthetic restorations,[16,17] orthodontic treatment,[18] smoking,[19] and periodontal diseases. In addition, plaque, gingival index, age and type of defect [3,12] were not statistically different between our groups.

Similar studies have been done previously using panoramic radiographs.[3] However, in such cases the expected bone gain or loss is rather small. Magnification of panoramic radiographs and superimposition of hard tissues could affect the accuracy of measurements. Therefore, we preferred CBCT.

Researchers have proposed various techniques to prevent this residual defect, such as specific flap designs,[5,20,21] root surface curettage and planing,[22] regenerative periodontal treatment,[23,24] guided tissue techniques, autografts, allografts, and PRF.[4] In this study, we planned to evaluate the effectiveness of MPM. Autologous, allogeneic or xenogeneic bone can be used in MPM for the mineral phase.[25] In this study, we used β-TCP particulate graft. It is a biocompatible and osteoconductive material.[26] It does not contain growth factors but supports osteoblast proliferation and mesenchymal cell differentiation. There are studies using it in combination with blood products to increase its effectiveness, particularly in sinus lift surgery.[27]

MPM is prepared by first collecting blood in empty tubes containing no anticoagulant or clot activator. After centrifugation, the upper layers of the tube contain fibrinogen, platelets and monocytes. This liquid phase is added to the bone graft material. When this plasma comes into contact with the calcium in the bone graft, the fibrinogen is converted into a fibrin network. This is an important property because it allows us to create a homogeneous composition containing bone graft, fibrin network, growth factors and cells. Moheb *et al*.[25] showed high cellular activity and formation of woven bone in the defects where MPM had been applied, but when a mixture of bone graft and PRF was used, only granulation tissue developed. They explained this by the stabilisation of the MPM graft.

Our results showed that while pocket depth decreased in all groups, the smallest gains were observed in the control group and the largest gains were observed in the MPM group. There was a significant difference in pocket depth between the MPM and control groups, but not between the other groups.

The depth of the periodontal pocket may not always correspond to the crestal bone level. Therefore, we measured both pocket depth and alveolar bone height. In all groups, the bone defect on the distal side of the second molar decreased significantly. We observed the smallest increase in the control group and the largest increase in the MPM group. While there was a significant difference between the MPM group and the β-TCP group, the β-TCP and control groups were not significantly different. This suggests that the blood products in MPM may be effective in healing the extraction socket.

In an animal study in which the regeneration effect of mineralized plasmatic matrix was evaluated by creating 6mm critical defects in 6 male sheep, 5 defects were created in each animal. 4 of them were filled with MPM. 1 was left empty as a control group. Animals were killed at third and six weeks. Samples were evaluated histologically. New bone formation was significantly higher in the MPM group than in the control group. [28]

In another study examined the effect of PRF efficacy on bone density after extraction, mandibular molars were extracted bilaterally. PRF was applied to the study group while the socket was left empty in the control group. Bone density was significantly higher in the PRF group when evaluated on radiographs.[29]

In addition to all the graft materials, the use of dentin grafts for socket filling has become an increasingly popular treatment. In a study reporting the use of autologous dentin grafts in the prevention of periodontal defects after extraction of 3rd molars, the use of autologous dentin was evaluated in terms of the prevention of deep periodontal pocket formation distal to the mandibular 2nd molars. 10 patients were included in this split mouth study. 20 mandibular 3rd molar extractions were performed. The experimental areas were filled with dentin graft from the extracted 3rd molars, While the socket in the control group was left empty. At the 6-month follow-up, less pocket depth and more bone gain were found in the grafted areas. The study suggests that the graft obtained from the extracted 3rd molars may be useful in preventing periodontal defects distal to the 2nd molars. [30]

It has been reported that periodontal bone defects should be at least 4 mm in order to compare regenerative techniques with controls.[31] In other words, if the defect is less than 4 mm, it is not reasonable to compare any type of regenerative technique with a defect that is left to heal alone. In our study, all but one defect (3.90 mm) were deeper than this critical size.

Initially, there was a statistically significant difference between the bone defects of the MPM group (mean 7.97 ± 1.04 mm) and the β-TCP group (mean 6.23 ± 1.37 mm). It can be argued that there should have been no such variation, i.e. all groups should have been similar. This would of course be ideal, but the situation was unfavourable for the MPM group, which showed greater bone gains at the end. In the opposite scenario, where the β-TCP group had a deeper bone defect at the beginning, such a difference could be a more important problem. We think our situation is acceptable.

This study was not designed as a split-mouth study and this may be considered as a limitation. Compared with the current literature, our sample size is not insufficient, but to draw more valid conclusions, studies with larger sample sizes and longer follow-up are needed.

CONCLUSION

After surgery to remove impacted lower third molars, the bone defect and periodontal pocket on the distal aspect of the second molar will undergo partial healing, even without the use of regenerative techniques. However, the healing process can be further enhanced with the use of MPM, which is a simple and user-friendly method.

Ethical Approval

The required ethical approval for this study was received by Necmettin Erbakan University Non-Pharmaceutical and Medical Device ethics committee (2016/010).

Financial Support

No financial support was received from any institution or organization for this study.

Conflict of Interest

The authors deny any conflicts of interest related to this study

Author Contributions

Design: AK, BKI Data collection and proccessing: AK, BKI Analysis and interpretation: ŞD Literature review: ŞD Yazma: BKI, AK, ŞD

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Diş Hekimliği Dergisi

Vol: 1 No: 1 Year: 2024 | Research Article | e-ISSN: 2687-5535

https://doi.org/10.51122/neudentj.2024.90

Comparison of Push-Out Bond Strengths of Different Fiber Post Systems Bonded with Resin Cement

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Article Info

Article History

Received: 19.10.2023
Accepted: 14.02.2024
Published: 30.04.2024

Keywords:
Fiber Post Systems,
Push-Out Test,
Resin Cement.

ABSTRACT

Aim: This study compares the push-out bond strengths of 3 different fiber post systems bonded with resin cement to root canal dentin.

Material and Methods: The study used 15 extracted single-rooted mandibular canine teeth. After the endodontic treatment of the teeth, they were randomly divided into three groups to apply different post-systems (n=5). Reforpost glass-fiber, Polydentia glass-fiber, and AAA Transparent fiber post systems were used in this study. The posts have adhered to the root canal with Panavia F2.0. A total of 6 slices of 1 mm thickness in the transversal direction were obtained, two from each of the coronal, middle, and apical sections of the prepared samples. The push-out test was performed from apical to coronal at a 0.5 mm/min speed. ANOVA and Tukey HSD tests were used for statistical analysis ($p<0.05$).

Results: The highest push-out binding values were observed in Polydentia (5.04±0.54); the lowest was seen in Reforpost (1.5±1.03). There was no statistical difference between the push-out binding values of the samples' apical, middle, and coronal regions for Reforpost and Transparent groups. In Polydentia group, the push-out binding values of the coronal region samples were significantly higher than those in the middle region. When the post groups were compared, the difference between the push-out binding values of all groups was statistically significant.

Conclusion: The surface properties of the posts can affect the push-out bonding values. Polydentia showed the highest push-out binding values. In addition, the push-out attachment values of the posts may vary in different root canal regions.

Rezin Simanla Yapıştırılan Farklı Fiber Post Sistemlerin Push-out Bağlanma Dayanımlarının Karşılaştırılması

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 19.10.2023
Kabul Tarihi: 14.02.2024
Yayın Tarihi: 30.04.2024

Anahtar Kelimeler:
Fiber Post Sistemler,
Push-Out Test,
Rezin Siman.

ÖZET

Amaç: Bu çalışmanın amacı, rezin simanla kök kanal dentinine bağlanan üç farklı fiber post sisteminin push-out bağlanma dayanımları karşılaştırmaktır.

Gereç ve Yöntemler: Çalışmada 15 adet çekilmiş tek köklü kanin diş kullanıldı. Dişlere endodontik tedavi yapıldıktan sonra farklı post sistemi kullanılmak üzere rastgele 3 gruba ayrıldı (n=5). Çalışmada, Reforpost cam fiber post, Polydentia cam fiber post ve AAA Transparent fiber post sistemleri kullanıldı. Postlar kanal içine Panavia F2.0 ile üretici firmanın talimatları doğrultusunda yapıştırıldı. Hazırlanan örnekler %100 nemde 24 saat 37 °C'de 1 gün bekletildikten sonra her bir diş kökünün postu içeren kısmının koronal, orta ve apikal bölümlerinin her birinden 2'şer adet olmak üzere, 1 mm kalınlıkta transversal yönde toplam 6 kesit elde edildi. Push-out testi, 0,5 mm/dk hızla apikalden koronale doğru yapıldı. Verilerin istatistiksel analizi için ANOVA ve Tukey HSD testleri uygulandı ($p<0,05$).

Bulgular: En yüksek push-out bağlanma değerleri Polydentia grubunda (5,04±0,54) görülürken; en düşük değerler reforpost grubununda (1,5±1,03) görüldü. Reforpost ve AAA Tranparent gruplarının apikal orta ve koronal bölge örneklerinin push-out bağlanma değerleri arasında istatistiksel olarak farklılık görülmedi ($p>0,05$). Polydentia grubunda ise; koronal bölge örneklerinin push-out bağlanma değerleri orta bölgedeki örneklerden anlamlı olarak daha yüksek bulundu ($p=0.006$). Post grupları birbirleriyle karşılaştırıldığında; tüm grupların push-out bağlanma değerleri arasındaki fark istatistiksel olarak anlamlı bulundu ($p<0,05$).

Sonuç: Postların yüzey özellikleri push-out bağlanma değerlerini etkilemektedir. Polydentia en yüksek push-out bağlanma değerlerini göstermiştir. Ayrıca postların push-out bağlanma değerleri kökün farklı bölgelerinde değişkenlik gösterebilmektedir.

To cite this article:
Gürses M., Çetin AR., Tüysüz OK., Özkan AK. Comparison of Push-Out Bond Strengths of Different Fiber Post Systems Bonded with Resin Cement. NEU Dent J, 2024;6:70-8. https://doi.org/10.51122/neudentj.2024.90

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INTRODUCTION

Post systems are used in the rehabilitation of endodontic-treated teeth whose dental crown has been partially or entirely destroyed.[1] The clinical success of post-supported restorations is related to factors such as the effectiveness and durability of the post, dentin, and adhesive combination.[2] With adequate bonding between these components, the forces occurring along the root are distributed evenly, and the tooth structure is protected. Failure in one of these components prevents the homogeneous distribution of incoming chewing forces and can create stress areas in the tooth structure.[3]

The fact that metallic posts' elasticity modulus is more remarkable than root dentin causes stress areas at the dentin/post interface. This situation is one factor that predisposes to root fractures.[4,5] Moreover, the natural color and opacity properties of metal or metal alloy posts negatively affect the aesthetic appearance of the final restoration. Additionally, some alloys can oxidize, producing dark pigments that cover and darken the roots and gum edges of teeth.[4–6]

In order to eliminate these problems, new types of materials have been produced for root canal posts. Among the existing post systems, fiber post systems, which show high success rates in clinical practice and their advanced aesthetic features, are widely preferred today.[7] Important advantages of fiber posts are that their elastic modules are close to dentin and that they reduce stress transmission to the root canal walls and the risk of vertical fractures.[7,8] Studies have reported that the combined use of fiber post systems with adhesive resin cement is efficacious in improving the bonding of these systems with root dentin.[9,10]

There are various fiber post systems available to clinicians today. From an ideal post system, it is expected to have easy applicability, high aesthetic properties, an elastic modulus close to dentin, minimal stress on the tooth, and good sealing properties. Among fiber post systems, glass fiber posts (GFP) have a modulus of elasticity similar to dentin and significantly reduce the risk of root fracture.[5,11–13] In addition, the color and opacity of GFPs are close to dentin, and they do not undergo oxidation.[6] The attachment of GFPs to the root canal is based on adhesive cementation. The retention of these posts in the canal depends on the bond strength between the post/cement/root dentin.[14] As it progresses to the apical region of the root, the decrease in light transmittance limits its polymerization process.[15] Efforts are being made to strengthen polymerization and adhesion in this region by using translucent post systems and dual-cure resin cement. Additionally, different morphological options are available in fiber post systems. Parallel and conical-shaped fiber posts are widely preferred. Retention is tried to be increased with parallel-shaped fiber posts. Since conical fiber posts have a form closer to the root-canal anatomy, canal-post compatibility is expected to increase and less stress will be transmitted to the tooth by using these post systems.

This study compares the push-out bond strength of 3 different fiber post systems bonded with adhesive resin cement to root canal dentin. The null hypothesis of the study: 1) There will be no difference between the push-out bond strengths of different post systems. 2) There is no difference between push-out binding values in different root canal regions.

MATERIAL AND METHODS

This in vitro study was approved by the Faculty of Dentistry Ethics Committee, Selçuk University (approval no: 2023/44). The study used 15 single-rooted mandibular canine teeth with completely closed roots, no cracks or fractures, similar root diameters and lengths, and straight root canals. Teeth were stored in distilled water until samples were prepared. The crowns of the teeth were removed by cutting in the horizontal direction under water cooling below the cementoenamel junction using a diamond bur to leave a root length of 15 mm for each tooth. After accessing the root canals, the number 10 K-file (Mani Inc., Tochigi, Japan) was advanced enough to be visible from the root tip, and working lengths were determined to be 1 mm shorter than the determined length.

Endodontic Treatment Procedure

Endodontic access cavities of the teeth were prepared with the help of a round bur. A number 10 K-type file (Mani Inc., Tochigi, Japan) was advanced until it was visible from the root tip, and the working length was determined to be 1 mm shorter than the determined length.

Root canals were prepared using the F3 size Protaper Ni-Ti rotary instrument series (Dentsply, Maillefer, Ballaigues, Switzerland). During root canal shaping, the canals were washed with 2 mL of 5.25% NaOCl after each file. After shaping, the canals were washed with 10 ml of distilled water and dried using paper points.

Root canal fillings were performed with AH-plus sealant (Dentsply, Konstanz, Germany) and F3 numbered Protaper gutta-percha cones (Diadent Group Int., Chungcheongbuk-do, Korea). The canal accesses were temporarily closed with zinc phosphate cement (Imibond-F, Imicryl Dental, Turkey), and the roots were stored in the incubator at 37 °C and 100% humidity for seven days.

Preparation of Post Cavities

The temporary filling material on the access cavities was removed. 11 mm post slots were prepared with size #3 Gates-Glidden drill (Mani Inc., Tochigi, Japan). At least 4 mm of canal-filling material was left in the apical third. Post slots were washed with 2 mL of 5.25% NaOCl, followed by 10 mL of distilled water, and dried using paper points.

Groups of Study

The samples were randomly divided into three groups using three different post systems (n=5). Each group was divided into 3 subgroups: coronal, middle, and apical regions (n = 10). G*Power version 3.1.9.4 (Erdfelder, Faul and Buchner) was used to determine the sample size and the effect size was determined as 0.5. In the study, Reforpost Refill glass fiber post (Angelus, Londrina, PR, Brazil), Polydentia glass fiber post (Polydentia SA, CH-6805 Mezzovico, Switzerland), and AAA Transparent fiber post (StarDent, China) systems were used. The surfaces of the fiber posts to be used were cleaned with alcohol and air-dried. The post systems have adhered to the canal with Panavia F2.0.

Panavia F2.0 Rezin Cement Application Procedure

After mixing, equal amounts of ED PRIMER liquids A and B were applied to the coronal part and the tooth structure around the post. After waiting for 60 seconds, it was dried with light air. Afterward, resin-containing pastes A and B were mixed equally and placed in the post cavity. After placing the posts in the cavity, they were polymerized with an LED light device (1000 mW /cm2, Valo, Ultradent, UT, USA) for 40 seconds.

Push-out Test

The prepared samples were kept at 100% humidity for 24 hours at 37 °C for one day. A total of 6 slices of 1 mm thickness in the transversal direction were obtained, two from each of the samples' coronal, middle, and apical sections. Sections were prepared using a slow-speed water-cooled diamond saw (Isomet, Buehler Ltd., Lake Bluff, IL, USA). The thickness of each section was checked with a digital caliper (Mitutoyo Corp 500 series, Kanagawa, Japan) with an accuracy of 0.01 mm.

The push-out test was performed using a universal testing machine (Elista, Istanbul, Turkey) by applying a 0.5 mm/min load from the apical to the coronal direction. Pushing force was applied until the post separated from the root surface. The maximum load at failure was recorded in Newtons (N). The push-out bond strength of each slice was calculated and expressed in (MPa).

To determine the exact bonding surface, the post diameters were measured before the push-out test on each surface of the post/dentin sections using the digital caliper.

The bonding area was calculated using the formula:[16]

(R1 represents the larger post radius, R2 the smaller post radius, and h is the thickness of each part.)

Failure Modes

After the push-out testing, all slices were analyzed under a stereomicroscope at 20 × magnification to determine the failure mode.

The patterns were classified as:

- Adhesive failure 1 (cement/dentin): Resin cement had wholly separated from the dentin surface.
- Adhesive failure 2 (cement/post): Resin cement completely separated from the post surface.
- Mixed failure: Resin cement is on the dentin and post surface.

Statistical Analysis

One-way analysis of variance (ANOVA) test was used to compare the data. Multiple comparisons were evaluated with the Tukey HSD test method ($p<0.05$).

Table 1: Materials used in the study.

Material	Manufacturer	Composition
Reforpost Refill (Parallel) glass fiber post	Angelus, Londrin, PR, Brazil	80% fiberglass, 20% epoxy resin; fiber structure extending longitudinally into the resin matrix (radiopaque post)
Polydentia (Conical) glass fiber post	Polydentia SA, CH-6805 Mezzovico, Switzerland	80% fiberglass, fiber structure extended longitudinally into polyester resin matrix (radiopaque post)
AAA Transparent (Conical) fiber post	StarDent, China	65% quartz fiber (radiolucent post)
Panavia F2.0	Kuraray/ Noritake, Japan	ED Primer A: HEMA, 10-MDP, 5-NMASA, water, accelerator ED Primer B: 5-NMASA, water, accelerator, sodium benzene sulfinate Paste A: Silanated silica, microfillers, 10-MDP, methacrylates, photochemical initiator Paste B: Silanated barium glass, surface treated NaF, dimethacrylates, chemical initiator

RESULTS

The mean push-out binding and standard deviation values of the groups in MPa are shown in Table 2.

The highest push-out binding values were observed in the Polydentia group (5.04 ± 0.54); the lowest was seen in the Reforpost group (1.5 ± 1.03). There was no statistical difference between the push-out binding values of the apical, middle, and coronal region samples of the Reforpost and AAA Transparent groups ($p>0.05$). In the Polydentia group, the push-out binding values of the coronal region samples were significantly higher than those in the middle region ($p= 0.006$). When the post groups were compared, the difference between the push-out binding values of all groups was statistically significant ($p<0.05$).

Failure Mode Analysis

The predominant failure modes of Reforpost, Polydentia, and AAA Transparent groups were adhesive failure 1 (dentin/cement) and mixed (dentin/cement and post/cement) failure modes. Adhesive failure 2 (post/cement) mode was less common in all groups (Table 3).

Table 2: The mean push-out binding and standard deviation values of the groups in Mpa.

Groups	Root Canal Regions		
	Apical	***Middle***	***Coronal***
Reforpost	2.21 ± 0.72aA	1.5 ± 1.03aA	2.82 ± 1.52aA
Polydentia	4.4 ± 0.53abB	4.07 ± 0.61aB	5.04 ± 0.54bB
AAA Transparent	2.62 ± 0.45aC	2.66 ± 0.58aC	3.27 ± 0.58aC

* Different lowercase letters in the same row and different uppercase letters in the same column indicate statistical significance ($p<0.05$).

Table 3: Distribution of failure modes.

Groups	Adhesive Failure 1	Adhesive Failure 2	Mix Failure	Total
Reforpost				30
coronal	6	1	3	10
middle	6	1	3	10
apical	4	0	6	10
Polydentia				30
coronal	4	3	3	10
middle	6	1	3	10
apical	5	1	4	10
AAA Transparent				30
coronal	1	0	9	10
middle	3	1	6	10
apical	5	2	3	10

DISCUSSION

This study compared the push-out bond strength values of three different fiber post systems bonded with dual-cure resin cement in different root regions. According to the results of the study, it was seen that the null hypotheses were rejected. There was a statistically significant difference between the binding values of the post systems. In addition, the difference between the binding values in different root regions was statistically significant.

The most common problem in traditional post-supported restorations is the stress centers formed in the tooth due to irregularities in stress distribution. This stress can enlarge microcracks in the tooth and post-core structure, leading to dentin fractures overtime.[3,17] This problem is being tried to be solved with fiber post systems that are easy to apply, have an elastic modulus similar to dentin, have high aesthetic properties, and do not show corrosive properties.[18–20]

The fact that fiber posts have a high flexure strength and elasticity modulus similar to dentin reduces the possibility of tooth fracture by ensuring a homogeneous distribution of the forces on the restoration.[21,22] Fiber posts have passive retention in the root canal, so resin cements are needed to increase post retention. Additionally, the need for a perfect fit of the fiber post into the root canal space is another critical limitation in using these systems.[23]

Adhesion with root dentin is a very complex process. In addition to the limiting anatomical structure of the dentin tissue, many factors such as the presence of the smear layer, bacterial contamination, operator experience, root canal irrigant used, adhesive system, and root canal sealer affect the adhesion between root dentin-post. In our study, post spaces were washed with 2 mL of 5.25% NaOCl, followed by 10 mL of distilled water. NaOCl is a strong organic tissue solvent. It also has a high antibacterial effect. An attempt was made to increase the infiltration of the adhesive resin into the dentin by removing the smear layer with 5.25% NaOCL irrigation. Additionally, the dual-curing polymerization mechanism of the resin cement used in the present study is expected to provide a more homogeneous conversion rate along all root canals.[24] Moreover, the researchers try to increase the bond strength between root dentin and fiber posts by using fiber post systems with different surface properties or translucent.[25–27] In our study, a translucent fiber post system (conical-shaped) was used alongside two opaque fiber post systems (conical/parallel-shaped).

The number and distribution of dentinal tubules vary anatomically in different regions of the tooth root. Since these differences affect adhesion to dentin tissue, they are essential for the success of restorations bonded to dentin. It has been reported that the number of tubules in root dentin decreases from the coronal to the apical direction.[28] The studies report that the highest bond strength is in the coronal region, and the lowest is in the apical region, regardless of the post system applied. Higher bond strength values measured in the coronal region were associated with more dentinal tubules in this region. As the number of tubules increases, the areas where adhesive resins can penetrate increases.[10,29–31] Similarly, in our study, the highest binding values in the Polydentia group were seen in the sections in the coronal region of the root. Besides, there was no statistical difference between the push-out binding values of the apical, middle, and coronal region samples of ReforPost and AAA Transparent post systems.

In our study, it was observed that the push-out bond strength values of all post systems were statistically different ($p<0.05$). The highest values were Polydentia (coronal: 5.04 ± 0.54); the lowest values were seen in the Reforpost glass-fiber post system (middle: 1.5 ± 1.03). The compositions of Polydentia and Reforpost glass-fiber post systems are similar. They contain the same amount of glass fiber (80%). The most significant difference between these systems is the post geometry. The Polydentia post system is in conical form; Reforpost is in parallel form. The conical form is more suitable for the anatomy of the tooth root. Additionally, the thickness of the resin cement used to bond conical posts can be more uniform throughout the root canal. This situation may contribute to the balanced distribution of the forces on the post-supported restoration and increase the push-out bond resistance of the post. These factors may influence the Polydentia post system, showing higher bond strength values than Reforpost.

The difficulty of photoactivation and polymerization in the apical region is a significant limitation in the cementation of post restorations.[15,32] For this reason, manufacturers have developed transparent post systems. Studies have shown that transparent posts increase photoactivation in intraradicular dentin.[33] However, other studies have shown that achieving the same performance with opaque posts is possible even in the apical third.[34] Our study's AAA Transparent fiber post system showed the second-highest push-out bond strength values. Compared to Reforpost, the conical shape and translucent feature of the AAA Transparent fiber post system increased the bond strength values. However, this post system showed significantly lower values than Polydentia, which has a conical form and opaque structureThe AAA Transparent post system differs from the other post systems in the study with its 65% quartz-fiber content. The composition of the post materials may also be effective in failures that may occur at the interfaces of the tooth-cement-post trio.

Different studies in the literature evaluate the push-out bond strength of fiber posts.[35–37] Comparative studies have used different adhesive and fiber post systems with different content and structures. When the results of these studies are examined, it is seen that the researchers did not reach a common conclusion.[38–40]

When the failure modes of post systems were evaluated in our study, adhesive failure 1 (dentin/cement) and mixed failure (dentin/cement, post/cement) were commonly observed. However, reaching a clear conclusion about the failure mode in the post systems adhesion is impossible. Additionally, different failure modes were observed predominantly in different root-canal regions of the same post system. For this reason, the number of samples should be increased and supported by clinical studies to analyze the bond strength of fiber post systems in more detail.

CONCLUSION

The push-out bond strength of conical-shaped fiber post systems was more successful than the parallel-shaped post systems. The use of transparent post systems can strengthen adhesion, but in our study, the highest bonding values were seen in the opaque Polydentia fiber post system. Push-out bonding values of post systems may vary in different root regions. In all fiber post systems in our study, the highest push-out bonding values were detected in the coronal region of the root.

Ethical Approval

The necessary ethical approval for this study has been obtained from the Selcuk University Non-Drug and Medical Device Ethics Committee (2023/44).

Financial Support

No financial support was received from any institution or organization for this study.

Conflict of Interest

There is no conflict of interest in this study.

Author Contributions

Design: MG, ARC, Data collection or data entry: MG, ARC, OKT, AKO Analysis and interpretation: MG, ARC, OKT, AKO Literature review: MG, ARC, OKT, AKO Writing: MG, ARC

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NEU PRESS

Diş Hekimliği Dergisi

Vol: 6 No: 1 Year: 2024 | Research Article | e-ISSN: 2687-5535

https://doi.org/10.51122/neudentj.2024.91

Do Parents' Dental Neglect and Anxiety Affect Their Children's Dental Neglect and Anxiety?

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Article Info

Article History

Received: 26.05.2023
Accepted: 30.11.2023
Published: 30.04.2024

Keywords:
Anxiety,
Oral Health,
Pediatric Dentistry.

ABSTRACT

Aim: Dental neglect is an obstacle to obtaining the necessary dental care in protecting and maintaining basic oral health. Dental anxiety can cause difficulties in behavior management, maintenance of dental treatments, and poor oral hygiene. In this study, it was aimed to examine the relationship between dental neglect and anxiety levels of both parents and their children.

Material and Methods: 220 people including 110 parents and 110 children were included in the study. The Dental Neglect Scale (DNS), Modified Dental Anxiety Scale (MDAS), and Visual Analogue Scale (VAS) were used for parents. In addition, the Dental Neglect Scale (DNS), the Faces version of the Modified Child Dental Anxiety Scale (MCDASf), and the Wong Baker Faces Pain Rating Scale (WBFS) were applied to children. The statistical analysis was performed using Spearman Correlation test and Mann Whitney-U test.

Results: In the study, a positive correlation was found between parent's and children's neglect scores (r=0.261; p=0.006). Likewise, a positive correlation was observed between the DMFT and anxiety scores of the children (r=0.237; p= 0.013). In addition, it was observed that there was a statistical correlation between the level of pain felt at the last dental treatment and anxiety in children (r=0.316; p=0.001).

Conclusion: It was observed that the dental neglect of the children of parents who neglected their own oral health increased. It is thought that informing parents about the importance of oral health and the consequences of dental neglect will have positive effects on their children's oral health.

Ebeveynlerin Dental İhmal ve Anksiyete Düzeyleri Çocuklarının Dental İhmal ve Anksiyete Düzeylerini Etkiler mi?

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 26.05.2023
Kabul Tarihi: 30.11.2023
Yayın Tarihi: 30.04.2024

Anahtar Kelimeler:
Anksiyete,
Ağız Sağlığı,
Çocuk Diş Hekimliği.

ÖZET

Amaç: Dental ihmal, temel ağız sağlığının korunması ve sürdürülmesinde gerekli dental bakımın alınması için engel teşkil etmektedir. Dental anksiyete ise; davranış yönlendirilmesinde, dental tedavilerin idamesinde zorluklara ve kötü ağız hijyenine sebep olabilmektedir. Bu çalışmada ebeveynlerin ve çocuklarının dental ihmal ve anksiyete düzeyleri arasındaki ilişkinin incelenmesi amaçlandı.

Gereç ve Yöntemler: Çalışmaya 110 ebeveyn 110 çocuk olmak üzere 220 kişi dahil edildi. Ebeveynler için Dental İhmal Ölçeği [Dental Neglect Scale (DNS)], Modifiye Edilmiş Dental Anksiyete Ölçeği [Modified Dental Anxiety Scale (MDAS)] ve Görsel Analog Ölçeği [Visual Analogue Scale (VAS)] kullanıldı. Çocuklar üzerinde ise Dental İhmal Ölçeği [Dental Neglect Scale (DNS)], Modifiye Çocuk Dental Anksiyete Ölçeği Yüz Versiyonu [MCDASf] ve Wong Baker Ağrı Değerlendirme Ölçeği [Wong–Baker Faces Pain Rating Scale (WBFS) uygulandı. Verilerin analizi Spearman Korelasyon testi ve Mann Whitney-U testi ile yapıldı.

Bulgular: Çalışmada ebeveynlerin ve çocukların ihmal değerleri arasında pozitif korelasyon olduğu bulundu (r=0,261; p=0,006). Ankete katılan çocukların DMFT ve anksiyete değerleri arasında pozitif bir korelasyon gözlendi (r=0,237; p= 0,013). Ayrıca çocuklarda son dental tedavide hissedilen ağrı düzeyi ile anksiyete arasında istatistiksel olarak ilişkili olduğu görüldü (r=0,316; p=0,001).

Sonuç: Kendi ağız sağlığını ihmal eden ebeveynlerin çocuklarının dental ihmal düzeyinin arttığı görüldü. Ebeveynlerin ağız sağlığının önemi ve dental ihmalin sonuçları konusunda bilgilendirilmesinin çocuklarının ağız sağlığı üzerinde pozitif etkileri olacağı düşünülmektedir.

To cite this article:
Aydınoğlu S., Arslan İ., Bilgir BS., Yazar M., Karan NB. Do Parents' Dental Neglect and Anxiety Affect Their Children's Dental Neglect and Anxiety? NEU Dent J. 2024;6:79-88. https://doi.org/10.51122/neudentj.2024.91

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INTRODUCTION

Dental negligence is defined as not taking the necessary precautions to protect basic oral health, preventing pain, infection and loss of function, and not performing the needed dental treatment.[1] It is the responsibility of parents or caregivers to follow the health-related needs of children and protect their oral health. Since children's motor skills do not develop sufficiently before the age of 3, they cannot meet their self-care needs without parental help. Although the child wants to take over oral care, which is one of the self-care habits, from the parent after about the age of 3, the parent must accompany the brushing as they cannot provide effective cleaning on their own until the age of 6.[2]

Tooth decay that is not treated early can have negative effects on the child's overall health and quality of life. Children who are exposed to untreated severe early childhood caries that cause negative conditions such as pain, infection and trauma are dragged into dental neglect.[3,4] Parents' attitudes, knowledge and thoughts on the subject are very important in preventing the development of caries in children and maintaining oral health.[5,6] Parents need to accept oral health as a part of general health and be aware that tooth decay is a preventable condition with early preventive approaches.[7] The Dental Neglect Scale is used to evaluate the extent to which the parent or caregiver is interested in the child's oral health, how often they take them to the dentist, and their awareness of oral health. DNS is viewed as an important tool to help identify the cause of poor oral health in children.[8]

Dental anxiety, which is a problem that affects large masses and can be encountered by every individual, is the feeling of discomfort that may occur towards the dentist and the treatment.[9] Dental anxiety causes the child to resist the parent and the dental team, leading to difficulties in behavioral management, avoidance of dental treatment, and consequences such as poor oral health.[10] It is necessary to evaluate and prevent dental anxiety in order to overcome these problems, facilitate diagnosis and treatment, and also ensure an enjoyable dentist visit.[11]

Numerous factors, including age, gender, education, socioeconomic background, and the number of siblings, have been found to influence children's dental fear.[12] Numerous surveys have been conducted to evaluate the influence of particular factors on dental anxiety.[12,13] There is a correlation between a parent's dental anxiety and their child's dental anxiety, and the family's attitude has been found to be significant in the development of dental anxiety.[14] Considering that families are role models for their children in the development of dental fear and anxiety, it has been reported that families' awareness and knowledge on this subject can help reduce children's anxiety level.[15]

For this purpose, the oral health, dental neglect and anxiety levels of the mothers and children in the current study were determined and the relationships between them were examined. In addition, an assessment was conducted regarding the impact of anxiety and neglect on dental health.

MATERIALS AND METHODS

Ethical Approval

This study was reviewed by the Recep Tayyip Erdoğan University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee and was approved with protocol number 2019/171. Parents who were informed about the content of the research and whose written consent was obtained were included in the study.

Study Design and Sample Size

This cross-sectional study was carried out on children who applied to the Recep Tayyip Erdoğan University Faculty of Dentistry, Department of Pedodontics, for examination and treatment between October 2022 and April 2022. Children between the ages of 6 and 12, who did not have any

physical/mental disabilities or systemic diseases, and their parents were included in the study. According to the sample calculation made with the G-Power program, the minimum number of participants was determined as 220 (110 children and 110 parents) with 95% confidence (1-α), 95% (1-β) test power and d = 0.445 effect size. [16]

Implementation of Surveys

In the first stage of the study, after demographic information was recorded in the survey form prepared for the parents, DNS and MDAS were applied to the parents. In addition, the parents were questioned about their visits to the dentist in the last 6 months, and the level of pain they felt during the last dental treatment was determined using the Visual Analogue Scale (VAS).

In the second phase of the study, DNS and the Modified Child Dental Anxiety Scale Facet Version ($MCDAS_f$) were administered to the children. The level of pain felt by the children during their last dental treatment was recorded with the Wong Baker Pain Rating Scale (Wong–Baker Faces Pain Rating Scale (WBFS).

Dental Neglect Scale (DNS)

The six questions included in the DNS, which was used to measure the dental neglect levels of the parents participating in the study, are given in the Figure 1. Each question in the scale is evaluated between 1 (I completely agree) and 5 (I completely disagree).[17] The total DNS score varies between 6 and 30, and an increase in the score indicates high dental neglect.

Figure 1. Questions of Dental Neglect Scale[17]

	DNS for Parents	DNS for Children
1	I do my dental care at home	My child does his own oral care at home
2	I get the necessary dental care	My child gets the necessary dental treatment
3	I need dental care, but I postpone it	My child brushes his teeth as much as necessary
4	I brush my teeth enough	My child controls his snacks between meals as much as necessary
5	I control my snacks sufficiently	My child believes that his oral health is important
6	I know that oral health is important	My child needs dental treatment, but I am postponing it
7	-	My child needs dental treatment, but she/he is postponing it.

There are 7 questions in the DNS used to evaluate the dental neglect levels of the children participating in the study. These questions are also shown in the Figure 1. Each question in the scale is evaluated between 1 (I completely agree) and 5 (I completely disagree).[8] The total DNS score varies between 7 and 35, and an increase in the score indicates high dental neglect.

Modified Dental Anxiety Scale (MDAS)

The 5 questions in the MDAS, which is a valid and useful method to measure parents' dental anxiety levels, are shown in the Figure 2. Each question in the scale is evaluated between 1 (No worry) and 5 (Extremely anxious). The total score in MDAS varies between 5 and 25, and an increase in the score indicates high dental anxiety.[18]

Figure 2. Modified Dental Anxiety Scale[18]

1	How would you feel if you were going to the dentist tomorrow?
2	How would you feel if you were sitting in the waiting room for treatment?
3	How would you feel if one of your teeth were to be filled?
4	How would you feel if your teeth were to be cleaned and polished?
5	How would you feel if local anesthesia was injected into your gum above your upper back

Modified Children's Dental Anxiety Scale Faced Version ($MCDAS_f$)

The 8 questions included in the MCDASf, which is used to measure children's dental anxiety levels, are given in the Figure 3. Each question in the scale is evaluated between 1 (Comfortable - Not Worried) and 5 (Very worried). The total score in MCDASf varies between 8 and 40, and an increase in the score indicates high dental anxiety.[19]

Figure 3. Modified Children's Dental Anxiety Scale Faced Version[19]

1	How do you feel when you go to the dentist?	
2	How do you feel when your teeth are looked at?	
3	How do you feel when your teeth are cleaned and polished?	
4	How do you feel when your gums are injected?	
5	How do you feel when you have a filling in your tooth?	
6	How do you feel when your tooth is extracted?	
7	How do you feel when you are put to sleep for dental treatment?	
8	How do you feel when you receive a mixture of gas and air that does not make you sleep but helps you relax for the treatment?	

Visual Analogue Scale (VAS)

VAS, which is an effective, easy-to-understand measurement tool, is also frequently used to measure pain parameters. The scale

consists of a line 10 cm long horizontally. There are numbers between 0 and 10 on the line. 0 = No pain, 10 = Worst/Unbearable pain. After the procedure, the patient is asked to give a value between these two numbers on the scale shown, depending on the level of pain he/she feels.[20]

Wong Baker Pain Rating Scale (WBFS)

It is used as a valid and reliable scale in the evaluation of pain because it is easily and quickly understood by children.[21] In this scale, where facial expressions are evaluated, there are 6 facial expressions rated from 0 to 10 according to the severity of pain. Scores from the scale between 0 and 4 indicate mild pain, scores between 4 and 6 indicate moderate pain, scores between 6 and 8 indicate severe pain, and scores between 8 and 10 indicate unbearable pain.

Clinical Evaluation

According to WHO guidelines, a single doctor performed intraoral examinations under reflector light on the children and their parents who completed the survey. The examinations involved the use of a mirror and an examination probe. Accordingly, the oral health of children and their parents was evaluated using the number of decayed, filled, and extracted teeth (Decayed, Missing, and Filled Teeth (DMFT)) and the Simplified Oral Hygeine Index (OHI-S).[22,23]

For the OHI-S index, the buccal surfaces of teeth 16 and 26, the lingual/palatal surfaces of teeth 36 and 46, and the labial surfaces of teeth 11 and 31 were examined. In case the tooth to be used was missing, symmetrical tooth/teeth were examined. In the scoring between 0 and 3, 0 = “no plaque”, 1 = “less than 1/3 plaque”, 2 = “1/3 to 2/3 plaque”, and 3 = “more than 2/3 plaque”. The OHI-S plaque value for the patient was calculated by dividing the total value obtained by 3.

Statistical analysis

IBM SPSS Statistics 21.0 program was used for statistical evaluation. The descriptive analysis of the study were given with mean, standard deviation, median, minimum and maximum values. Mann Whitney U test was used to analyze variables that did not show normal distribution. Spearman Correlation test was applied to analyze the measurement data. Statistical significance level was accepted as $p<0.05$.

RESULTS

The survey was conducted on 110 children aged 6-12 and their parents. Table 1 provides the study participants' demographic information. It was found that 49.1% of the children were males and 50.9% were girls. The average age was determined as 8.55±1.80. It was observed that 92.7% of the children did not have a systemic disease, 3.6% did not visit the dentist in the last 6 months, and 37.3% were the first child of the family. While 75.5% of the parents participating in the survey were observed to be female, it was determined that 70.9% did not have a systemic disease. It was also determined that 58.2% did not visit the dentist in the last 6 months.

Table 2 has shown the average index values for the parents children involved in the survey. Children's neglect, anxiety, DMFT, OHIS mean and standard deviation values were 13.75±4.1, 19.63±6.6, 6.73±2.9, 0.92±0.6, respectively. Parents' neglect, anxiety, DMFT, OHIS mean and standard deviation values were 13.28±4.2, 8.77±4.6, 10.46±5.4, 1.28±0.9, respectively. While the average pain level felt during the last treatment was 1.77±2.2 in children, it was found to be 2.45±3.1 in parents.

The correlation analysis of the measured index values of the children and parents in the study is given in Table 3. There was no significant association between the parameters evaluated in children and neglect values ($p>0.05$). Also, there was no statistically significant association between the parameters evaluated in parents and neglect values ($p>0.05$). A positive relationship ($r = 0.261$; $p = 0.006$) was found between the neglect values of children and their parents. Consequently, it was established that parents who neglected their

own oral health also significantly neglected their children's oral health.

A positive correlation was observed between anxiety and DMFT values of the children participating in the study (r = 0.237; p = 0.013). Consequently, it was determined that the DMFT values of children with high anxiety levels also increased. Additionally, a positive relationship was detected between anxiety in children and the degree of pain felt during the last dental treatment (r=0.316; p=0.001). It was observed that the child's past painful dental experiences negatively affected the anxiety value.

A positive correlation was detected between the level of pain felt during the last dental treatment and anxiety values in the parents who participated in the survey, as in the children (r = 0.256; p = 0.007). While it was seen that the pain levels felt by the child and their parents during the last dental treatment were related to their own anxiety values, there was no important relationship between the anxiety values of the child and their parents (p>0.05).

Table 4 shows the relationship between the child's neglect and anxiety values and other variables. Accordingly, a significant relationship was found between the children's anxiety values and their ages (p = 0.03). It was observed that as the children's ages increased, their anxiety levels decreased. There was no significant association between the other evaluated parameters and neglect and anxiety values (p>0.05).

Table 1: Demographic characteristics of the participants in the study

	PARENTn (%)	**CHILD** n (%)
Gender		
Female	83 (75.5)	56 (50.9)
Male	27 (24.5)	54 (49.1)
Systemic Disease		
Yes	32 (29.1)	8 (7.3)
No	78 (70.9)	102 (92.7)
Dental Visit		
I have been to the dentist in the last months	46 (41.8)	106 (96.4)
I haven't been to the dentist in the last months	64 (58.2)	4 (3.6)
Birth Order		
First Child	-	41 (37.3)
≥ Second Child	-	69 (62.7)

Table 2: Average index values of the parents and children included in the study

	PARENT		**CHILD**	
	Mean ±SD	M (Min-Max)	Mean ±SD	M (Min-Max)
Dental Neglect	13.28±4.2	13 (6-26)	13.75±4.1	13 (7-26)
Anxiety	8.77±4.6	7 (1-25)	19.63±6.6	19.5 (8-40)
Pain felt during last treatment	2.45±3.1	1 (0-10)	1.77±2.2	2 (0-10)
OHI-S	1.28±0.9	1 (0-6)	0.92±0.6	1 (0-5)
DMFT	10.46±5.4	9 (2-26)	6.73±2.9	6 (1-16)

SD: Standard deviation M: Median Min: Minimum, Max: Maximum

Tablo 3: Correlation analysis of index values of the parents and children included in the study

			PARENT					CHILD				
			DMFT	OHI-S	Pain	Anxiety	Neglect	DMFT	OHI-S	Pain	Anxiety	Neglect
PARENT	DMFT	r	1									
	OHI-S	r	0.034	1								
	Pain	r	0.078	0.170	1							
	Anxiety	r	0.070	0.163	**0.256***	1						
	Neglect	r	0.007	0.181	0.020	0.151	1					
CHILD	DMFT	r	0.008					1				
	OHI-S	r		0.058				0.096	1			
	Pain	r			0.023			0.157		1		
	Anxiety	r				0.047		**0.237***	0.165	**0.316***	1	
	Neglect	r					**0.261***	0.127	0.103	0.048	0.002	1

Table 4: Examination of children's average neglect and anxiety values and demographic data

	Neglect		Anxiety	
	Mean ±SD	M(Min-Max)	Mean ±SD	M(Min-Max)
Age (Year)				
6-9	13.93±4.3	13(7-26)	20.54±6.7	21(8-40)
10-12	13.35±3.4	13(7-21)	17.59±5.9	17(8-33)
p value		0.851		**0.03***
Gender				
Female	12.79±3.5	12(7-22)	20.09±7.2	20(8-40)
Male	14.76±4.4	14(7-26)	19.15±5.9	19(9-35)
p value		0.376		0.457
Systemic disease				
Yes	12±1.5	11.5(10-14)	19.12±6.7	19(10-30)
No	13.89±4.2	13(7-26)	19.67±6.6	19.5(8-40)
p value		0.208		0.268
Dental visit				
I have been to the dentist in the last months	13.77±4.1	13(7-26)	19.62±6.5	19.5(8-40)
I haven't been to the dentist in the last months	13.25±1.7	13.5(11-15)	19.75±8.6	21.5(8-28)
p value		0.917		0.156
Birth order				
First child	14±4.3	13(7-26)	19.41±6.9	18(8-40)
≥ second child	13.61±3.9	13(7-26)	19.75±6.4	20(9-35)
p value		0.537		0.669

SD: Standard deviation, M: Median, Min: Minimum, Max: Maximum

DISCUSSION

Dental neglect is characterized by the physical neglect of the oral cavity, the failure to provide dental care, and the lack to take the required precautions to maintain oral health.[8] Dental anxiety is expressed as a state of intense uneasiness that cannot be fully described, caused by fear and delusions about dental treatment.[24] Parents' dental neglect and anxiety levels and their past dentist experiences may cause them to neglect their children's oral health and develop dental anxiety. For this purpose, the effects of parents' dental neglect and anxiety values on their children's dental neglect and anxiety values were evaluated. Additionally, the relationship between neglect, anxiety, the level of pain felt during the last dental treatment, and oral health was also examined.

In order to achieve and maintain oral health in children, their parents must be involved in oral health and dental care. Until the age of seven, it is the parents' responsibility to

be directly involved in the child's daily oral hygiene practices.[8] Any signs of dental neglect, especially in early childhood, are thought to be directly related to the parent. A study showed that parents' habit of visiting the dentist regularly will cause lower DNS in children.[25] Similarly, this study has shown a significant correlation between the parents' dental neglect values and their children's dental neglect values. Accordingly, it was determined that parents who did not pay due attention to their own oral hygiene did not pay due attention to their children's oral care and health.

Dental neglect begins in childhood and extends from adolescence to old age, being affected by various factors such as lifestyle and daily habits.[17,26] In a study conducted on this subject, dental neglect values in children were found to be 21.46. [16] In the present study, it was found that dental neglect values were much lower in children. It is thought that the variability between dental neglect values is related to the different sociocultural environments in which the studies are conducted and the frequency of dental visits and the formation of a conscious patient profile. In a study conducted on adults in Hong Kong, dental neglect values were found to be 14.81. [27] It was observed that the dental neglect values of the parents in the present study were close to the findings of the study done by McGrath et al.[27]. According to these values, it is seen that dental neglect is at similar rates even in different cultures and societies. According to the literature review, there are separate studies on dental neglect in adults and children. However, there is no study that evaluates the dental neglect levels of parents and their children together with their effects on oral health and anxiety values. In this regard, it is considered that the current study can contribute to the literature.

Dental anxiety is defined as the common fear and anxiety in children and adolescents that occur due to dental treatments that are affected by various environmental and social factors.[28,29] In a study conducted on a similar population on this subject, dental anxiety values were found to be 21.18. [16] It was observed that the dental anxiety values found in another study conducted on Nepali children including three different age groups were similar to the findings of the study conducted by Aydinoglu and Arslan[16].[30] In a study conducted in Romania, it was found that the dental anxiety values of 90.5% of the participants were 19 and above.[31] The current study found that dental anxiety values agreed with the findings of previous research evaluating dental anxiety in children. A total score of 19 or above on the MCDASf indicates the presence of dental anxiety.[31] These values can be considered an indicator of the presence of dental anxiety in the societies where the studies were conducted. The similarity between dental anxiety values obtained in the studies emphasizes that anxiety is a common problem that can be seen in every society and social environment.

Dental anxiety, which is common in children, may be a risk factor for tooth decay. Some studies have not found a relationship between caries and dental anxiety[16,32], but in a study conducted by Yahyaoglu et al.[33], it was determined that children with high anxiety values also had high DMFT values. Supporting this result, the current study also showed that children's dental anxiety levels increased as DMFT values increased. This situation is thought to be related to the deterioration of general oral health and the increase in the number of decayed teeth due to the tendency to avoid treatment due to anxiety. In patients with high dental anxiety, measures to reduce anxiety and relax patients can contribute to the protection of oral health.

It has been stated that bad dental experiences in the past increase anxiety.[34,35] Locker et al. [36] declared that the experience of a painful dental treatment was the most important determinant of dental anxiety. In a study done by Baygın et al.[37], it was stated that there was a positive relationship between the level of anxiety before the procedure and the degree of

pain felt during the procedure. In a relevant study, it was concluded that anxiety may arise due to negative experience or a feeling of uncertainty due to lack of information about the treatment to be performed, due to the correlation between anxiety and pain scores.[37] In this study, a positive relationship was observed between the pain levels and anxiety values felt by both children and their parents during the last treatment. Accordingly, it can be thought that past painful dental experiences negatively affect the anxiety values of individuals, both adults and children.

It is stated that there is a significant association between parents' dental anxiety and the development of dental anxiety in their children.[38] Nevertheless, Alwin et al.[39] reported that the relationship between child and parent anxiety was weak and that dental anxiety in the child did not originate from the parent. In this study, no direct relationship was found between parents' and their children's anxiety values. This may be due to the fact that dental anxiety is affected by many other factors such as age, gender and sociodemographic characteristics.

Dental anxiety is a risk factor that has negative effects on oral and dental health in many societies, starting in childhood and continuing into adulthood.[11] It has been stated that dental anxiety values are higher at younger ages.[35,40,41]In a study conducted by Folayan et al.,[42] it was reported that dental anxiety started to decrease as of 6-7 years of age, and the ability to cope with fears improved as age increased. In the present study, it was seen that dental anxiety decreased with increasing age. Children can learn to control their fears over time as they get older. This can help keep anxiety under control.

CONCLUSION

Conducting the study in a single center where socioeconomic and cultural diversity is limited limits the current study in terms of sample profile. Multicenter studies with a wide patient profile are needed on this subject. In addition, questioning the presence of pain after the last dental procedure may not always provide an objective answer in terms of pain assessment. This is among the limitations of the study. When the literature is examined, there are many studies on dental anxiety conducted separately in adults and children; however, there appears to be a limited number of studies evaluating the association between the anxiety values of children and their parents. Literature review shows that there are many studies on dental anxiety conducted separately in adults and children. As the first study to look at the connection between anxiety values of parents and their kids and dental neglect, it is anticipated that the current study will add to the body of literature.

Ethical Approval

The ethics committee approval for the study was obtained from Recep Tayyip Erdogan University Faculty of Medicine Non-Interventional Clinical Research Ethics Committee (Decision no: 2019/171).

Financial Support

No financial support was received from any institution or organization for this study.

Conflict of Interest

The authors deny any conflicts of interest related to this study.

Author Contributions

Study design: SA; Data collecting: BSB, MY; Data entry: SA, İA; Data analysis and interpretation: SA, İA, NBK; Literature review: BSB, MY; manuscript writing: SA, İA, BSB, MY.

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NEU PRESS

Diş Hekimliği Dergisi

Vol: 1 No: 1 Year: 2024 | Research Article | e-ISSN: 2687-5535

https://doi.org/10.51122/neudentj.2024.92

Investigation of the Effect of Denture Cleaning Solutions on Surface Hardness and Surface Roughness of Soft Lining Materials

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Article Info

Article History

Received: 17.07.2023
Accepted: 01.04.2024
Published: 30.04.2024

Keywords:
Denture Cleaning Solution, Soft Lining Materials, Surface Roughness, Surface Hardness.

ABSTRACT

Aim: The purpose of this study is to investigate the effects of commercial and non-commercial agents used to clean dentures on the surface roughness and hardness of two soft lining materials.

Material and Methods: A total of 50 samples were used in this study. Samples were prepared from acrylic resin (Visco Gel) and silicone-based (Molloplast B) soft lining materials. The samples' roughness and hardness values were measured. After the samples were kept in distilled water, white vinegar, denture cleanser tablet, 2% chlorhexidine gluconate, and 5% sodium hypochlorite for 15 minutes, 30 minutes, 45 minutes, 60 minutes, 2 hours, 8 hours, 24 hours, and 48 hours, roughness and hardness values were measured again. Statistical analysis was performed using the computer program SPSS Statistics 20.0 (SPSS Inc. Chicago, IL, USA) at a 95% confidence interval and p=0.05 significance level. Three-way ANOVA and Tukey's multiple comparison tests were used for the statistical analysis of data.

Results: The analysis of variance determined that the material type and time had a very significant effect (p<.001) on surface roughness and hardness values, while the solutions in which samples were kept had an insignificant effect (p>.05).

Conclusion: The surface roughness and hardness of acrylic resin and silicone-based soft lining materials were affected by denture cleaning solutions to different extents.

Protez Temizleyici Solüsyonlarının Yumuşak Astar Maddelerinin Yüzey Sertliği ve Yüzey Pürüzlülüğüne Etkisinin İncelenmesi

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 17.07.2023
Kabul Tarihi: 01.04.2024
Yayın Tarihi: 30.04.2024

Anahtar Kelimeler:
Protez Temizleme Solüsyonu, Yumuşak Astar Maddeleri, Yüzey Pürüzlülüğü, Yüzey Sertliği.

ÖZET

Amaç: Bu çalışmanın amacı, protezlerin temizlenmesi amacıyla kullanılan ticari ve ticari olmayan ajanların iki farklı yumuşak astar materyalinin yüzey pürüzlülüğü ve sertliğine etkisinin incelenmesidir.

Gereç ve Yöntemler: Bu çalışmada akrilik rezin (Visco Gel) ve silikon esaslı (Molloplast B) yumuşak astar materyallerinden toplam 50 adet örnek hazırlandı. Örneklerin pürüzlülük ve sertlik değerleri ölçüldü. Örnekler distile su, beyaz sirke, protez temizleyici tablet, %2 klorheksidin glukonat ve %5 sodyum hipoklorit te 15 dakika, 30 dakika, 45 dakika, 60 dakika, 2 saat, 8 saat, 24 saat ve 48 saat bekletildikten sonra pürüzlülük ve sertlik değerleri tekrar ölçüldü. İstatiksel analiz %95 güven aralığında ve p=0,05 anlamlılık düzeyinde SPSS Statistics 20.0 (SPSS Inc. Chicago, IL, ABD) bilgisayar programı kullanılarak yapıldı. Verilerin istatiksel analizinde üç yönlü ANOVA ve Tukey çoklu karşılaştırma testleri kullanıldı.

Bulgular: Yapılan varyans analizleri sonucunda; yüzey pürüzlülük ve sertlik değerleri üzerinde materyal türünün ve zamanın çok anlamlı (p<,001), bekletilen solüsyonların anlamsız (p>,05) olduğu belirlendi.

Sonuç: Akrilik rezin ve silikon esaslı yumuşak astar materyallerinin yüzey pürüzlülüğü ve sertliği protez temizleme solüsyonlarından farklı miktarlarda etkilenmiştir.

To cite this article:
Yeşil Z., Çakar-Güler C. Investigation of the Effect of Denture Cleaning Solutions on Surface Hardness and Surface Roughness of Soft Lining Materials. NEU Dent J. 2024;6:89-100. https://doi.org/10.51122/neudentj.2024.92

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INTRODUCTION

Among the primary issues with removable dentures is the disrupted compatibility between the mucosa and the denture base plate. The disruption of this compatibility adversely affects the denture's stability and retention, causing a reduction in a patient's chewing function.[1] Pain may occur due to the compression of the mucosa between the alveolar bone and the denture base plate due to impacts during chewing. In such cases, the denture is completely renewed or made compatible by performing lining between tissues and the base plate.[2] Soft lining materials are defined as polymers applied to dentures' tissue surfaces to balance forces and reduce the force in atrophied areas in complete and removable partial dentures.[3] These days, commonly used soft lining materials are categorized into two types based on their content: silicone-based and acrylic resin-based.[4,5] Depending on polymerization methods, soft lining materials are divided into four groups: autopolymerized, heat-polymerized, light-polymerized, and microwave-polymerized. Autopolymerized soft liners can be used temporarily for two to six weeks, whereas heat-polymerized types can be used permanently for six months to five years.[6] The architecture of soft lining materials, characterized by their textured surfaces, promotes the adhesion and proliferation of oral microorganisms.[7,8] Denture hygiene is extremely important since patients use dentures during the day and dentures are in constant contact with the oral environment containing diverse microorganisms.[9] The elevated microbial burden present on dentures contributes significantly to the heightened occurrence of oral complications, such as denture stomatitis and inflammatory papillary hyperplasia.[10] Since plaque formation is the main factor in the etiology of denture stomatitis, it is essential to ensure effective plaque control on the surface of soft lining materials.[11] Toothbrush or denture cleaning solutions are preferred for plaque control. It is recommended to use denture cleansers because mechanical cleaning with a toothbrush may damage a soft lining material.[12] According to their content, denture cleaning solutions can be classified into alkaline hypochlorites, disinfectants, alkaline peroxides, acids, and enzymes.[13] Denture cleansers that patients use prevent the formation of fungal and bacterial infections that typically cause denture-related stomatitis.[14] Various effervescent denture cleansers are available on the market in tablet or powder form.[15] Denture cleanser tablet, with the trade name Corega, is a commonly used denture cleanser.[16] Corega denture cleanser can remove light stains from denture bases and loosen residues.[17] Although denture cleansers are used routinely, they can impact the color stability, surface hardness, and surface roughness of denture base materials.[15,18] Sodium hypochlorite (NaOCl) is an effective disinfecting agent usually utilized as a denture cleanser. It has been demonstrated that, due to its bactericidal and fungicidal properties, sodium hypochlorite can decrease the organic matrix in biofilms and help remove stains when utilized as an overnight immersion solution.[18,19] Effective results were achieved for plaque formation on denture surfaces with a 0.2% concentration of chlorhexidine gluconate.[20] Vinegar is an easily available household cleaning product with an affordable price and low toxicity in comparison with other solutions. Vinegar is essentially a 6-13% weak acetic acid that only partially dissociates in aqueous solutions.[10] White vinegar is often utilized at concentrations of 50% and 100% to disinfect toothbrushes and denture bases.[10] Da Silva et al.[21] and Yildirim-Bicer et al.[22] It is recommended to employ a 100% vinegar solution for a duration of 10 minutes as a denture disinfection method, particularly effective against Candida albicans.

The increased hardness of soft lining materials is at the forefront among the various physical properties that may be impacted by using denture cleaning materials because the increased hardness of soft lining materials is an important factor that leads to clinical failure.

The desired shock absorption property disappears with the increased hardness. The influence of cleansers on the surface roughness of soft lining materials represents a critical determinant that may influence the adherence of microorganisms, consequently exacerbating oral complications.[23]

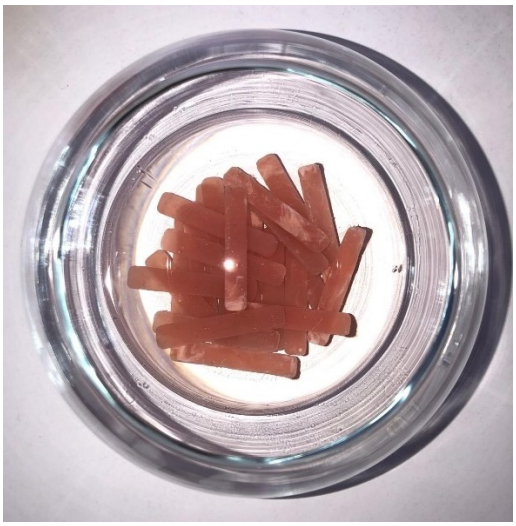
The present study was conducted to investigate the effects of commercial and non-commercial agents used to clean dentures on the surface microhardness and roughness of two soft lining materials.

The study's null hypothesis is that denture cleaning solutions will increase the surface roughness and hardness of two different soft lining materials over time. The alternative hypothesis was created as follows: for both soft lining groups, surface roughness and hardness will increase with the increased storage duration in solutions.

MATERIAL AND METHODS

The present study used Visco Gel (Dentsply Ltd., De Trey Division, Weybridge, UK) as an acrylic resin-based soft lining material and Molloplast B (Detax Karl Huber GmbH, Ettlingen, Germany) as a silicone-based soft lining material and used white vinegar (Bizim Vatan, Türkiye), denture cleanser tablet (Corega, GlaxoSmithKline, London, UK), 2% chlorhexidine gluconate (Microvem, Türkiye), 5% sodium hypochlorite (Microvem, Türkiye), and distilled water as denture cleansers. A total of 50 samples (25 from the acrylic resin-based and 25 from the silicone-based soft lining material) were prepared with the dimensions 65 mm x 10 mm x 3 mm using a metal mold in line with the standard ISO 1567[24]. The dimensions can be seen in the image showing a part of the silicone-based samples in Figure 1. Acrylic resin-based materials were formed by cold curing in specially prepared metal molds without applying any heat treatment. Silicone-based materials were obtained by placing them in a specially prepared metal mold and boiling them**.** Silicone-based soft lining materials were placed in cold water in a specially prepared metal mold, slowly heated to 100°C, and boiled for 2 hours. The samples were allowed to reach room temperature and then were removed from the metal mold. After smoothing the samples' surface with 600 grit sandpaper, they were polished with a pumice brush for 15 seconds. To ensure that residual monomers were removed, all specimens were immersed in distilled water maintained at a temperature of 37°C for a duration of 48 hours. Surface microhardness and roughness values were determined after the samples were allocated randomly into five groups (n=5), each comprising five specimens, and subsequently labeled with numerical identifiers. Following the immersion of the samples in distilled water**,** NaOCl at a ratio of 1:5, denture cleanser tablet, chlorhexidine gluconate water, and white vinegar, their surface microhardness and roughness values were measured. Measurements were made at the 15th, 30th, 45th, and 60th minutes and at the 2nd, 8th, 24th, and 48th hours.

Figure 1. A part of silicone-based samples kept in distilled water



The materials' surface hardness (Shore A values) was determined with an Equotip (Proceq) test testing device. Figure 2 shows the Equotip testing device. The samples' surface hardness values were measured from three different points on the lower and upper surfaces and averaged. A contact profilometer (Taylor Hobson, Surtronic 25) was used to measure surface roughness. Figure 3 shows the

profilometer. The testing conditions were determined at a diameter of 5 µm and a tip speed of 0.25 mm/sec. The mean Ra value was calculated in µm by aligning the tip of the profilometer from one end to the other on the samples' surfaces. Surface roughness was measured three times on both surfaces, and surface roughness values were determined by averaging them.

Figure 2: The Equotip device measuring samples' hardness

Figure 3: A sample whose surface roughness is measured with a profilometer

Statistical analysis

Analysis using statistical methods was carried out using the computer program SPSS Statistics 20.0 (SPSS Inc. Chicago, IL, USA) at a 95% confidence interval and p=0.05 significance level. The statistical analysis of data was carried out by Tukey's multiple comparison test and three-way analysis of variance (ANOVA). The t-test was used to analyze the statistical significance of data between two samples. The sample size was determined as a minimum of 50 samples using the package G*Power (G*Power Ver. 3,0,10, Franz Faul, Üniversität Kiel, Germany) with a 25% effect size, 80% power, and α=0.05 type I error rate.

RESULTS

The analysis of variance conducted to evaluate the samples' surface microhardness values determined that the material type and time had a very significant effect ($p<.001$), the solutions in which samples were kept had an insignificant effect ($p>.05$), the time-material and time-solution interaction had a significant effect ($p<.05$), and the other interactions had an insignificant effect ($p>.05$). Table 1 contains the mean and standard deviation results for surface microhardness values.

As seen in Table 1, the highest surface microhardness value was identified in acrylic resin-based (40.20 Shore A) samples kept in bleach for two days. Surface microhardness values usually increased in samples kept in all solutions, the highest increase was detected in samples kept in bleach, and the lowest increase was in samples kept in distilled water.

Table 2 presents the outcomes derived from Tukey's multiple comparison test, specifically examining surface microhardness values relative to the duration of storage.

According to Table 2, the difference between the durations after preparation and 30 minutes; 15 minutes and 30, 45, and 60 minutes, 2 hours and 8 hours; 30 minutes and 45 minutes; 2 hours and 8 hours was statistically insignificant ($p>.05$), while differences between all other durations were statistically significant ($p<.001$).

Table 1. Mean and standard deviation results for surface hardness (Shore A) values of samples

MATERIAL	DURATION	Solution in Which Samples are Kept									
		Distilled Water		Corega		White Vinegar		Chlorhexidine Gluconate		Bleach	
		X	Std. Deviation	X	Std. Deviation	X	Std. Deviation	X	Std. Deviation	X	Std. Deviation
ACRYLIC RESIN	0 min	30.80	3.42	32.60	0.89	31.80	1.79	32.60	2.30	32.00	1.22
	15 min	34.40	4.04	35.40	1.52	36.20	3.03	36.80	4.21	36.60	2.61
	30 min	34.60	4.34	34.40	0.89	32.80	3.27	35.40	4.39	35.00	1.00
	45 min	35.00	3.61	35.60	1.14	33.60	3.05	36.20	4.32	35.80	0.84
	60 min	35.40	3.21	36.00	1.22	34.40	2.70	37.00	4.30	36.40	0.55
	2 h	36.00	2.92	36.60	1.14	35.60	2.30	37.80	3.42	37.40	0.55
	8 h	36.40	2.97	37.00	1.00	36.60	2.07	38.80	2.77	38.40	0.55
	1 day	36.60	2.70	37.80	0.84	37.20	1.92	39.40	2.30	39.40	0.55
	2 days	37.00	2.55	38.40	1.14	37.80	2.28	40.00	1.87	40.20	0.45
SILICON EBASED	0 min	27.80	1.64	27.40	2.41	28.40	2.51	29.00	1.87	25.20	1.48
	15 min	29.00	1.22	28.60	2.61	30.00	2.83	31.80	2.59	27.40	2.30
	30 min	28.20	2.17	27.60	1.67	27.80	3.42	29.60	3.21	27.40	2.30
	45 min	28.60	1.82	28.40	2.07	28.80	2.68	30.00	3.24	28.00	1.58
	60 min	29.00	1.58	29.00	1.87	29.20	2.59	30.60	3.13	28.80	1.64
	2 h	29.40	1.52	29.80	1.92	29.80	2.17	31.20	3.11	29.80	1.64
	8 h	29.80	1.30	30.40	1.52	30.60	1.95	31.80	2.95	32.00	4.12
	1 day	30.40	0.89	31.00	1.22	31.20	1.64	32.40	2.88	33.00	4.24
	2 days	31.40	1.34	32.40	1.52	32.60	1.14	33.80	2.59	34.60	3.78

Table 2. Results of Tukey's multiple comparison test for surface microhardness values according to storage duration

Time	Time	Mean of Squares	SE	df	t	PTukey
After preparation	15 min	-2.86	0.21	40.00	-13.67	<.001
	30 min	-1.52	0.40	40.00	-3.83	0.012
	45 min	-2.24	0.37	40.00	-6.07	<.001
	60 min	-2.82	0.36	40.00	-7.80	<.001
	2 h	-3.58	0.33	40.00	-10.86	<.001
	8 h	-4.42	0.35	40.00	-12.56	<.001
	1 day	-5.08	0.34	40.00	-15.05	<.001
	2 days	-6.06	0.32	40.00	-18.81	<.001
15 min	30 min	1.34	0.46	40.00	2.94	0.109
	45 min	0.62	0.43	40.00	1.46	0.868
	60 min	0.04	0.43	40.00	0.09	1.000
	2 h	-0.72	0.40	40.00	-1.80	0.684
	8 h	-1.56	0.43	40.00	-3.64	0.020
	1 day	-2.22	0.42	40.00	-5.24	<.001
	2 days	-3.20	0.41	40.00	-7.76	<.001
30 min	45 min	-0.72	0.19	40.00	-3.72	0.016
	60 min	-1.30	0.21	40.00	-6.13	<.001
	2 h	-2.06	0.24	40.00	-8.58	<.001
	8 h	-2.90	0.33	40.00	-8.67	<.001
	1 day	-3.56	0.35	40.00	-10.13	<.001
	2 days	-4.54	0.36	40.00	-12.71	<.001
45 min	60 min	-0.58	0.08	40.00	-7.25	<.001
	2 h	-1.34	0.12	40.00	-11.33	<.001
	8 h	-2.18	0.25	40.00	-8.78	<.001
	1 day	-2.84	0.27	40.00	-10.38	<.001
	2 days	-3.82	0.29	40.00	-13.29	<.001
60 min	2 h	-0.76	0.08	40.00	-8.96	<.001
	8 h	-1.60	0.23	40.00	-7.00	<.001
	1 day	-2.26	0.25	40.00	-8.92	<.001
	2 days	-3.24	0.27	40.00	-12.09	<.001
2 h	8 h	-0.84	0.21	40.00	-3.93	0.009
	1 day	-1.50	0.23	40.00	-6.45	<.001
	2 days	-2.48	0.24	40.00	-10.16	<.001
8 h	1 day	-0.66	0.09	40.00	-7.67	<.001
	2 days	-1.64	0.13	40.00	-12.36	<.001
1 day	2 days	-0.98	0.08	40.00	-12.45	<.001

Table 3. Results of the t-test for surface microhardness values of materials

Material	Material	Mean of Squares	SE	df	t	PTukey
Acrylic resin	Silicone	6.18	0.56	40.00	10.98	< .001

Table 3 contains the t-test results for hardness values of both materials.

The findings from the t-test presented in Table 3 indicate significant variations in surface microhardness among the materials tested.

The analysis of variance performed to evaluate surface roughness values determined that the material type and time had a very significant effect (p<.001), the solutions in which samples were kept had an insignificant effect (p>.05), the time-material and time-solution interaction had a significant effect (p<.05), and the other interactions had an insignificant effect (p>.05).

Table 4 contains the mean and standard deviation results for the surface roughness values of the materials.

Table 4. Mean and standard deviation results for surface roughness values (Ra) of samples

MATERIAL	DURATION	Solution in Which Samples are Kept									
		Distilled Water		Corega		White Vinegar		Chlorhexidine Gluconate		Bleach	
		X	Std. Deviation	X	Std. Deviation	X	Std. Deviation	X	Std. Deviation	X	Std. Deviation
ACRYLIC RESIN	0 min	0.80	0.26	0.89	0.37	1.12	0.38	1.02	0.19	0.93	0.31
	15 min	0.91	0.32	1.28	1.07	1.43	0.75	1.68	0.47	0.96	0.31
	30 min	1.25	0.69	1.44	0.60	1.54	0.44	1.64	0.17	1.32	0.55
	45 min	1.34	0.70	1.50	0.65	1.69	0.39	1.68	0.16	1.47	0.60
	60 min	1.45	0.74	1.68	0.62	1.94	0.37	1.77	0.23	1.90	0.63
	2 h	1.60	0.73	1.87	0.57	2.26	0.35	1.87	0.37	2.17	0.54
	8 h	1.67	0.74	2.13	0.57	2.51	0.38	2.05	0.45	2.49	0.50
	1 day	1.78	0.68	2.33	0.48	2.64	0.46	2.24	0.44	2.75	0.42
	2 days	1.92	0.62	2.57	0.48	2.61	0.69	2.37	0.49	3.02	0.34
SILICON EBASED	0 min	0.52	0.16	0.58	0.21	0.42	0.17	0.44	0.07	0.44	0.11
	15 min	0.79	0.41	1.20	1.24	0.49	0.34	0.78	0.56	0.68	0.30
	30 min	1.07	0.47	0.53	0.22	0.69	0.48	0.76	0.42	0.67	0.24
	45 min	1.16	0.49	0.67	0.22	0.83	0.45	0.94	0.41	0.85	0.24
	60 min	1.26	0.50	0.89	0.26	0,94	0.45	1.11	0.39	1.04	0.22
	2 h	1.35	0.48	1.08	0.28	1.12	0.41	1.32	0.42	1.15	0.11
	8 h	1.44	0.48	1.29	0.27	1.23	0.40	1.50	0.40	1.36	0.11
	1 day	1.50	0.46	1.43	0.27	1.36	0.37	1.66	0.42	1.59	0.11
	2 days	1.56	0.45	1.56	0.26	1.47	0.37	1.79	0.40	1.75	0.09

According to Table 4, the highest surface roughness value was identified in acrylic resin-based (3.02 Ra) samples kept in bleach for two days. Surface roughness values generally increased in samples kept in all solutions, the highest increase occurred in samples kept in bleach, and the lowest increase was in samples kept in distilled water.

The results of Tukey's multiple comparison test for surface roughness values according to the storage duration is displayed in Table 5.

No significant difference was observed between the 15-minute and 30-, 45-, and 60-minute intervals, and differences between all other durations were statistically significant (p<.001), and the data corresponding to this analysis is provided in Table 5.

According to the t-test results in Table 6, there were significant differences in surface roughness values among the materials.

The findings from the three-way ANOVA are tabulated in Tables 7 and 8.

Table 5. Results of Tukey's multiple comparison test for surface roughness values according to storage duration

Time	Time	Mean of Squares	SE	df	t	PTukey
After preparation	15 min	-0.30	0.08	40.00	-3.78	0.013
	30 min	-0.37	0.06	40.00	-5.78	<.001
	45 min	-0.50	0.07	40.00	-6.87	<.001
	60 min	-0.68	0.07	40.00	-9.53	<.001
	2 h	-0.86	0.07	40.00	-12.63	<.001
	8 h	-1.05	0.07	40.00	-15.28	<.001
	1 day	-1.21	0.07	40.00	-18.14	<.001
	2 days	-1.34	0.07	40.00	-18.95	<.001
15 min	30 min	-0.07	0.11	40.00	-0.65	0.999
	45 min	-0.19	0.11	40.00	-1.67	0.760
	60 min	-0.38	0.11	40.00	-3.28	0.049
	2 h	-0.56	0.11	40.00	-4.92	<.001
	8 h	-0.75	0.11	40.00	-6.50	<.001
	1 day	-0.91	0.11	40.00	-8.01	<.001
	2 days	-1.04	0.12	40.00	-8.92	<.001
30 min	45 min	-0.12	0.03	40.00	-3.87	0.010
	60 min	-0.31	0.03	40.00	-9.08	<.001
	2 h	-0.49	0.04	40.00	-12.85	<.001
	8 h	-0.68	0.04	40.00	-15.89	<.001
	1 day	-0.84	0.05	40.00	-17.90	<.001
	2 days	-0.97	0.06	40.00	-17.03	<.001
45 min	60 min	-0.19	0.02	40.00	-10.61	<.001
	2 h	-0.37	0.03	40.00	-13.49	<.001
	8 h	-0.55	0.03	40.00	-17.50	<.001
	1 day	-0.72	0.04	40.00	-19.87	<.001
	2 days	-0.85	0.04	40.00	-19.65	<.001
60 min	2 h	-0.18	0.02	40.00	-10.07	<.001
	8 h	-0.37	0.02	40.00	-15.24	<.001
	1 day	-0.53	0.03	40.00	-16.80	<.001
	2 days	-0.66	0.04	40.00	-16.43	<.001
2 h	8 h	-0.19	0.01	40.00	-16.00	<.001
	1 day	-0.35	0.02	40.00	-17.05	<.001
	2 days	-0.48	0.03	40.00	-15.82	<.001
8 h	1 day	-0.16	0.02	40.00	-10.69	<.001
	2 days	-0.29	0.03	40.00	-11.43	<.001
1 day	2 days	-0.13	0.01	40.00	-8.95	<.001

Table 6. Results of the t-test for roughness values of materials

Material	Material	Mean of Squares	SE	df	t	PTukey
Acrylic resin	Silicone	0.69	0.10	40.00	7.01	< .001

Table 7: Results of the three-way analysis of variance (ANOVA) according to hardness values of materials

Source	Sum of Squares	df	Mean of Squares	F	P
Time	1379.27	8	172.41	74.95	< .001
Time*Material	52.20	8	6.53	2.84	0.005
Time*Solution	121.75	32	3.80	1.65	0.017
Time*Material*Solution	42.24	32	1.32	0.57	0.971
Total	736.09	320	2.30		

Table 8. Results of the three-way analysis of variance (ANOVA) according to surface roughness values of materials

Source	Sum of Squares	df	Mean of Squares	F	P
Time	81.03	8	10.13	95.44	< .001
Time*Material	2.16	8	0.27	2.54	0.011
Time*Solution	5.29	32	0.17	1.56	0.031
Time*Material*Solution	3.35	32	0.10	0.99	0.493
Total	33.96	320	0.11		

DISCUSSION

As demonstrated in the current study, the surface roughness and hardness values increased in samples kept in all solutions, the study's null hypothesis was accepted. Over time, an increase was detected in surface roughness and hardness due to the increased storage duration in solutions for both soft lining groups, and accordingly, these findings strongly indicate support for the alternative hypothesis.

Studies have used sodium hypochlorite as a solution at different concentrations that turns into hydrogen peroxide solutions when mixed with water.[19] Disinfectant solutions such as chlorhexidine gluconate, which are not commercially available for denture cleaning, have been tested in laboratory settings and significantly decreased the amount of plaque on the denture when dentures were immersed.[19] Hence our study preferred cleaning solutions used and not used for commercial purposes in the market.

The current work found the highest surface microhardness value in acrylic resin-based (40.20 Shore A) samples kept in bleach for two days. Mese and Güzel[5] assessed the impacts of storage duration in denture cleaning solutions on the tensile bond strength and hardness of acrylic resin-based heat-polymerized (Vertex Soft), acrylic resin-based autopolymerized (Coe-Soft), silicone-based heat-polymerized (MolloplastB), and silicone-based autopolymerized (Mollosil Plus) soft lining materials. The samples were immersed in water maintained at a temperature of 37°C for durations spanning 1 day, 1 week, 1 month, 3 months, and 6 months. Consequently, it was found that the silicone-based heat-polymerized (Molloplast B) soft lining material had significantly higher tensile bond strength and lower hardness values in comparison with the other materials. Our research also found that the silicone-based heat-polymerized soft lining material (Molloplast B) had lower surface hardness values at the end of the storage duration in solutions compared to the acrylic-based autopolymerized soft lining material (Visco Gel).

The present research detected the highest surface roughness value in acrylic resin-based (3.02 Ra) samples kept in bleach for two days. It was determined that the surface roughness values of samples kept in all solutions usually increased, the highest increase occurred in samples kept in bleach, and the lowest increase was in samples kept in distilled water. In line with the results of this study, Paranhos et al.[25] determined an increase in surface roughness values depending on the concentration of sodium hypochlorite and the immersion time. Our study revealed that the surface microhardness and roughness values of soft lining materials increased over time. In their study, Mohammed HS et al.[26] prepared samples from acrylic resin and silicone-based soft lining materials to keep them for 1, 7, 30, and 90 days. Measurements were performed at these time intervals. No significant increase was identified in terms of hardness in both the test and control acrylic lining groups on day 1. However, our study observed a significant increase in the hardness values of acrylic resin-based soft lining materials at the end of day 1.

Whereas the solutions utilized to clean dentures usually adversely impact the

characteristics of soft lining materials and reduce their elastic properties, acrylic resin-based ones are more affected than silicone-based ones. The above-mentioned changes occur due to the loss of diverse chemical substances, involving plasticizers and monomers, from soft lining materials.[27] The study determined that surface microhardness and roughness values increased more in samples prepared from acrylic resin-based soft lining materials compared to silicone-based ones.

Tan et al.[28] found in their research that perborate-containing denture cleansers increased surface roughness, as in the current study. Garcia et al.[29] determined that surface roughness was not impacted when they immersed the samples prepared from the soft lining material into the denture cleanser tablet solution. This study revealed that surface roughness values increased in both acrylic resin- and silicone-based soft lining materials when treated with denture cleaning solutions.

The increased surface roughness of acrylic resin-based soft lining materials may be associated with the possible loss of soluble components, e.g. plasticizers, that cause voids in the material.[26] Over time, these voids become probably responsible for the increased size, leading to surface roughness and protrusions. A rough surface also facilitates the colonization of microorganisms due to plaque accumulation.[30]

In the research done by Gonçalves et al.[31] in 2023 on the hardness values of soft lining materials after keeping them in cleaning solutions, three of the products used were from acrylic-based groups, and one was from a silicone-based group. The researchers immersed all materials in distilled water for varying durations. Unlike our study, samples were kept only in distilled water as a denture cleaning solution, while our study used more than one cleaning solution. Consequently, the least change in hardness occurred in the group with the silicone-based soft lining material (Ufi Gel p). Accordingly, the researchers suggested that it might be preferred for longer-term use. Among the other three acrylic-based groups, the most change in hardness took place in the group with the brand Soft Confort. In our study, the least change in terms of hardness values also occurred in the groups with the silicone-based soft lining material, even in different solutions.

Ueda et al.[32] researched the effects of mechanical and chemical cleaning on the surface morphology of silicone-based soft and hard lining materials. For each group, samples were prepared in a plate shape with a thickness of 1.5 mm (1-control group-only base material, 2-hard lining, and 3-soft lining groups). After the control group samples were kept in water, the hard and soft lining group samples were cleaned using denture brushes with hard and soft bristles, respectively. An abrasion test with a toothbrush and an immersion test using an enzyme-containing peroxide denture cleanser was conducted by simulating a period of about four months. The study found that using an enzyme + neutral peroxide denture cleanser for chemical cleaning did not cause surface roughening of the silicone-based soft lining material. Our study revealed that peroxide-containing denture cleanser tablets (Corega) showed efficacy in altering the surface roughness of both soft lining material types (silicone- and acrylic-based).

Mutluay and Tezvergil[33] assessed alterations in the softness and surface properties of soft lining materials after repeated loading in water. Three polysiloxanes (Silagum AM Comfort, Molloplast B, and Mollosil Plus) and two acrylic-based (Vertex Soft and Astron LC Soft) registered soft lining materials and one vinyl polysiloxane (Imprint 2 Garant) as the reference impression material were assessed. A control group of every material was immersed only in distilled water. Non-destructive cyclic loading was conducted for 200,000 cycles in distilled water at a temperature of 37°C, applying a strain of 16.6% and a frequency of 1.6 Hz. Afterward, the samples were replicated and compared to controls with roughness measurements, detail reproduction, and scanning electron microscopy. Moreover, Shore A hardness values were assessed both before and after immersion in water.

Polysiloxane-based materials better sustain their surface texture, softness, and surface smoothness under cyclic loading than acrylic resin-based materials. In our study, silicone-based soft lining materials preserved their surface properties better both in distilled water and other solutions in comparison with acrylic-based soft lining materials.

Niarchou et al.[34] evaluated the color stability and hardness of visible light-polymerized and autopolymerized soft lining materials after exposing them to various denture cleaning treatments. Six soft denture lining materials were subjected to four cleaning procedures. A Shore A durometer measured hardness, while a tristimulus colorimeter assessed color changes. The smallest change in hardness occurred in Sofreliner, and the most change was observed in the soft lining material Light Liner. While Versasoft and Sofreliner appeared to have the smallest color change after storage in all cleaning solutions, Light Liner and Eversoft yielded the highest values. Silicone-based materials displayed the smallest changes in both color and hardness when utilizing distilled water or any of the other cleaning treatments. Our study generally measured lower hardness values in silicone-based soft lining materials.

Rao et al.[35] investigated the impacts of denture cleansers on the flexibility of soft lining materials. The researchers used two soft liners (Molloplast B and Refit) and two denture cleansers (Clinsodent and Fittydent). Samples were tested with a Hounsfield tensometer. The researchers concluded that clinical performance would be more effective with the increased softness and elastic recovery of the denture soft lining. They found that silicone-based materials, e.g. Molloplast B, quickly restored surface properties and were preferable to an acrylic-based material. Our study made similar inferences.

This study detected the lowest roughness values in samples kept in distilled water among samples prepared from both soft lining materials. Among the samples prepared from the acrylic resin-based soft lining material, the highest surface roughness values were determined in the samples kept in bleach. Among the samples prepared from the silicone-based soft lining material, the highest roughness values were detected in the samples kept in chlorhexidine gluconate solution. The highest increase in surface hardness values occurred in the samples kept in bleach for both soft lining materials, while the lowest values were found in the groups kept in distilled water. The observed reduction in surface microhardness and roughness values in samples immersed in distilled water is attributed to the lesser structural impact exerted by water, contrasting with the more pronounced effect of bleach on the samples' structure, leading to heightened roughness and hardness. It is thought that silicone-based soft lining materials increase surface roughness due to their being adversely affected by chlorhexidine gluconate. Hence using chlorhexidine gluconate cleaning solutions may not be recommended, particularly in cases where silicone-based soft lining materials are used.

We consider it inappropriate to compare due to differences in the tests and research protocols utilized in studies. It is very challenging to associate the results of the current work with other research due to differences in sample size, type of soft lining materials, experimental duration, surface preparation, and cleaning solutions utilized. One limitation of this study is that only two of the numerous soft lining materials available were assessed and the research was carried out within a laboratory setup. Testing conditions utilized in in vitro studies may not fully reflect the oral environment. The characteristics of soft lining materials in the clinical state differ considerably from laboratory tests. Among the limitations of this study is that it was carried out as an in vitro study, a limited number of solutions were used, and measurements were performed at short time intervals. Hence, future research should be planned in a manner that they would include soft lining materials applied to dentures in the patient’s mouth and different solutions and involve long-term follow-ups.

CONCLUSION

Within its current limitations, this in vitro study provides strong evidence that the soft lining materials we will choose in the clinic should be silicone-based materials maintaining their structure for a long time. Concerning the denture cleaning solution we can recommend to patients, evidence showed that distilled water or white vinegar, which disrupt surface structure properties the least, should be preferred. The data derived from this study offer a valuable point of reference for understanding which denture cleaning solution is more compatible with which lining material.

Ethical Approval

Since sources obtained from humans or animals were not used in this study, ethics committee approval was not obtained.

Financial Support

No financial support was received from any institution or organization for this study.

Conflict of Interest

The authors declare that they have no competing interests.

Author Contributions

Design: ZY, Data collection or data processing: ZY, CÇG, Analysis and comment: ZY, CÇG, Literature search: ZY, CÇG, Writing: CÇG.

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NEU PRESS

Diş Hekimliği Dergisi

Vol: 1 No: 1 Year: 2024 | Research Article | e-ISSN: 2687-5535

https://doi.org/10.51122/neudentj.2024.93

Management of Dental Trauma of Last-Year Medical Students Attending Medical School in Tokat

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Article Info

Article History

Received: 02.10.2023
Accepted: 26.02.2024
Published: 30.04.2024

Keywords:
Avulsion,
Dental Emergencies,
Dental Trauma,
Medical Students.

ABSTRACT

Aim: Since trauma often requires immediate intervention, the initial care of patients is typically provided by emergency room physicians. Emergency departments prioritize the treatment of conditions that threaten the patient's overall health, which can lead to overlooking the treatment of traumatic dental injuries. Early intervention in dental and surrounding tissue injuries is crucial for prognosis. Therefore, it is important to assess the knowledge and awareness of dental trauma among medical doctors, who are often the first responders in trauma cases. The aim of this study is to evaluate the knowledge and approaches of senior-year medical students regarding dental traumas in Tokat city, Türkiye.

Materials and Methods: For this cross-sectional study, a validated questionnaire consisting of 10 questions previously used in similar studies was used. Students completed the questionnaire online using the Google® Forms program. The data obtained in this study were analyzed using the SPSS v23 (Chicago, IL, USA) software package program. Frequency and percentage values were obtained.

Results: While 7.1% of the students stated that they would reimplant the avulsed tooth, 71.4% stated that they would refer the patient to the dentist. While 42.8% of the students preferred sterile saline solution for handling the avulsed tooth, 20.2% preferred wet gauze. While 85.7% of the students found the level of knowledge about oral and dental injuries insufficient, 71.4% stated that they would like to participate in an educational program on this subject.

Conclusions: It has been observed that senior medical school students have insufficient knowledge about intervening in injuries to teeth and surrounding tissues. Curriculum regulation and training programs are required to improve students' knowledge and awareness about injuries to teeth and surrounding tissues. Students should also be informed that they can access the free IADT ToothSOS Mobile App on the International Association for Dental Trauma (IADT) website (http://www.iadt-dental-trauma.org), which can guide them on emergency response to dental trauma when they encounter dental trauma.

Tokat İlindeki Tıp Fakültesine Devam Eden Son Sınıf Öğrencilerinin Dental Travmaya Yaklaşımları

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 02.10.2023
Kabul Tarihi: 26.02.2024
Yayın Tarihi: 30.04.2024

Anahtar Kelimeler:
Avülsiyon,
Dental Aciller,
Dental Travma,
Tıp Fakültesi Öğrencileri.

ÖZET

Amaç: Travmalar genellikle acil müdahale gerektiren durumlar olması nedeniyle hastalara ilk müdahale acil servislerde tıp doktorları tarafından yapılmaktadır. Acil servislerde öncelik, hastaların genel sağlığını tehdit eden durumların tedavisidir bu nedenle, travmatik dental yaralanmalarının tedavisi göz ardı edilebilmektedir. Diş ve çevre dokuların yaralanmalarında erken müdahele prognoz acısından çok önemlidir. Bu nedenle travma vakalarında genellikle ilk karşılaşılan tıp doktorlarnın dental travmalar hakkında bilgi düzeylerinin ve farkındalıklarının değerlendirilmesi önemlidir. Bu çalışmanın amacı, Türkiyede Tokat ilinde tıp fakültesine devam eden son sınıf öğrencilerinin dental travmalar ile ilgili bilgi düzeylerini ve yaklaşımlarını değerlendirmektir.

Gereç ve Yöntemler: Bu kesitsel çalışma için daha önce benzer konuda yapılmış çalışmalarda kullanılmış geçerliliği test edilmiş 10 sorudan oluşan anket kullanıldı. Öğrenciler anketi Google® Forms programını kullanarak çevrimiçi doldurdu. Bu çalışmada elde edilen verilerin analizi SPSS v23 (Chicago, IL, ABD) paket programı kullanılarak yapıldı. Frekans ve yüzde değerleri elde edildi.

Bulgular: Öğrencilerin 7,1'i avulse olmuş dişi reimplante edeceğini belirtirken, %71,4'ü hastayı diş hekimine yönlendireceğini belitti. Öğrencilerin %42,8'i avulse olmuş dişin taşınması sırasında steril salin solüsyonunu tercih ederken, %20,2'lik bölümü ise ıslak gazlı bezi tercih ettti. Öğrencilerin %85,7'si ağız-diş yaralanmaları hakkındaki bilgi düzeyini yeterli bulmazken, %71,4'ü bu konu hakkında eğitici programa katılmak istediğini belirtti.

Sonuç: Tıp fakültesine devam eden son sınıf öğrencilerinin diş ve çevre dokulardaki yaralanmalara müdahale konusundaki bilgilerinin yetersiz olduğu gözlenmiştir. Öğrencilerin diş ve çevre dokulardaki yaralanmalar ile ilgili bilgi ve farkındalıklarını geliştirmeye yönelik müfredat düzenlemesi ve eğitim programları gereklidir. Ayrıca öğrencilere, dental travmayla karşılaştıklarında dental travmaya acil müdahale konusunda kendilerini yönlendirebilecek ücretsiz IADT ToothSOS Mobil Uygulamasına Uluslararası Dental Travma Birliği (IADT) web sitesinden (http://www.iadt-dental-trauma.org) ulaşabilecekleri hakkında bilgi verilmelidir.

To cite this article:
Coşgun A., Coşgun, MF. Management of Dental Trauma of Last-Year Medical Students Attending Medical School in Tokat, NEU DENT J. 2024;6:101-7. https://doi.org/10.51122/neudentj.2024.93

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INTRODUCTION

Traumatic dental injuries are among the most common injuries among children.[1] The most important issue in the healing period of all dental injuries is to determine the appropriate treatment option as soon as possible. When treatment is delayed, success and tooth vitality are negatively affected.[2, 3]

The International Association of Dental Traumatology (IADT) publishes the Guide for the Evaluation and Management of Traumatic Dental Injuries to provide an approach for the immediate and emergency care of traumatic dental injuries. IADT published its first treatment guidelines in 2001; It was also updated in 2007. Another update was published in the journal Dental Traumatology in 2012. The latest revised 2020 version of the Guide for the Evaluation and Management of Traumatic Dental Injuries has been published. This update of the Treatment Guidelines includes systematic reviews and articles covering the years 1996-2019 in EMBASE, MEDLINE, PUBMED, Scopus and Cochrane Databases, and a comprehensive evaluation of studies published in the Dental Traumatology journal between 2000-2019. This new revision represents the best current evidence based on available literature and expert opinion.[4]

Since traumas are conditions that require urgent intervention and often occur outside of working hours and on holidays, patients are primarily admitted to the emergency departments of hospitals, and medical physicians are the first to greet patients here before dentists.[5, 6] The priority in emergency departments is the treatment of conditions that threaten the general health of patients. For this reason, intervention in dental traumas usually remains in the background and the treatment of teeth and surrounding tissues may be ignored. However, early intervention in dental injuries is of great importance in terms of prognosis.[7]

For this reason, it is of great importance to evaluate the level of knowledge and approaches of medical doctors, who are usually the first applicants in trauma cases.[8] The aim of the present study is to determine the approaches of senior-year students at the faculty of medicine of Tokat Gaziosmanpaşa University, located in Tokat, towards dental and surrounding tissue injuries.

MATERIAL AND METHODS

Study Design and Ethical Approval

The present survey study was approved by Tokat Gaziosmapaşa University Clinical Research Local Ethics Committee (Date: February 2, 2023; protocol no: 83116987-116; registration number:23-KAEK-034).

The questionnaire form for this cross-sectional study was created using validated questions that had been used in previous similar studies.[8-12] While creating the questionnaire form, the basic issues that are important in emergency intervention in trauma cases were determined and a questionnaire containing demographic information and ten multiple-choice questions was prepared to determine the level of knowledge on these issues. The questionnaire consists of 3 sections. In the 1st section, demographic information of the students (gender of the students), in the 2nd section, the students' level of knowledge about dental trauma (6 questions), in the 3rd section, the questions were organized under the titles of students' thoughts about dental trauma, and their own level of knowledge about dental trauma (4 questions).

The senior-year students continuing their education at Tokat Gaziosmanpaşa University Faculty of Medicine in the academic education and training period of 2022-2023 who agreed to participate in the survey study were included in the study. The internet link of the prepared questionnaire was sent to the students via SMS or social media (WhatsApp©) by the Faculty of Medicine administration. Students who agreed to participate in the study completed the questionnaire online using the Google® Forms program. No name or other personal information was recorded to ensure privacy and confidentiality.

It was planned to deliver the questionnaire form prepared for the study to 125 students in their final year of study at Tokat Gaziosmanpaşa University Faculty of Medicine, which would constitute the study population.

Statistical Analysis

The data obtained in this study were analyzed using the SPSS v23 (Chicago, IL, USA) software package program. Frequency and percentage values were obtained.

RESULTS

Demographic Data

A total of 84 students participated in our study. Among the students participating in the study, the number of female students was 51 (60,7%) and the number of male students was 33 (39,2%).

Data Related To Students' Level Of Knowledge About Dental Trauma

In response to the question, "What do you do when you encounter a child who has a fractured tooth or teeth as a result of an accident and whose general health is not under threat?", 65,4% of the students answered, "I tell the family that the child should definitely go to the dentist for his/her teeth", while 34,5% of the students answered, "I immediately refer the child to the dentist ". (Table 1)

In response to the question, " What would you do if you encountered a child with an accidentally avulsed permanent tooth whose general health was not threatened?" 71,4% of the students answered, "I immediately refer the child to the dentist ", while 7,1% of the students answered, "I place the tooth in the socket (where it came out) and send it to the dentist immediately". (Table 1)

To the question, "What is the urgency (in terms of duration) of consulting a dentist after oral-dental trauma?" 40,4% of the students answered "Within a few hours", 34,5% answered "Within 1 day" and 20,2% answered "Immediately". (Table 1)

To the question, "What do you do if a tooth is avulsed due to trauma and falls to the ground and becomes contaminated?" 64,2% of the students answered, "I wash the tooth with the sterile saline solution", 23,8% said, "I do nothing" and 8,3% said, "I wash the tooth under tap water". (Table 1)

To the question, "What do you do if an avulsed tooth is fractured due to trauma?", 77,3% of the students answered, " I refer to the dentist with the fractured tooth", 14,2% said, "I have no knowledge on this subject" and 4,7% said, "I still place the broken tooth in its socket". (Table 1)

To the question, "How should a traumatized avulsed tooth be stored until it reaches the dentist?" 42,8% of the students answered, "In sterile saline solution"; 20,2% answered, "In a wet gauze"; 14,2% answered, "In any aseptic solution". (Table 1)

Data Related to The Students' Thoughts About Dental Trauma and Their Own Level of Knowledge About Dental Trauma

To the question, "Do you have information about what to do when a permanent tooth is avulsed as a result of an accident?" 95,2% of the students answered "No", while 4,7% answered "Yes". (Table 2)

To the question, "Do you think it is important to participate in an educational program about oral and dental injuries?" 77,3% of the students answered "Yes", 15,4% answered "No idea" and 7,1% answered "No". (Table 2)

To the question, "Do you think your level of knowledge about oral and dental injuries is sufficient?" 85,7% of the students answered "No"; 10,7% answered "No idea"; 3,5% answered "Yes". (Table 2)

To the question, "Would you like to participate in an educational program about what to do in oral and dental injuries?" 71,4% of the students answered "Yes"; 15,4% answered "No idea"; 13,09% answered "No". (Table 2)

Table 1: Students' level of knowledge about dental trauma

	n	(%)
1. "What do you do when you encounter a child who has a fractured tooth or teeth as a result of an accident and whose general health is not under threat?",		
I immediately refer the child to the dentist.	29	34.5
I tell the family that the child should definitely go to the dentist for his/her teeth	55	65.4
I don't feel the need to do anything about teeth.	0	0
2. What would you do if you encountered a child with an accidentally avulsed permanent tooth whose general health was not threatened?		
I immediately refer the child to the dentist.	60	71.4
I place the tooth in the socket (where it comes out) and send it to the dentist immediately.	6	7.1
I rinse the child's mouth with tap water and wrap the tooth in a damp cloth.	18	21.4
3. What is the urgency (in terms of duration) of consulting a dentist after dental trauma?		
Immediately	17	20.2
Within 30 minutes	4	4.7
Within a few hours	34	40.4
Within one day	29	34.5
4. What do you do if the tooth is avulsed due to trauma and falls to the ground and becomes contaminated?		
I clean the tooth by scrubbing it with a brush.	0	0
I wash the tooth under tap water.	7	8.3
I wash the tooth with a sterile saline solution.	54	64.2
I wash the tooth with hydrogen peroxide.	3	3.5
5. What do you do if an avulsed tooth is fractured due to trauma?		
I still put the fractured tooth in its socket (in place).	4	4.7
I refer to the dentist with the fractured tooth.	65	77.3
I do not deal with the fractured piece	3	3.5
I have no knowledge on this subject	12	14.2
Other (specify).....	0	0
6. How should a traumatized avulsed tooth be stored until it reaches the dentist?		
On ice	2	2.3
In a container with tap water	0	0
In a wet gauze	17	20.2
In sterile saline solution	36	42.8
In cotton	5	5.9
In the child's mouth	0	0
In any aseptic solution	12	14.2
In milk	6	7.1
Other (specify) Don't know	6	7.1

Table 2: Students' thoughts about dental trauma and their own level of knowledge about dental trauma

	n	(%)
7. Do you have information about what to do when a permanent tooth is avulsed as a result of an accident?"		
Yes	4	4.7
No	80	95.2
8. Do you think it is important to participate in an educational program about oral and dental injuries?		
Yes	65	77.3
No	6	7.1
9. Do you think your level of knowledge about oral and dental injuries is sufficient?		
Yes	3	3.5
No	72	85.7
Do not know	9	10.7
10. Would you like to participate in an educational program about what to do in oral and dental injuries?"		
Yes	60	71.4
No	11	13.09
Do not know	13	15.4

DISCUSSION

Appropriate and immediate intervention for post-traumatic injuries is critical to increase the chances of a favorable treatment outcome.[7] For this reason, physicians should be aware of the importance of emergency treatment and have accurate and up-to-date information about traumatic dental injuries. Mouradian et al. [13] stated that it is unethical for medical practitioners to ignore traumatic dental injuries and not provide appropriate guidance. In Türkiye, there are very few medical faculties that provide oral dental health courses to medical students. Among the faculties that provide oral health education, the number of course hours devoted to oral and dental health is quite limited because the educational curriculum is quite full. During this time, mostly general oral dental health education is given and very little emergency dentistry is mentioned.[14, 15] There are few studies evaluating the level of knowledge of medical students about dental trauma.[8, 9, 16-18] This study provided basic information about the current level of knowledge of senior-year medical students about dental avulsion.

Permanent anterior teeth are essential in young patients not only for aesthetics but also for phonetic, masticatory, and psychological health.[7] According to the guidelines of the International Association of Dental Traumatology, immediate replantation is the best and most appropriate treatment for permanent teeth that have been avulsed due to trauma.[19] In the present study, only 7,1% of the participants stated that they would place the avulsed tooth in its socket and send it to the dentist immediately. In the study conducted by Eden et al. [8] on senior-year medical faculty students in Izmir, this percentage was 45,4%, while in the study conducted by Bozatlıoğlu et al.[9] in Istanbul, it was 23,9%. In this case, it can be concluded that the knowledge level of the students about replantation of avulsed teeth is insufficient.

If replantation of the avulsed tooth is not possible, an important step is to use the right transport medium to increase the extra-oral time to 1 hour. Transport mediums are used to maintain the viability of periodontal connective cells, increase their vitality, and prevent future damage, such as ankylosis and resorption, which can lead to tooth loss. This can be achieved by storing the tooth in a suitable medium such as milk, saliva, or saline.[7, 20, 21] In the present study, 42,8% of the students stated that the tooth avulsed as a result of trauma should be carried in a sterile saline solution until reaching the dentist. Similar to our study, this percentage was 43,4% in the study by Eden et al.[8] In the study conducted by Subhashraj et al.[22] in India, 35% of young physicians stated that the avulsed tooth should be carried in saline. It can be concluded that students' knowledge about the storage conditions of avulsed teeth is inadequate.

In the study conducted by Abu-Dawoud et al.[23] in Kuwait, the majority of young physicians (83.3%) stated that they did not receive any information about what to do in case of avulsed teeth. In the present study, 95,2% of the students stated that they had no information about what to do with an avulsed tooth as a result of an accident, and 85,7% stated that their level of knowledge about oral dental injuries was insufficient. In addition, 77,3% of the students stated that they thought it was important to participate in an educational program about oral and dental injuries, and 71,4% stated that they would like to participate in an educational program about what to do with oral and dental injuries. This means that students are aware of their low level of knowledge about dental trauma and are willing to receive education about dental trauma. This is one of the findings that should be taken into consideration.

In this study, it was concluded that the knowledge of medical faculty students about dental trauma was inadequate. There are studies in the literature [8, 9] with similar results to our study. In the study conducted by Duruk et al. [17]

the knowledge levels of preclinical dentistry students, clinical dentistry students, medical students, and medical students who were given 1 hour of training on dental trauma about emergency management of avulsed teeth were investigated. In this study, it was concluded that medical and preclinical dentistry students lacked knowledge about emergency management of avulsed teeth, while clinical dentistry and trained medical students were very knowledgeable. This result shows the importance of education. It would be appropriate to provide more comprehensive oral and dental health information in the medical school curriculum.[9]

The International Association for Dental Trauma website (http://www.iadt-dental-trauma.org) has the revised 2020 version of the Guidelines for the Assessment and Management of Traumatic Dental Injuries, the free IADT ToothSOS Mobile App on emergency response to dental trauma, and flowcharts and posters on dental trauma. Posting these flowcharts or posters on dental trauma in all emergency departments and informing emergency physicians and medical trainees about the Guidelines for the Assessment and Management of Traumatic Dental Injuries and the IADT ToothSOS Mobile App would be very informative for emergency physicians and medical trainees to provide appropriate primary care for the child with dental trauma.

The aim of this study was not only to evaluate the level of education of students about dental traumas and their approach to dental traumas, but also to raise awareness of dental traumas in students and to inform students about emergency response to traumatic dental injuries. For this reason, after the completion of the questionnaire, informative documents about emergency responses to traumatic dental injuries were sent to the students.

The present study has some limitations. First, the generalizability of the study was limited by the use of data obtained from only one medical school in one university. Secondly, this study was conducted on a small number of students. More comprehensive multicenter studies with more participants should explore ways to explore opportunities to improve dental trauma education and awareness of dental trauma among medical students. Despite these limitations, the results of the present study provide valuable information about medical students' level of knowledge about dental trauma.

CONCLUSION

In conclusion, the findings of the present study suggest that the knowledge of the final year medical faculty students about dental trauma is insufficient, therefore, it is thought that it would be appropriate to include more comprehensive oral and dental health information in the medical faculty education curriculum. In this training, interdisciplinary seminars, case presentations, and practical courses on dental trauma would be appropriate. In addition, sufficient training time should be allocated for trauma to teeth and surrounding tissues in the resident training programs of emergency medicine specialty institutions, and the quality of patient care of these patients should be improved. Students should also be informed that they can access the free IADT ToothSOS Mobile App on the International Association for Dental Trauma website (http://www.iadt-dental-trauma.org), which can guide them on emergency response to dental trauma when they encounter dental trauma.

Acknowledgment

The authors would like to thank all the students who took part in this study.

Ethical Approval

Since sources obtained from humans or animals were not used in this study, ethics committee approval was not obtained.

Financial Support

No financial support was received from any institution or organization for this study.

Conflict of Interest

The authors declare that they have no competing interests.

Author Contributions

Design: AC, MFC Data collection and processing: AC, Analysis and interpretation: AC, MFC Literature review: AC, MFC Writing: AC.

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NEU PRESS

Diş Hekimliği Dergisi

Vol: 1 No: 1 Year: 2024 | Review Article | e-ISSN: 2687-5535

https://doi.org/10.51122/neudentj.2024.94

Prescribed Treatment Options for Gag Reflex

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Article Info

Article History

Received: 26.12.2023
Accepted: 01.04.2024
Published: 30.04.2024

Keywords:
Gagging,
Gagging Management,
Pharynx,
Review.

ABSTRACT

The gag reflex represents a crucial protective mechanism preventing the entry of foreign objects into the pharynx, larynx, or trachea. Impairment of this reflex can have adverse effects on an individual's oral health and overall well-being. An abnormal gag reflex can be detrimental and potentially impact social integration and comfort in social environments. Avoidance of treatment due to an exaggerated gag reflex in patients may lead to more severe oral and dental health issues. Complications such as intensified aesthetic concerns and halitosis, arising from aggravated oral and dental health problems, can contribute to patients withdrawing from social interactions. Consequently, individuals may find themselves trapped in a vicious cycle. The gag reflex can be triggered by a variety of physical or psychological stimuli. Its causes are multifaceted, encompassing iatrogenic effects, as well as local and systemic disorders, anatomical factors, and psychological factors such as classical and operant conditioning. Symptoms of an excessive gag reflex are not limited to specific age groups and can affect both pediatric and adult patients with varying degrees of severity. Treatment methods range from universally applicable approaches to those requiring specialized training due to the multifactorial nature of the condition. Given the multifactorial nature of the causes of an excessive gag reflex, exploring and implementing diverse therapeutic strategies may be necessary."

Öğürme Refleksinde Öngörülen Tedavi Seçenekleri Yaklaşımları

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 26.12.2023
Kabul Tarihi: 01.04.2024
Yayın Tarihi: 30.04.2024

Anahtar Kelimeler:
Öğürme,
Öğürme Yönetimi,
Farenks,
Derleme.

ÖZET

Öğürme refleksi, yabancı nesnelerin farenks, gırtlak veya trakeaya girişini önleyen çok önemli bir koruyucu mekanizmayı temsil eder. Bu refleksin bozulması, bireyin ağız sağlığı ve genel refahı üzerinde olumsuz etkilere sahip olabilir. Anormal bir öğürme refleksi zararlı olabilir. Hastalarda abartılı öğürme refleksi nedeniyle tedaviden kaçınılması, daha ciddi ağız ve diş sağlığı sorunlarına yol açabilir, ağırlaşan ağız ve diş sağlığı sorunları nedeniyle yoğunlaşan estetik kaygılar ve ağız kokusu gibi komplikasyonlar, hastaların sosyal etkileşimden uzaklaşmasına neden olabilir ve sonuç olarak bireyler kendilerini bir kısır döngünün içinde bulabilirler. Öğürme refleksi çeşitli fiziksel veya psikolojik uyaranlarla tetiklenebilir. Bunun nedenleri çok yönlü olup, iyatrojenik etkilerin yanı sıra lokal ve sistemik bozukluklar, anatomik faktörler, klasik ve edimsel koşullanma gibi psikolojik faktörleri de kapsar. Aşırı öğürme refleksinin semptomları belirli yaş gruplarıyla sınırlı değildir ve hem pediatrik hem de yetişkin hastaları değişen şiddet derecelerinde etkileyebilir. Tedavi yöntemleri, evrensel olarak uygulanabilir yaklaşımlardan, durumun çok faktörlü doğası nedeniyle özel eğitim gerektiren yaklaşımlara kadar çeşitlilik gösterir. Aşırı öğürme refleksinin nedenlerinin çok faktörlü doğası göz önüne alındığında, çeşitli terapötik stratejilerin araştırılması ve uygulanması gerekli olabilir.

To cite this article:
Yıldız S., Aşık B., Özyılmaz ÖY. Prescribed Treatment Options for Gag Reflex, NEU Dent J. 2024;6:108-18. https://doi.org/10.51122/neudentj.2024.94

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INTRODUCTION

Humans are one of the most social living things. Along with obtaining basic needs such as shelter, nutrition and health, socialization is considered to be an emotional need for humans. However, in order to socialize and become a part of society, first people need to feel comfortable enough, and the more comfortable one feels physically and psychologically, the more likely they are to engage and integrate into society. Having various physical defects such as stuttering, weight, skin problems, oral and dental health/aesthetics problems, and flaws in physical appearance can make it difficult to socialize. Among these factors, oral and dental aesthetics/health problems such as cavities, bad breath, non-white teeth, missing teeth have a significant impact. [1]

The Pharyngeal or Gag reflex is a defensive physiological response elicited by stimuli applied to the palatal region, posterior tongue, peritonsillar area, and the posterior pharyngeal wall. It functions as a protective mechanism, preventing the inadvertent ingress of foreign objects into the oral and oropharyngeal cavities. Variability in the manifestation of this reflex is observed among individuals, with some exhibiting a reduced or entirely absent response, while others display a heightened and atypical reaction. Noteworthy is the clinical significance of an exaggerated or abnormal gag reflex, constituting a substantive health concern. The implications of such reflexive responses extend across various domains of dental practice, encompassing diagnostic assessments, radiographic procedures, and therapeutic interventions. A thorough understanding of the Pharyngeal or gag reflex is crucial for dental practitioners, as any abnormalities can significantly affect the implementation and effectiveness of dental procedures. It can impact people's willingness to seek treatment for oral and dental health/aesthetic problems.[2] People with reactive/excessive gag reflex tend to stay away from necessary treatments, enters a vicious cycle of experiencing recurring dental problems and withdrawing from social environments due to these dental problems.[2] Treatment avoidance makes it difficult for people to integrate into society or be in social environments comfortably. Reduction of the psychological stimuli as much as possible in patients with a severe gag reflex is highly recommended. Since the gag reflex is managed by the parasympathetic nervous system, drugs that selectively suppress the parasympathetic nervous system have been tried and successful results have been obtained. Other techniques including acupressure and use of sedatives that have been tried.[3]

This review discusses treatment options for excessive gag reflex.

Glossopharyngeal Nerve Block

A successful glossopharyngeal nerve block can reduce excessive gag reflex. This nerve block technique is relatively safe, simple, and easy-to-master technique compared to general anesthesia and can be used for treatment of patients with exaggerated gag reflexes or for dental treatments in the back of the mouth. Care should be taken when using this procedure by avoiding inadvertent injection of a local anesthetic to intravascular. [4]

Acupuncture

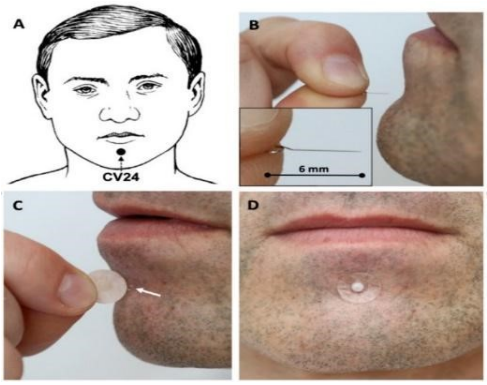
Traditional medicine is not a science based on analytical cause-and-effect logic like modern medical sciences. Within the framework of traditional therapeutic modalities, acupuncture operates on the principles of balancing the opposing forces of Yin and Yang, representative of positive and negative cosmic energies, to comprehend the nature of diseases. The fundamental mechanism underpinning acupuncture involves the meticulous application of needles that elicit a response in the nervous system, particularly activating small nerve fibers attuned to sharp pain. These activated fibers transmit signals to the central nervous system, where ensuing effects involve the interception of signals originating from identical neural regions or the modulation of pain signals emanating from interconnected

segments.[2] A secondary mechanism of acupuncture operates in a more focal manner, specifically targeting muscle trigger points. This localized approach facilitates pain alleviation by inducing vasodilation, thereby augmenting oxygen delivery to the targeted areas. The net effect involves the mitigation of muscle contractions, culminating in relief from discomfort, as elucidated in the foregoing discourse.[5]

Invitations were extended to practitioners affiliated with the British Dental Acupuncture Association to participate in an audit investigating the efficacy of acupoint conception vessel 24 (CV-24) in regulating the gag reflex. Patient inclusion criteria were strictly defined through a standardized procedural instruction sheet and a meticulously constructed registration form. In accordance with the inclusion criteria, each patient underwent a maxillary alginate impression before or after receiving acupuncture treatment at acupoint CV-24. The study assessed the gag reflex using the Gag Severity Index (GSI) before and after acupuncture needle insertion. The Gagging Inhibition Index (GPI) was then calculated. GSI and GPI metrics were recorded at three stages of the dental impression-taking process: when the empty impression tray was introduced into the oral cavity, when the filled tray was placed, and when the impression-taking procedure was completed. The study found that CV-24 point acupuncture is effective in managing severe gag reflexes during dental procedures, including impression-taking. However, it is important to note that the results of this audit require validation through a well-designed randomized controlled trial to confirm the strength and applicability of this therapeutic approach.[3] To apply this method, it is necessary to accurately identify the CV-24 point located in the horizontal mentolabial groove, which is approximately halfway between the chin and the lower lip, as shown in Figure 1.[6]

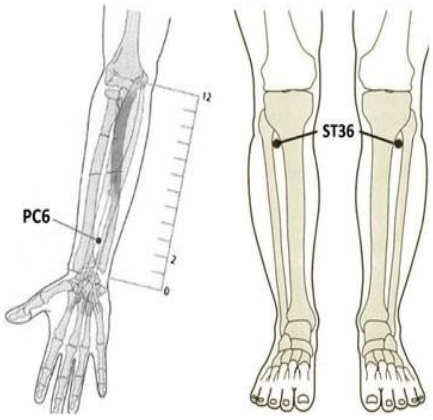
Bilello et al. [7], examined 20 patients, aged between 19 and 80, who had a gag reflex while taking dental impressions. Upper and lower alginate impressions were taken from all patients who met the inclusion criteria before and immediately after acupuncture. After each experience, participants recorded their feelings of nausea using a visual analogue scale (VAS). Upon analysis of the data, a statistically significant decrease in gag reflex scores was observed following acupuncture intervention ($p<0.05$), as outlined in the report.[7]

Figure 1: Conception vessel (CV-24) acupuncture point.[27]



Diep et al.[8] conducted an investigation to assess the efficacy of acupuncture and transcutaneous electrical acupoint stimulation (TEAS) at pericardium 6 (PC-6) and stomach 36 (ST-36) in suppressing the gag reflex when compared to a placebo control group devoid of acupuncture. The study employed a methodologically sound quantitative approach. Sixty participants were randomly selected to receive acupuncture, TEAS, or simulated TEAS (fake TEAS) at PC-6 in the forearm and ST-36 in the lower leg (Figure 2).

Figure 2: Pericardium 6 (PC-6) and stomach 36 (ST-36). [28]



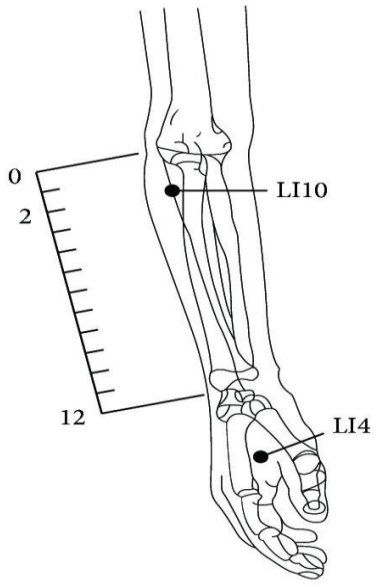
The gag reflex was evaluated by administering an air-water spray into each participant's throat to determine their maximum tolerance threshold, with insertion length serving as an index of this reflex. The study's outcomes suggest that stimulating PC-6 and ST-36 has effects similar to those observed in the placebo group, indicating comparable efficacy in mitigating the gag reflex. This finding highlights the need for further exploration and validation through robust research methodologies.[8]

In an additional investigation, the application of the PC-6 (Neiguan point) as an acupuncture locus for the modulation of the gag reflex was explored. In recognition of the challenges associated with needle acupuncture in pediatric patients, an alternative approach employing laser acupuncture was implemented to administer painless stimulation. The outcomes of this study revealed that the non-invasive laser acupuncture stimulation of the PC-6 point induced a reduction in pulse rate, an augmentation in oxygen saturation levels among patients, and a concomitant diminution of the gag reflex, all achieved without any discernible side effects. These findings align with the observations of Lu et al.,[9] who documented the efficacy of needle acupuncture at the PC-6 point in controlling the gag reflex.[3]

The anti-emetic attributes associated with acupuncture were further expounded upon, wherein the heightened levels of β-endorphins were implicated in its anti-emetic effect. Additionally, acupuncture was posited to desensitize chemoreceptor trigger zones in the brain through the mediation of neurochemical substances, thereby contributing to its anti-emetic efficacy. This multifaceted understanding underscores the intricate mechanisms through which acupuncture, whether delivered via traditional needle or laser modalities, exerts its regulatory influence on the gag reflex, providing valuable insights for clinical applications.[10]

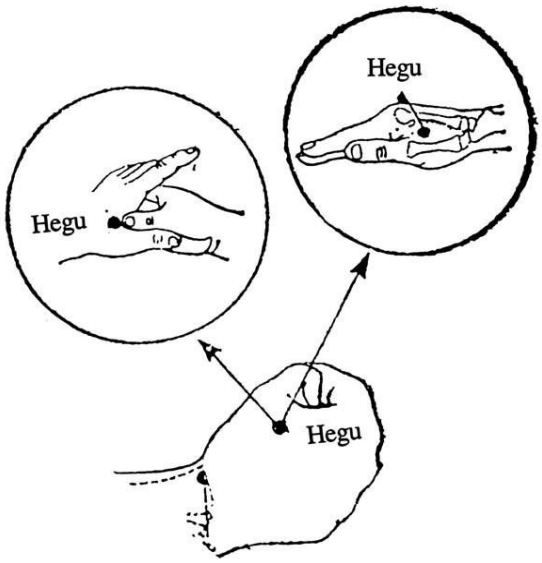
Agrawal et al.,[11] assessed the effects of electroacupuncture on gag reflex reduction. They randomly divided thirty patients into three groups: Group A, Group B, Group C. Patients in group A and B received an electroacupuncture device on the ear acupoint and Hegus point [Large intestine 4, (Li-4)], respectively whereas Group C, serving as placebo group, had Shou San Li point [Large intestine 10, (Li-10)] stimulated. Electroacupuncture (microcurrent electrical stimulation) was applied for 1 minute (Figure 3, Figure 4). GSI and GPI were used to measure gag reflex, and the evaluation was performed in two steps. Point A and point B were found to be significantly effective in reducing the severity of the gag reflex. Point C showed insignificant results. In addition, the Li-4 point is more effective than the ear acupuncture point in controlling the gag reflex in patients in the 20-70 age group.[11] Although ear acupuncture is an effective method to overcome the gag reflex and can be accepted by all patients, it requires enough experience and cannot be applied by every dentist.[9]

Figure 3: Large intestine 4 (Li 4) and large intestine 10 (Li 10) acupuncture point.[29]



Ear acupuncture points have been shown to become ineffective in the denervated ear; Therefore, it can be concluded that stimulation of ear acupoints occurs through the ear nerves, which also innervate the external auditory canal. [12]

Figure 4: Hegus (Large intestine 4) point.[30]



Use of Earplugs

The utilization of the earplug technique emerges as a practical and efficacious intervention to mitigate the gag reflex, particularly in the context of oral procedures such as maxillary teeth impression processes.[13]

Çakmak et al.[13] detailed that the severity of the gag reflex exhibited a reduction with the application of earplugs during interventions targeting the hard palate, uvula, and tongue; however, its effectiveness was less pronounced in procedures involving the posterior wall of the oropharynx.

The rationale underlying the efficacy of earplugs lies in their potential to impede the gag reflex, postulated to traverse the auriculotemporal nerve and the Arnold branch of the trigeminal nerve en route to the spinal nucleus, exerting a constraining influence on the walls of the external auditory canal. This technique not only proves effective in facilitating maxillary teeth impressions but also extends its utility to diverse dental procedures, such as periapical radiography of posterior teeth and tongue retraction. Its simplicity and noninvasiveness render it a valuable approach, potentially applicable to pediatric oral examinations. While the efficacy may exhibit variability among individual patients, the earplug technique stands as a noninvasive and pragmatic option, offering relief from the gag reflex before resorting to more invasive interventions.[13]

Eye Massage Devices

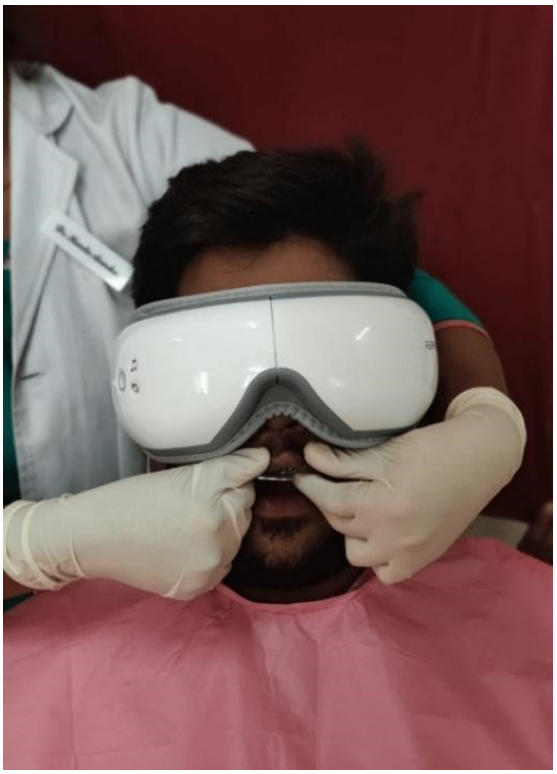
Utilizing eye massagers emerges as a potential strategy for preemptively alleviating anxiety associated with dental procedures, presenting a noteworthy departure from conventional methodologies. Serving as effective alternatives to traditional approaches, these devices leverage audio-visual aids to facilitate patient relaxation and assuage apprehensions related to the insertion of the impression tray during the dental impression process (Figure 5). The incorporation of an audio-visual component serves to temporarily divert patients from a potentially distressing environment, rendering short-term dental procedures, including impression-taking, local anesthesia administration, and intraoral radiography, more amenable and comfortable for the patient. This technique proves particularly beneficial for individuals with mild gag reflexes, aiding in the maintenance of a calm and comfortable demeanor throughout the procedure. For patients grappling with a severe gag reflex, the concurrent use of headphones featuring relaxing music, in conjunction with other established techniques, emerges as a potentially efficacious tool. To uphold patient safety standards, it is imperative that these headsets be appropriately spaced and subject to systematic disinfection protocols between appointments, ensuring the integrity of infection control measures. This multifaceted approach underscores the versatility and potential utility of employing eye massagers and auditory interventions in enhancing the overall patient experience during dental interventions.[14]

Nitrous Oxide

In 2016, a clinical investigation was conducted to assess the impact of nitrous oxide on individuals who self-reported a hypersensitive gag reflex. The investigation

followed a meticulously approved protocol sanctioned by the University Hospital Institutional Review Board. Before the study, the volunteers underwent comprehensive examinations to support their claims. Subsequently, they were subjected to a 2-dimensional digital x-ray procedure that focused on the right mandibular molar region, mimicking the positioning of a periapical radiograph. The assessment required precise placement and sustained retention of a sensor for 10 seconds.

Figure 5: Patient receiving eye massage during the measurement process. [14]



The Porter AVS 5000 unit was used to administer nitrous oxide and oxygen, along with the Rinn XCP-DS FITTM posterior periapical (PA) ring kit and a posterior PA digital sensor (Planmeca Pro Sensor) to replicate the radiographic image acquisition process. The study used a Hu-Freidy Type CW aspiration anaesthetic syringe with a 27-gauge disposable hypodermic needle and a cap to simulate an inferior alveolar (IANB) injection. The aim was to determine the effectiveness of nitrous oxide in reducing hypersensitive gag reflexes. The study employed advanced technology and procedural simulations to provide comprehensive insights. Participants were permitted to inhale room air, successively transitioning to 30%, 50%, or 70% concentrations of nitrous oxide until they could endure the placement of a sensor without eliciting retching or discomfort. Subjective responses were evaluated using a visual scale, complemented by additional statistical analyses to discern patterns in the outcomes. Remarkably, for certain individuals, a 30% nitrous oxide concentration proved adequate for tolerating the test, while others necessitated 50%; notably, for the remaining subjects, a 70% concentration was deemed sufficient. The amalgamation of 70% nitrous oxide and 30% oxygen facilitated all patients claiming an exceptionally severe gag reflex to withstand the introduction of a digital x-ray sensor adequately, enabling the acquisition of a periapical radiograph.

The precise mechanisms through which nitrous oxide attenuates the gag reflex remain unclear, as the specific pharmacodynamic pathways of nitrous oxide have not yet been fully elucidated. Plausible conjectures suggest that the anxiolytic properties inherent in nitrous oxide, known for their sedative effects, might contribute significantly to the amelioration of the gag reflex. Additionally, there exists the potential for N-methyl-D-aspartate receptor blockade by nitrous oxide, which could impede the transmission of painful sensations within the central nervous system. This intricate interplay of pharmacological actions underscores the need for further research to comprehensively delineate the pharmacodynamic intricacies of nitrous oxide in the context of gag reflex modulation.[15]

Behavioral techniques

Behavior changes are one of the most successful long-term solutions to treat patients with gag reflex issues. Behavioral techniques such as relaxation, distraction, suggestion/ hypnosis, systemic desensitization, errorless learning, and cognitive behavioral therapy are useful.[16]

Linthoingambi et al.[17] conducted a comprehensive examination into the efficacy of distraction techniques during diagnostic procedures, specifically upper and lower alginate impressions, among a group of 108 children aged 5-12 years. Employing a randomization protocol, the study incorporated various distraction methods denoted as G1 to G3 (G1: Normal gagging, G2: Mild gagging, G3: Moderate gagging), including the Mental Color Game, Audio-Visual, and Stress Ball interventions. The anxiety and gag reflex scores were recorded after impression procedure and analyzed statistically. Notably, a significantly heightened alteration in pre- and post-gag scores was observed in the Stress Ball group compared to counterparts in the Audio-Visual and Mental Color Game groups. Consequently, the study recommends the adoption of the Mental Color Game, Audio-Visual, and Stress Ball distraction methodologies as implicit tools for effectively managing both gag reflex and anxiety issues in pediatric populations.

In a separate investigation, 64% of patients (n = 30) reported the utilization of coping strategies to navigate challenges associated with their gag reflex. Predominantly, 13% of patients (n = 6) favored breathing techniques as their preferred coping mechanism. Additional strategies encompassed distraction, positive self-talk, self-hypnosis, utilization of imagery, incorporating regular breaks during treatment, adopting a forward-leaning posture in the dentist's chair, and consuming mints before treatment. A subset of participants acknowledged a lack of specific coping mechanisms for addressing gagging difficulties, while one individual articulated coping through avoidance. This multifaceted analysis sheds light on diverse coping strategies employed by patients, emphasizing the significance of tailored approaches in managing gag reflex-related challenges during dental procedures.[18]

De Veaux et al. [15] used the systematic desensitization technique to control gagging. Patients were asked to slowly put lollipops into their mouth and hold it until the gag reflex started. Patients were trained to perform this process several times a day. The amount of time they held the lollipop in their mouth increased gradually. After 4 weeks of therapy, impressions were taken from the patient without a gag reflex. In this clinical report, it was reported that the use of a intraoral scanner was a more comfortable alternative for a patient with a hypersensitive gag reflex.[15]

Sedation

Pharmacological sedation is an effective way to prevent the development of the gag reflex in patients. IV sedation eliminates exaggerated gag reflex in dental patients who experience anxiety and fear before dental treatment. The use of dexmedetomidine for sedation in patients with dental anxiety accompanied by an exaggerated gag reflex may be an alternative for the gag reflex.[19]

Hypnosis

Hypnosis is still an underutilized but effective non-pharmacological tool in dentistry. Effective sedation is provided while the patient maintains cooperation. It can help patients with dental anxiety and phobia as well as patients with severe gag reflexes.[20] A study[21], assessed this method on a 51-year-old woman who needed a full upper jaw prosthesis. The patient could not tolerate the treatment procedures due to her hypersensitive gag reflex, and it was predicted that she would not be able to wear the prosthesis even if it was completed. The patient was asked to help select the most desirable images and suggestions for use in hypnotherapy. Dental treatment and desensitization of the gag reflex were proceeded simultaneously, shortening the total treatment time.[21]

"Hypnopuncture," an integrative approach amalgamating hypnosis and acupuncture, presents a comprehensive therapeutic strategy for the enduring management of patients grappling with a pronounced gag reflex. Irrespective of the underlying causative factors, this treatment

regimen is applied consistently, offering a valuable intervention, especially in emergent dental scenarios where immediate patient compliance is pivotal. The overarching objective of such therapeutic endeavors remains the sustained control and mitigation of the gag reflex. A recent study by Eitner et al.[22] outlines a novel hypopuncture treatment protocol employed in a 50-year-old patient exhibiting a severe gag reflex. Remarkably, after just five sessions, the patient demonstrated an enhanced tolerance, allowing for subsequent dental procedures without the necessity for adjunctive tools.

This intervention employs hypnosis primarily for hypnosedation, distinct from psychotherapy, with a focal emphasis on stereognosis to facilitate desensitization. This innovative approach underscores its potential as an efficacious and expedient method for addressing and alleviating the challenges posed by a persistent gag reflex.[22]

Table Salt

Managing patients with an exaggerated gag reflex poses challenges, particularly during maxillary impressions or treatments in the posterior region, leading to discomfort. A straightforward yet effective method has been proposed to alleviate gagging in a substantial majority of patients. This intervention involves instructing patients to extend their tongue and briefly apply normal table salt to the tip for approximately 5 seconds (Figure 6). Impressions or radiography procedures can typically be conducted without undue difficulty following this intervention. Interestingly, the clinical observations do not appear to align seamlessly with established neuroanatomical principles. Conventionally, the glossopharyngeal nerve is acknowledged as the primary afferent branch governing the gag reflex, innervating the posterior third of the tongue and upper pharynx. However, the observed reduction in the gag reflex is hypothesized to result from concurrent stimulation of taste buds in the anterior two-thirds of the tongue by branches of the chorda tympani. This mechanism represents a form of simultaneous stimulation, analogous to the concept of extinction, such as experiencing pain relief during a lumbar puncture when the patient engages in deep breathing preceding the procedure. These findings challenge existing paradigms and underscore the complexity of sensory modulation in the oropharyngeal region, warranting further investigation to elucidate the underlying mechanisms.[23]

Figure 6: Patient with table salt on the tip of the tongue.

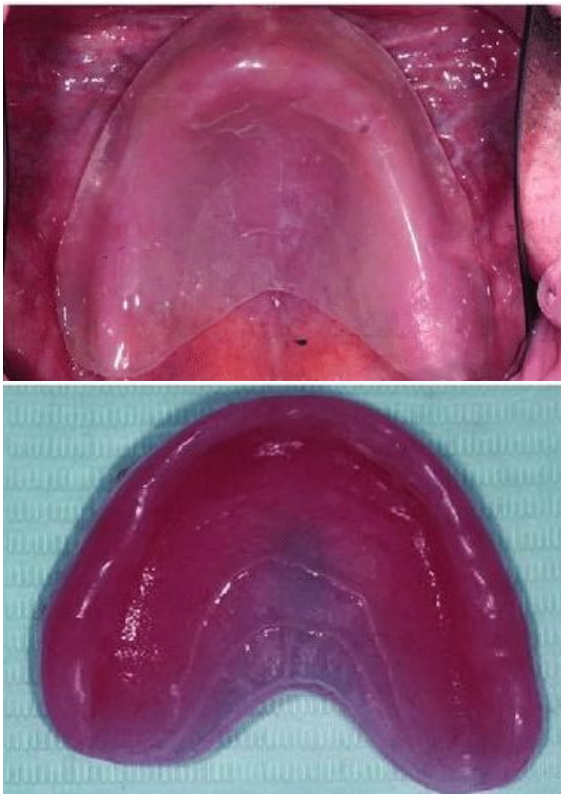
Treatment Methods for Removable Denture Patients

Some individuals may have a severe gag reflex, making it difficult for them to tolerate traditional maxillary complete dentures that cover the entire palate and extend along all borders. This challenge is even greater for patients who also have respiratory issues and an intense gag reflex, which can make it difficult to follow standard clinical procedures and significantly reduce the effectiveness of their prosthesis. To tackle this complexity, a viable approach involves preserving select natural teeth. This facilitates the implementation of a successful treatment paradigm using a horseshoe-shaped simple denture without a

palate or a bar-supported overdenture. This tailored strategy is instrumental in accommodating patients with severe gagging, allowing for effective prosthesis utilization. [24]

Furthermore, for completely edentulous patients with heightened gag reflexes, temporary interventions such as removable training plates made from acrylic material can be used as a desensitization measure before providing a permanent removable denture (Figure 7).[25] Additionally, patients who use removable prostheses are advised to practice regularly at home, with at least three sessions per day, five days a week. Gradual increases in usage time, implemented in 30-second intervals, are recommended until the patient reaches a comfortable threshold, typically defined by three consecutive periods without eliciting a gag reflex. Dietary guidance involves consuming soft foods, such as applesauce, during the acclimatization phase, progressing towards the inclusion of denser food items as the patient's tolerance develops.

Figure 7: Transparent acrylic education plaque.[31]



This approach highlights the need for individualized management of patients with severe gag reflexes, with a focus on customized interventions to improve prosthesis acceptance and patient well-being.[26]

CONCLUSION

Gag reflex is a protective mechanism. Reactive gag reflex can negatively affect people with oral and dental health/aesthetic problems resulting in treatment avoidance. It has multifactorial causes and excessive gag reflexes are observed in individuals of all ages. Thanks to developing technology and a better understanding of human nature and anatomy, patient with such issues can undergo any oral and dental health procedure available today.

Ethical approval

Ethics committee approval was not obtained in this study as resources derived from humans or animals were not used.

Financial Support

No financial support was received from any institution or organization for this study.

Conflict of Interest

The authors declare that they have no competing interests.

Author Contributions

Design: ÖYÖ, SY, Collecting and entering data: SY, BA, Analysis and comment: ÖYÖ, BA, Literature review: SY, BA, Writing: SY, BA, ÖYÖ.

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NEU PRESS

Diş Hekimliği Dergisi

Vol: 6 No: 1 Year: 2024 | Review Article | e-ISSN: 2687-5535

https://doi.org/10.51122/neudentj.2024.95

3D Printers and Their Use in Prosthetic Dentistry

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Article Info

Article History

Received: 24.07.2023
Accepted: 13.03.2024
Published: 30.04.2024

Keywords:
Prosthesis,
Additive Manufacturing,
Three-Dimensional Printer.

ABSTRACT

In recent years, the use of computer-aided design and computer-aided manufacturing (CAD/CAM) has increased considerably in addition to the traditional methods used in routine. CAD/CAM technology has many advantages. However, despite these advantages, it has a very important disadvantage such as material waste. Today, the technology that overcomes this problem is the additive manufacturing method with three-dimensional printers. This method has recently replaced the traditional subtractive computer-aided design and manufacturing technology in prosthodontics. The use of 3D printers has been increasing in recent years due to its advantages such as ease of production, time saving and material saving, freedom of design, error-free and faster production. It is also predicted that the use of this technology will increase in the future and will be the main method for digital manufacturing. The aim of this review is to evaluate the production methods of 3D printers, the areas of use in prosthodontics, the advantages and disadvantages of 3D production methods, and to review the purposes of use, materials used and developments in prosthodontics.

Üç Boyutlu Yazıcılar ve Protetik Diş Tedavisinde Kullanımı

Makale Bilgisi

Makale Geçmişi

Geliş Tarihi: 24.07.2023
Kabul Tarihi: 13.03.2024
Yayın Tarihi: 30.04.2024

Anahtar Kelimeler:
Protez,
Eklemeli Üretim,
Üç Boyutlu Yazıcı.

ÖZET

Son yıllarda rutinde kullanılan geleneksel yöntemlerin dışında CAD/CAM (computer aided design-computer aided manufacturing) sisteminin kullanımı teknolojinin gelişmesiyle birlikte hızla artmaktadır. CAD/CAM teknolojisinin birçok avantajı vardır. Fakat bu avantajlarına rağmen malzeme israfı gibi oldukça önemli bir dezavantajı bulunmaktadır. Günümüzde bu sorunun üstesinden gelen teknoloji ise üç boyutlu yazıcılar ile eklemeli üretim yöntemidir. Bu yöntem protetik diş tedavilerinde son zamanlarda geleneksel eksiltmeli bilgisayar destekli tasarım ve üretim teknolojisinin yerini almaktadır. 3 boyutlu yazıcıların kullanımı üretim kolaylığı, zaman tasarrufu ve malzeme tasarrufu, tasarım özgürlüğü, hatasız ve daha hızlı üretim gibi avantajlarından dolayı son yıllarda gittikçe artmaktadır. Ayrıca gelecek dönemde de bu teknolojinin kullanımının gittikçe artacağı söylenmekte ve dijital üretim için ana yöntem olacağı öngörülmektedir. Bu derlemenin amacı ise 3 boyutlu yazıcıların üretim yöntemlerini klinisyenlere aktarmak, protetik diş tedavisinde kullanım alanları, 3 boyutlu üretim yöntemlerinin avantajları ve dezavantajları ile ilgili değerlendirme yapmak ve protetik diş hekimliğindeki kullanım amaçlarını, kullanılan malzemeleri ve gelişmeleri gözden geçirmektir.

To cite this article:

Erdaş G. Yanıkoğlu N. 3D Printers and Their use in Prosthetic Dentistry, NEU Dent J. 2024;6:119-30. https://doi.org/10.51122/neudentj.2024.95

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INTRODUCTION

The history of 3D printers began with Dr. Kodama and continued with Charles Hull. Kodama attempted to obtain a patent for the technique he developed but was unsuccessful for unknown reasons.[1] On the other hand, Charles Hull successfully patented the stereolithography technique in 1986, which allowed for the production of 3D objects.[2] Additionally, in the same year, Hull also created the STL (Standard Tessellation Language) file format.[3]

3D designs are required for production using 3D printers. There are many programs available that can create these designs. Thanks to these programs, digital files required for 3D printing can be obtained. The digital files are typically in the STL format, which is widely used in 3D printing. The virtual object that has been designed using 3D software technology is then produced using materials such as polymers and resin composites, and undergoes heat or chemical processes.[4]

Increasing developments in computer technology and software systems have brought 3D printers to the present day. As an advanced technology, 3D software techniques allow for the production of complex and high-precision objects in various fields. 3D printers are primarily utilized in the production sector and are considered highly advanced products. They significantly reduce manufacturing preparation time, lower production costs, and facilitate the production of complex structures.[5]

3D printers, which were invented in the early 1980s, have been widely used, especially since 2010, due to their decreased production costs, making them easily accessible in many areas. 3D printers are used in various fields such as architecture, health, visual arts, space research, aviation, education, food, and automotive.[6]

The working system of 3D printers is based on the additive (layered) manufacturing method.[7]Additive manufacturing uses the three-dimensional (3D) geometric information of objects as the foundation for its production. This method utilizes raw materials like metal, composite, resin, and plastic, involving the addition of layers on top of each other.The term additive manufacturing is a general term that encompasses all manufacturing technologies that automatically produce parts by combining volume elements called voxels (the 3D equivalent of a pixel). With this method, the three-dimensional CAD model is converted into another type of model, a triangular lattice model.[8] Stereolithography is currently the most common method used for three-dimensional manufacturing. This method facilitates design flexibility and enables the production of materials that are otherwise difficult to manufacture quickly.[9,10]

In dentistry, 3D printers can be used to produce orthodontic digital models, surgical guides, crowns and bridges, surgical splints, dental models, personalized trays, and total, partial, or fixed prostheses, as well as temporary crowns, cast infrastructure modeling, and impression trays precisely and quickly in the clinical or laboratory environment. The production process is provided. The use of 3D printers in digital dentistry offers the opportunity to design personalized models, resulting in reduced chair time for patients and shorter durations for dental applications. This development is particularly important as it minimizes the margin of error in personalized dental designs.[11]

With the use of various printing materials, especially biocompatible resins, there has been a transition from the traditional 2-dimensional (2D) approach to 3D software technology in diagnosis, planning, and treatment methods in orthodontics. The aim is to adapt to the digital workflow in dentistry.[11]

Stereolithography (SLA) and Digital Light Processing (DLP) techniques are frequently preferred in dentistry. Another 3D printing technology is PolyJet technology. With this technology, the product is created by spraying liquid resin from hundreds of nozzle

heads onto a table surface and then curing it with UV light. High precision production can be achieved with a layer thickness of 16µm. However, it is an expensive technology. [12]

Types Of Additive Manufacturing Technologies

1- Vat Polymerization : Stereolithography (SLA) and Digital Light Processing (DLP):

2- Polyjet / İnkjet

3- Powder Bed Fusion: Selective Laser Sintering (SLS) ve Selective Laser Melting (SLM) Electron Beam Melting (EBM), Direct metal laser sintering (DMLS)

4- Colour-Jet-Printing (CJP):

5- Fused Deposition Modelling (FDM)

6- Laminated Object Manufacturing (LOM)

1.1. Stereolithography (SLA)

The SLA production method is the oldest and most basic production method used in dentistry. It is superior to other methods due to its high mechanical durability and clarity. It was first introduced by Charles W. Hull in 1986 and defined as object construction by adding thin layers of material polymerized by UV light. The production steps are listed below.[12]

1. A computer program is used to create a 3D model of the requested object.
2. The software system divides the 3D CAD model into layers. (Having more layers leads to better clarity.)
3. 3.UV light catalyzes the liquid resin inside the tank, leading to the creation of the initial layer of the object.
4. The platform is then lowered to produce the next layer.
5. The process is iterated until the complete model is formed.
6. Once the process is completed, the resulting object is immersed in a solvent and then placed in the UV oven, thereby completing the polymerization and concluding the production phase. [14]

The production time varies based on the size of the item being produced.Polymerization may take one to two minutes for each layer. It is also possible to produce multiple objects simultaneously. Yet, in this instance, the objects must be of small size.Thus, an object can be completed in an average of 6-12 hours. SLA is used in the manufacture of special maxillofacial implants, clear aligners, and mouth guards. [15–17].

The areas of use for this production method in prosthetic treatment are as follows:

- Temporary crown and bridge prostheses
- Wax model production
- Patient-specific model
- Obturator prostheses
- Denture bases [15-17]

Advantages:

It provides fast production, can create complex shapes in high resolution, and is relatively low-cost compared to other 3D production methods. [18]

Disadvantages:

Only light-curing liquid polymers can be used. These polymers can cause skin sensitivity upon contact with liquid and can be irritating when inhaled. Additionally, they have a limited lifespan and cannot be sterilized with heat. [15–18]

1.2. Dijital Light Processing İşleme (DLP)

Digital light processing (DLP) is based on polymerization technologyIt employs a method comparable to SLA and can be grouped in the same category, but it diverges in terms of the light source utilized. This technology includes rectangular micro-sized mirrors.[19] Microscopic mirrors provide the image for DLP. The angle of these mirrors can be adjusted, allowing them to reflect light into the projection. As the number of mirrors increases, the image resolution also increases.[20] The superiority of the DLP technique over the SLA technique lies in the fact that ultraviolet light is scanned with a single pulse, rather than

scanning each layer repeatedly. Both the SLA and DLP methods operate on similar principles, but both methods can produce variable outputs. In the DLP method, the images of each layer reflected by the projector consist of pixels, resulting in the formation of small rectangular volumes at the edges of the layer.[20] The resolution of the projector directly impacts the printing quality and volume. In the DLP system, a projector is located under the resin pool instead of a UV laser. [21] Additionally, thanks to the liquid resin tank, the DLP method minimizes waste and has a high production rate due to the use of light.[15-17]

Advantages:

The advantages are as follows:

1. Time-saving: It saves time.
2. Less resin requirement: It requires less amount of resin to produce the parts compared to printers that work from top to bottom.
3. Cost effectiveness: DLP systems are cheaper compared to printers that work from top to bottom.
4. Designed for complex ceramic parts: DLP systems are designed to produce complex ceramic parts that require high precision and accuracy.[15-17]

The disadvantages of liquid resin are twofold: it can cause skin sensitivity upon contact and it can be irritating when inhaled. Additionally, it cannot be sterilized with heat.[15-17]

2. Polyjet / Inkjet

The use of liquid resin as the raw material characterizes the process as polyjet, while utilizing ink as the raw material is referred to as inkjet.This method of production allows printing objects with more than one color. [22]

2.1. Polyjet

The production steps using this method are given below:[17,22]

1- The program generates a 3D model of the requested object.

2- The 3D model has been divided into slender layers.

3- Liquid photopolymers are sprayed onto the platform.

4- The photopolymers are quickly polymerized with ultraviolet light.

On top of the support structure, a fragile support material is placed. Various materials can be used in production, including liquid resins, waxes, and rubber materials. Photopolymer spraying allows for the creation of complex shapes (up to 56-16 microns) and the formation of intricate details.Photopolymer spraying technology offers a significant benefit by enabling the simultaneous use of multiple print heads, allowing for concurrent production with different materials. [17,22]

In this printing technology, thermoplastic polymers (wax, resin, and polylactic acid) are used.

In prosthetic treatment, it is utilized to create surgical guides and anatomical and working models.

Advantages:

This technology offers numerous benefits. Firstly, it conserves time. Secondly, the clarity and quality of the produced objects are quite high. Lastly, it can be used with materials of different colors and physical properties, allowing for versatility.[12]

Disadvantages:

There are many drawbacks associated with this.First, removing the support structure can be challenging and may cause skin irritation. Second, heat sterilization cannot be achieved using this method. Lastly, the cost of raw materials is also quite high. [12]

2.2 Inkjet

This system can produce a very high level of clarity, based on the method of applying minimal ink deposits through spraying. In this

system, powdered particles and ink are utilized. Therefore, the ink may include a coloring agent, binder solution, or ceramic suspension. [13]

Inkjet printing production stages are;

1- A three-dimensional model of the object has been generated.

2- 3D model is divided into layers, as in other production methods.

3- Ink is sprayed.

4- The creation of items relies on the gathering of ink droplets on dust particles and iterating this procedure in the shape of platforms.

5- Manufacturing platforms involves the ink undergoing a phase change, which varies depending on the raw material used. This can be achieved through ultraviolet light, heat, chemical reactions, or drying. [22,23] In this method; Materials such as ceramics, color agents, plaster and resin can be used.

Use in prosthesis: It is used in model preparation, epithesis prosthesis making, ceramic infrastructure material production, temporary prosthesis making, surgical apparatus making, apnea appliance and occlusal splint making. [12,14] Advantages: It offers color printing capabilities, enables the use of diverse raw materials with varying physical properties, and has a broad range of applications.

Disadvantage: It is a high cost technology. [17.22]

3. Powder Bed Fusion

3.1. Selective Laser Sintering(SLS) ve Selective Laser Melting (SLM)

SLM and SLS are both laser-based manufacturing techniques that share many similarities. Laser light is directed onto the powder layer by reflective mirrors, thus producing the desired object.[15]

Production stages are given below:

1- A three-dimensional model of the item is generated.

2- The model is decomposed into layers.

3- In the area where the beam encounters the dust, a molten puddle of powder forms, and these pieces fuse.

4- Each level is scanned using laser light. Subsequently, the powder deposition is decreased by one layer, and a new layer of material is added on top. This sequence is repeated until the object is created.

With these technologies, it has become possible to obtain complex structures.[3] The energy of the laser light used in the SLM system is higher. The SLM method differs from the SLS method in that it completely melts all powder particles homogeneously. However, this distinction cannot be said to be clear. The reason for this is that complete melting occurs when the raw material of the product alone is used in the SLS method. If a second binding material is used in addition to this material, partial melting will occur. In essence, the disparity between these approaches arises from both technical distinctions and the resulting products.[24] While SLS is mostly used in ceramics and polymer production, SLM is used in metal production. In addition to using one material in products produced with SLS, more than one raw material can be used in the SLM method.[15,16]

Metal and metal alloy products are also used in the SLM system. Therefore, the term 'direct metal laser sintering' (DMLS) is also employed to define this process. The heat generated during the sintering of metal products obtained through SLM results in stress, which subsequently leads to shrinkage, surface irregularities, reduced physical resistance, and compromised dimensional stabilization. To mitigate these adverse effects, a secondary process known as post-processing is implemented. Typically, this secondary process involves thermal treatment. The process offers the benefit of reducing thermal stresses, preserving structural integrity, and thereby improving mechanical properties.[25]

This method can utilize ceramics, metal alloys, and wax.[26] In the field of prosthetic dentistry, it is employed for various purposes, including the production of wax models for casting, dental implants, removable partial denture frameworks, and the infrastructure of crown bridge restorations. [15]

Advantages:

Polymeric materials can be sterilized by heat, have high resistance, can produce precision parts, and can be recycled if a metal alloy is used.

Disadvantages:

There is a risk of inhaling dust, high surface hardness, detailed finishing is required, it is a slow process, and support structures are difficult to remove.[3]

3.2. Electron Beam Melting (EBM)

In the process of electron beam melting, metal alloys are used for production.[17,22] Objects are obtained by melting metal particles in layers under high pressure. The operational principle of electron beams mirrors that utilized in x-ray devices. It is formed by heating tungsten wire, and the beam is directed magnetically. The energy is very high.The reason for this is that a beam of electrons replaces light. As a result, the resulting metal is more free of voids and stronger when compared to other additive methods.[18]

The material used is metal and its alloys (Co-Cr alloys, Titanium).

In prosthetic dental treatment, it is used in the infrastructure production of implants used in mandibular and maxillary reconstruction, and fixed restorations.[12]

Advantages: Since it is produced at high temperatures, it does not require subsequent heat treatment, and the production time is short.

Disadvantages: Accuracy is low, cost is high. There is a risk of inhalation of dust, and also a risk of explosion during processing.[12]

4. Colour-Jet-Printing (CJP):

In this method, powder is used as the main structure. The nozzle combines dust deposits with liquid drops, layer by layer. The dust pile gradually descends, and the object is formed in layers. A thin layer of dust forms on the object. The object is supported by uninfiltrated powder. Thus, no support material is required. The resulting objects are useful in the form of working models and visual prototypes. Their accuracy is not high, and these products have a fragile structure. As a final process, surface hardness and durability are increased by infiltrating epoxy resin or cyanoacrylate into the resulting object. The advantage of this approach is that items can be manufactured in any preferred color.[3]

It is mostly used in model preparation in prosthetic dental treatment.[19]

Advantages: Color printing can be achieved using safe materials without requiring a support structure, and it is relatively fast. [3]

Disadvantages: The resulting object is not durable enough and cannot be manipulated directly.[3] Moreover, although it is cheaper than other methods, it is still costly. Sterilization cannot be achieved with both liquid and heat. Its accuracy is insufficient to be used in prosthetic treatment applications.[19]

5. Fused Deposition Modelling

This method is the oldest 3D printing method.[20] It is mostly used by low-cost 3D printers. There are more than one techniques in this method. The techniques are basically based on sending materials through the nozzle. In this method, thermoplastic materials are generally used. Another method involves removing the raw material from the hopper using a pressure injector. The layers of the object are formed by sending the molten material through the tip and then hardening it.[16] The production of the object is thus finished. The supporting part is dissolved and melted with various solutions. Different raw materials with different thermal and mechanical properties can be used.[18] The object obtained has a porous structure, enabling it to gain properties similar to the elastic modulus of tissues. For this reason, its mechanical properties are similar, which is considered an advantage.[27]

In this method, thermoplastic polymers and ceramics are used. In prosthetic dental treatment, they are used in wax model making, anatomical model making, custom tray fabrication, and surgical model making for facial reconstruction.[14,19]

Advantages:

Some materials can be sterilized with heat, products with high porosity can be obtained, they are low to medium cost, and some materials can be sterilized with heat.[3]

Disadvantages:

They have variable mechanical durability, their production is delicate, and they are limited in reflecting details. [3]

6. Laminated Object Manufacturing (LOM):

This method includes layered manufacturing and ultrasonic manufacturing.[27] The method is based on separating metal strips layer by layer and then joining them using ultrasound welding. The process heat used is low compared to other methods and allows the creation of different shapes. It is possible to bond different materials to each other with sheet lamination.[27]

Advantages:

It utilizes less energy than alternative methods because the metal is not melted, but rather separated into layers.

Disadvantages:

Laminar objects, which are mostly used in the production of visual or aesthetic models, are not suitable for structural use.[27]

Application Areas of 3D Printers in Prosthetic Treatment

3D production is an advanced design and manufacturing method that has significantly evolved in recent years and has diverse applications in prosthetic dental treatments.

Its results can be predicted in advance, in saving time for doctors, patients, and technicians. The usage of is anticipated to rise in the coming years. [13]

In prosthetic treatment, the applications include:

- Production of ceramic restorations
- Model acquisition
- Personal trays production
- Surgical guide production for implant placement
- Temporary crowns and bridges preparation
- Total prosthesis production
- Occlusal splint preparation
- Production of epitheses and obturator prostheses
- Wax modeling
- Can be used in metal infrastructure production

Additive Manufacturing and Ceramics

- Zirconia and alumina with SLA method,
- Material extrusion method, in the production of feldspathic porcelain and zirconia,
- Powder bed fusion, in feldspathic porcelain production,
- Inkjet printing, for zirconia production,
- Binder spraying method is utilized in the fabrication of feldspathic porcelains during production.[15]

Studies have reported that fissure machining of zirconia restorations obtained by the SLA method can be processed much more clearly and accurately than the subtractive method. Implants consisting of zirconia material obtained by the DLP method have sufficient dimensional clarity and accuracy.[28,29]

Zirconia produced by the 3D production method is not only monolithic but also used as an infrastructure material. It has sufficient bond strength with porcelain. In the current literature, both monolithically produced and self-glazed zirconias are included. The binder spraying method is implemented to minimize or

eliminate potential drawbacks associated with the surface polishing process of zirconia in uncertain scenarios.[26]

Ceramics can be employed as raw materials for Selective Laser Sintering (SLS). Nonetheless, their elevated melting points and limited plastic characteristics pose challenges in the SLS fabrication process compared to polymers and metals. Ceramic production with the SLS technique mainly involves two primary approaches: direct ceramic SLS and indirect ceramic SLS. The first of these, the direct technique, fuses ceramic powders to produce the sintered end product. The second technique requires a binder phase in a polymer structure to combine the ceramic powders. The produced material is then sintered.[15,29]

Model Making and Personal Tray Production with Additional Manufacturing

Patient models are tools that convey the details of the patient's oral soft and hard tissues. In the conventional method, the model is obtained by taking an impression of the inside of the mouth with a measuring spoon or tray using impression materials. With the latest developing technologies, it has become possible to produce personal measuring trays with 3D printers. [30]

In a study, models were produced with 3D printers, and their accuracy rates were calculated. As a result, they reported that this rate was high. [31]

Another research endeavor focused on examining the precision of dental models created using affordable 3D printers to generate lifelike dental models and minimize expenses for dental students in their preclinical education. The wax models obtained in this study were scanned, and then the models were obtained with a 3D printer. There was no notable variance detected in the dimensions of the resultant models during the assessment.($p \geq 0.05$). [32]

In a research investigation carried out by Chen and colleagues, in addition to personal measuring spoons produced with conventional methods, it has been found that the accuracy rate of those produced with a 3D printer is higher.

Epitheses and Obturator Production with Additional Manufacturing

In a study, it has been shown that 3D printers are faster and cheaper in the long run compared to conventional production techniques in the production of metal infrastructures for removable partial dentures and fixed dentures.[33]

In another study, they aimed to use cone-beam computed tomography (CBCT) as an alternative to the traditional measurement technique in intraoral maxillectomy defects and to produce bulb sections of obturator prostheses with the SLA method and compare their dimensional accuracy. They reported that in these cases, it seems possible to produce bulbs that are sufficiently compatible with the defect area, thanks to 3D modeling created with CBCT images.[34]

Kortes et al. conducted a study where they diagrammed the digital workflow of surgical obturator production with 3D printers.[46] (Figure 5).

Additive Manufacturing and Temporary Prostheses

Peng et al.[35] reported in a study that digitally produced temporary crowns were more successful than those produced using traditional methods. Mai et al. [39] reported high compliance with temporary crowns produced by 3D printing, especially in the occlusal regions. The repair process of these materials or whether they are suitable for repair with conventional materials is unclear. Data on the changes in the mechanical properties of these materials in the mouth over time are still very lacking.[37]

In another study, the fracture strength of fixed temporary prostheses produced from PMMA using 3D printing, CAD/CAM, and conventional methods was examined. While the highest breaking strength was found in the CAD/CAM group, the lowest breaking strength

was shown in the group produced with a 3D printer. However, no statistically significant difference was found between the groups. In the same study, the samples were also evaluated in terms of surface roughness, and the highest surface roughness was found in the samples produced with a 3D printer.[38]

Another study included 34 patients with 34 premolars needing prosthetic rehabilitation: a total of 68 temporary crowns were fabricated from PMMA material, 34 by CAD/CAM and 34 by 3D printing. Immediately after fabrication, milled and printed provisions were scanned with a desktop scanner to obtain STL files that were added to the original CAD design to determine occlusal accuracy. A second occlusal comparison was made by scanning both temporal types after the samples were placed intraorally with the Trios scanner; intraoral scans were obtained to compare temporary STL files before and after occlusal adjustments. Upon completion of this study,the data obtained showed that the dimensional accuracy of the occlusal surfaces of temporary crowns produced with 3D printers was better compared to those produced with CAD/CAM. When comparing the results obtained, it was found that intraoral scans played a significant role in occlusion and in the production process. It was also determined that the 3D printing technique could be effectively used to manufacture temporary PMMA crowns.[39]

Additive Manufacturing and Metal Infrastructure Manufacturing

The additive manufacturing method allows for the preparation of fixed partial denture infrastructure using metal alloys. In conventional methods, first, the inside of the patient's mouth is measured, and then the patient model is obtained. Subsequently, after wax modeling, investment, and wax elimination, the casting process of the restoration is completed. All stages require technical precision and a significant amount of time. Each of these stages significantly affects the marginal fit of the restoration. Additive manufacturing provides the opportunity to eliminate all these steps.[40]

In a thesis study, it was discovered that the edge clearance values of substructures created using the SLM method were slightly lower than those produced by the casting method, although the difference was not statistically significant ($p > 0.05$). Upon analyzing the edge openings of the metal ceramic restorations, it was found that the average edge openings of the final restorations manufactured through the SLM method (31.29±5.56) were significantly lower than those obtained by the lost wax method ($p < 0.01$).[40]

Additive Manufacturing and Complete Denture Prostheses

In a research investigation by Prpić and collaborators, a comparison was made on the flexural strength and surface hardness of complete denture bases produced via three different CAD/CAM systems, three distinct traditional heat polymerization methods, a 3D printing technique, and a polyamide material. The study revealed that two sets of CAD/CAM materials displayed the highest surface hardness values, while another group featuring polyamide material exhibited the lowest surface hardness values. Furthermore, the research indicated that materials printed using 3D printing technology showcased the lowest levels of flexural strength. Overall, the study's findings suggested that CAD/CAM materials possessed superior mechanical characteristics in contrast to heat-polymerized and 3D printed acrylics. [41]

In another study, the fit measurements between the denture tissue surface and the plaster model of denture base produced with the 3D printing technique were compared with those produced with the conventional method. The two groups did not show any statistically significant difference. Thus, this study indicates that using 3D printing to create a complete prosthesis seems to be clinically acceptable.[42]

Alharbi et al.[43] In an in vitro study, the bond strength between the tooth and the base material of total dentures produced by

conventional methods was compared with dentures produced by 3D printing. The fact that cohesive fracture is dominant in prostheses produced by conventional methods suggests that there is a stronger bond strength between the teeth and the resin base in this group. The observed failure modes indicated that both fabrication techniques exhibited satisfactory bond strength.

Lo Russo et al.[44] In an in vivo study, they performed intraoral scanning of edentulous patients. Ten mandibular and ten maxillary edentulous arches were scanned, and half were produced with CAD/CAM and the other half with a 3D printer according to the appropriate workflow. The accuracy rates of the inner surfaces of the prostheses were compared. The maxillary and mandibular denture base group produced with the CAD/CAM technique showed better clarity on its entire inner surface compared to 3D printing.

CONCLUSION

3D printers will have a huge impact on dentistry in the future. Intermediate restorations made using 3D printing have been reported to yield good results and are considered clinically usable. However:

- In total dentures created with 3D printers, there is a bonding issue between the 3D printed denture base and the denture tooth, necessitating further verification regarding strength and deformation. Furthermore, some studies have indicated that the compatibility of the prosthesis with the tissue is high.
- Custom trays produced with 3D printers have shown clinical utility, with some studies suggesting that they are more adaptable than conventionally manufactured ones. Nonetheless, challenges related to design time and effort persist.
- The utilization of 3D software technology holds the promise of enhancing prosthetic manufacturing methods, materials, and processes. While fixed section restorations have shown favorable edge fit, there are still notable voids in the available literature regarding 3D printing technology, with several studies awaiting validation. Moving forward, comprehensive research efforts will be essential for further exploration in this domain.

Ethical Approval

Since sources obtained from humans or animals were not used in this study, ethics committee approval was not obtained.

Financial Support

No financial support was received from any institution or organization for this study.

Conflict of Interest

The authors declare that they have no competing interests.

Author Contributions

Design: NY, GE Data collection and processing: NY, GE, Analysis and interpretation: NY, Literature review: GE, Writing: GE

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