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DNA was extracted using a MagNA Pure-Compact DNA Isolation Kit (Roche Diagnostics GmbH, Mannheim, Germany)

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1. Burrow MF, Tagami J, Negishi T. Early tensile bone strengths of several enamel and dentin bonding systems. J Dent Res 1994; 74: 522-8.

Journal Article Electronic Publication Ahead of Print

2. McKeage K. Tobramycin inhalation powder: a review of its use in the treatment of chronic pseudomonas aeruginosa infection in patients with cystic fibrosis. Drugs 2013; [Epub ahead of print] Available from: http://link.springer.com/article/10.1007%2Fs40265-013-0141-0

Book

3. Mueller HJ, Freeman D. FT-IR spectrometry in materiology. 2nd Ed., Ohio: American Society for Metal 1994, p.51-56.

Chapter in a book

4. Alexander RG. Considerations in creating a beautiful smile. In: Romano R, editor. The art of the smile. London: Quintessence Publishing, 2005, p.187-210.
5. Hudson FB, Hawcroft J. Duration of treatment in phenylketonuria. In: Seakins J, Saunders R, editors. Treatment of inborn errors of metabolism. London: Churchill Livingstone, 1973, p.51-56.

Thesis

6. Maden I. Effect Of Nd:YAG Laser Treatment In Addition To Scaling And Root Planning. Doctoral Dissertation, Istanbul University Institute of Health Sciences Periodontology Department, 2009.

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Figure 1. Panoramic radiograph of the patient taken 6 months after surgery, note irregular borders of the lesion.

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Articles will normally appear in the order in which they were accepted as publication,

Table 1. *Concise explanation of the table contents (SD: standard deviation, CTA: cartilage tissue area, NBA: new bone area).*

	Control group (Mean % ± SD %)	First group (Mean % ± SD %)	Second group (Mean % ± SD %)
CTA	21.41 ± 4.2	2.5 ± 2.4	11.42 ± 4.2
NBA	11.48 ± 0.2	21.41 ± 14.22	11.41 ± 4.2

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European Oral Research

Contents

Original Research Articles

Clinical success rate of fissure sealants: One-year follow-up*

Mine Koruyucu¹ ⓘ,
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Cengiz Aydınoğlu² ⓘ,
Pelin Barlak² ⓘ,
Figen Seymen¹ ⓘ

Purpose
The aim of this study is to evaluate clinical success rate of resin-based fissure sealants applied at Istanbul University, Department of Pediatric Dentistry after 1 year of application.

Materials and Methods
Children with at least one pair of caries-free permanent first molars with deep pits and fissures were included in the study. The ages of children ranged from 7-13 (mean age: 9.2±1.22). Resin-based fissure sealant was applied to the 322 fissures of the first permanent molars in 100 children. 12 months after the application, children were recalled for examination. Recall examinations were carried out by the same dentist. Fissure sealants were evaluated at 12th month by using Ryge criteria: Retention (R), precence of caries (PC), marginal adaptation (MA), marginal discoloration (MD) and cracking (C).

Results
12 months after the application, all of the children were recalled and fissure sealants were examined. Our findigs are: R: Alpha 95 (29.5%), Bravo: 143 (44.4%), Charlie: 84 (26%); PC: Alpha 274, Bravo 48 (14.9%); MD: Alpha 322; MA: Alpha 279, Bravo 43 (13.3%); C: Alpha 321, Bravo 1 (0.3%).

Conclusion
The preventive effects of the sealant are only maintained as long as it remains completely intact and bonded in place. After applying fissure sealants, patients must be recalled and sealants must be checked to provide retention and marginal adaptation.

Keywords: Fissure sealant, Ryge criteria, Marginal adaptation, Retention

Introduction

The caries is a serious problem in dental health and researchers are still studying on preventive treatment of tooth decay formation. It is indicated that pits and fissures are the best preventive applications for dental caries (1,2).

A few years following eruption has the highest risk for the caries. Teeth are not in contact with their opposite along eruption, so it makes plaque accumulation. This period is about 1.5 years for first and second molar teeth and it is up to 1-2 months for premolar teeth. Molar teeth locate backward in mouth so it is difficult to brush them. All of these factors increase the rate of caries in molar teeth fissures and pits (3). As long as teeth contact with saliva, spit in calcium, magnesium, fluoride and other trace elements enable calcification by entering the enamel structure by diffusion. Therefore, it is more susceptible to decay after eruption for 2 years permenant teeth (4).

Tooth morphology is important to 'plaque formation and accumulation', 'clearance capability of saliva', 'dental hygiene'. Pit and fissure type are individualized. Decay susceptibility depends on verticality of tubercul bevel and depth of fissure (5,6). Because of these reasons, researchers are studying on capping these areas. Pit and fissure sealants are improved,

and some materials are used as polyurethane, cyanoacrylate, polycarboxcylate cements, glass ionomer cements and BIS-GMA based resin cement (7).

Fissure sealants prevent accumulation of food borne debris in fissures and pits which are prone to decay. Fissur sealants are classified according to their content, whether they have filler, their color, fluoride content and polymerization features (6,8).

Although occlusal surfaces are clothing the 12.5% area of tooth surface, it is seen that tooth decays occur in 50% rate on that surfaces among the school age children (1,2). About 1/3 rate of total amount of caries are in fissure and pits, 2/3 rate of them are seen in interfaces. Fissure color changes in occlussal caries. Enamel becomes more opaque and tooth color becomes darker. It is hard to see decay on radiograph before it becomes a deep dentine decay (8).

According to Nagano definition (9): U type: anatomically cleanable, so resistant to caries (a) ; I type: some types can come up to dentine so high risk for caries (b); V type: not deep like I type and less risk for caries (c); K type: high risk for caries (d) (Figure 1).
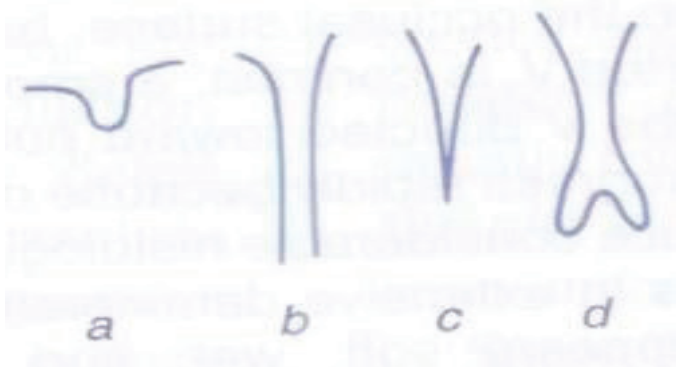
Figure 1. *Morphological forms of fissures.*

It is hard to clean deep fissures from food remnant and bacterias and fissure base line is near to dentinoenamel junction. Although in shallow fissure, enamel thickness is about 1.5-2 mm, this number may change to 0.2 mm. Remineralisation with fluoride can occur at pH 6.7-7.3. But in fissure it is more acidic through plaque. Remineralisation cannot occur at low pH.[8] This explains that occlusal surfaces are susceptible to decay (10,11).

The purpose of this study is to evaluate the clinical success of fissure sealants at the end of 12th month.

Materials and Methods

In our study, we evaluated 100 children between the ages 7-13 (mean 9.2±1.22) years and their completely erupted 322 first molars with fissure sealants which are applied in Istanbul University Faculty of Dentistry of Pediatric Dentistry Department students' clinics. The protocol of this study is approved by İstanbul University Faculty of Dentistry Medical Research Ethics Board (No:2013/104) and parents of children participating in the study were informed about the study and written informed consents were taken.

Fissure sealant applications were done by İstanbul University Faculty of Dentistry student clinic under the control of one pediatric dentist. Before the application of fissure seal-

ants, each tooth was brushed with pumice-water slurry with polishing brush. After washing, the surface was dried with air-water spray, and was isolated with cotton rolls and saliva enjector insulation. Occlusal surface up to the tubercule hill was etched with 37% phosphoric acid (3M™ ESPETM Scotchbond™ Etching Gel) for 30 seconds and then washed with water 30 seconds and dried with air freshener until it was obtained as chalky enamel image. After the enamel surface was prepared, fissure sealant material (3M™ Sealant ESPE Clinpro™) were applied with disposable brush and polymerized 40 seconds with 40 seconds using a conventional visible light-curing unit (HILUX™ 250 Halogen curing light). Occlusion was checked using articulation paper, the contact points on teeth were corrected under water cooling with grany diamond milling cutter to prevent overload formation and to ensure the durability of fissure sealants.

After 12 months, patients were called for follow-up and applied fissure sealants were controlled by mirror and sond. Teeth were dried lightly with air spray and occlusal surface were examined carefully. One year previously applied fissure sealants on the teeth with deep pit and fissures at the high risk which did not have caries or restorations were examined according to the Ryge criterias (Table 1) and the form was filled out for each patient.

Table 1. *Clinical evaluation by Ryge Criterias.*

Retention	ALPHA	Full retention
	BRAVO	Half retention
	CHARLIE	Loss of full restoration
Caries presence	ALPHA	No diagnosed caries
	BRAVO	Diagnosed caries
Ridge adaptation	ALPHA	Full ridge adaptation
	BRAVO	Existance of space
Fracture	ALPHA	No fracture
	BRAVO	fractured
	CHARLIE	
Edge Coloration	ALPHA	No coloration between restoration and tooth
	BRAVO	Less than half of edge environment coloration
	CHARLIE	More than half of edge environment coloration

Results

The 12th month clinical value of the fissure sealants that were applied to the permenant first molars in study are shown in Table 2.

In this study, 322 fissure sealants were applied to 100 children and clinical evaluation of all sealants were made in compliance with Ryge criterias. The results of clinical examination were recorded separately for each tooth.

At the end of the 12th month, retention rate was determined; 95 (29.5 %) teeth had complete retention, 143 (44.4%) teeth had half retention and 84 (26%) teeth had completely lost the sealants. The presence of caries and tooth resto-

Table 2. *12-month clinical follow-up data according to the Ryge Criteria*

	Retention	Presence of caries	Marginal adaptation	Marginal coloration	Fracture
	A-B-C	A-B	A-B	A-B-C	A-B
N	95-143-84	274-48	279-43	322-0-0	321-1
%	29.5-44.4-26	85.1-14.9	86.7-13.3	100-0-0	99.7-0.3
A:Aplha B:Bravo C:Charlie N:Number of fissure sealants					

ration were observed in 48 (14.9%) teeth. 43 (13.3%) of 322 fissure sealants were observed with marginal adaptation disorder, only 1 (0.3%) was cracked (Figure 2, Figure 3).

In our study, no marginal discoloration of sealants is observed and recorded as Alpha all the teeth.
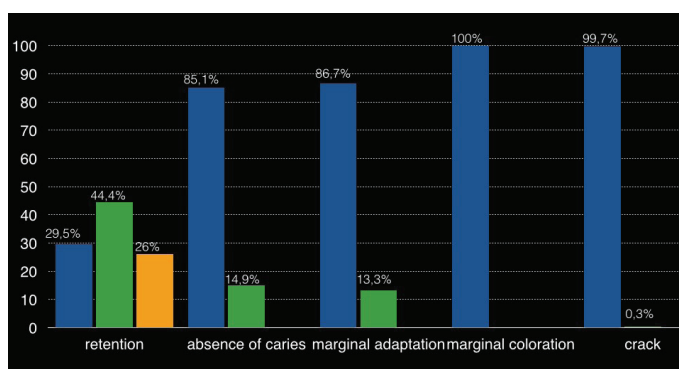
Figure 2. Appearance of datas as a percentage.
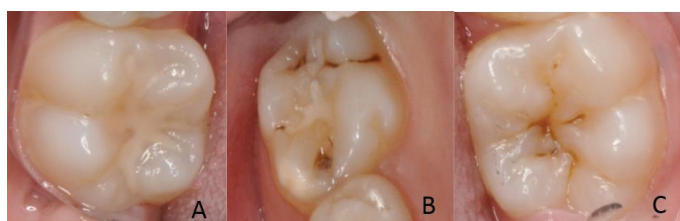
Figure 3a,b. A: ALPHA retantion B: BRAVO retantion C: CHARLIE retantion .

Discussion

Today, it is seen that light cure resin-based materials are widely used as a pit and fissure sealant. In this study, the light cure resin fissure sealant material is used.

It is reported that the most important criteria of the evaluation of the success of fissure sealant material are micromechanical connection between enamel surface and material and long-term retention. This retention depends on isolation of working area, material viscosity, preparation of enamel surface and using of adhesive systems (12). In assessment of the retention of fissure sealant, as we did in our study, the degree of the material's structural integrity; whether it is full retention, half retention or full loss is important (13,14).

At the beginning, partial retention of fissure sealants on occlusal surface was accepted as clinical success. During the period when the adhesive dentistry had started it was an optimistic approach, but two decades later studies showed that it was not true. It is shown that both the tooth which has partial retention and not applied fissure sealant have same susceptibility to caries (15,16).

Conry *et al.* (17) reported that the sufficient fissure sealant material leaving deep fissure out or fissure sealant sharp fringe because of material breakage cause plaque involment and caries.

In a study by Simonse (18), the longest clinical follow-up study, fissure sealants are applied to permenant first molars, after 5 years 82% of them, after 10 years 57%, after 15 years 28%, provide full retention. After 15 years, 35% of fissure sealants continue as half retention. In 31% of teeth that fissure sealants are applied, decay or tooth restoration presence is observed and the decay rate of the teeth without fissure sealant is 83%. In this study, fissure sealants are applied only once and it is considered that decay rate can be brought close to zero by making regular checks and repairing of partial losses. When the researches examined, it is reported that the first permenant molars with fissure sealants are observed with failure rate of 5-10% per annum.

The study by Dennison *et al.*(19) reports that the highest failure of fissure sealants is observed in first six months so they should be followed at least six months. In this study the retention rates were compared to previous studies, the success of the resin materials was found to be at lower values.

Majere and Major (20), using resin-based fissure sealants in clinical studies, reported that they observed approximately 90% rate of complete retention at the end of five years. In a study by Elbay *et al*. (21) the time of retention of seven different fissure sealants followed by a year, they observed that resin-based sealants stated in a retention rate of at least 85%. In this study, after one-year follow-up full retention rate was found as 29.5%.

In a study Gazi University Faculty of Dentistry concluded in 2012, it is evaluated the 1st,3rd,6th,12th,24th month clinical success of resin-based and glass ionomer-based fissure sealants done by grade 5 students are evaluated. The result of an annual review, 57 (38.5%) of 143 resin-based fissure sealants are observed with full retention, 66 (46.1%) with partial retention and 20 (13.5%) with total loss. In glass ionomer-based 145 fissure sealants are observed as 47 (35.1%) with full retention, 58 (40%) with partial retention, 40 (27%) with total loss. The presence of decay or restoration are detected in only 5 (3.3%) of the 143 resin-based fissure sealants and in 3 of the glass ionomer-based sealants (2%) are identified with decay or restoration (22). The retention rate we have achieved as a result of this study are similar to these rates.

Adequate moisture control is known to be crucial to the success of making a fissure sealant application. Controlling the humidity is releated to the eruption level of teeth, the patient's ability to cooperation, material and isolation method. To provide isolation for non-full-erupted tooth is difficult and possibility of communication with noncoopere children is considered. Resin-based materials exhibit more technical

precision than polyacid based materials because of its hydrophobic structure (5,9).

The acidified and washed adhesive systems are commonly used in the fissure sealant application. Phosphoric acid is accepted as a standard method for etching enamel surface. However, it is no longer possible to remove microbial dental plaque and remnants, washing after etching to remove acid forms an unpleasant taste in the mouth, and so it is reported that it may cause undesired behavior in pediatric patients (23). Therefore, fissure sealants that do not require isolation or washing during the process and with less technique sensitivity are developed to ensure retention (24).

In a study by Bendinskaite *et al.* (25), they reported that no significant difference was found in 5 years follow-up between etching used in enamel preparation and air abrasion technique. In another study, it is evaluated that the fissure sealants applied following acid etching, ER, Cr:YSGG laser application showed similar retention value in 18 months follow-up. It also focused on how effective etching duration for clinical success. Duggal et al. (26) conducted a study of 264 permenant first molars. The application of fissure sealants was done with different etching duration as 15,30,45,60 seconds. After 6 months and 1 year follow-up, they concluded that different etching duration did not affect the retention of fissure sealants.

To achieve ideal penetration, covering the pit and fissures, and marginal adaptation for fissure sealants, another required factor is material viscosity. In a study by Irinoya *et al.* (27), they evaluated the effect of viscosity and they reported that low viscosity fissure sealant had better penetration compared to high viscosity. However, Barnes *et al.* (28) concluded that viscosity was not important for covering success of material, so instead of modification of the material the surface energy of enamel can be changed for clinical success.

Conclusion

To achieve success in the clinical application of fissure sealants, besides right diagnosis, it is important to apply manifacturer's instructions and be careful in every stage. Good isolation must especially be provided, regular dental examination should be done and appliance should be repeated to the teeth which do not show full retention so that the effectiveness of fissure sealant continues. It should especially be emphasized for parents that it is important to bring their children to control appointments for their oral dental health.

Türkçe Özet: *Fissür Örtücülerin Klinik Başarısı: 1 Yıllık Takip. Amaç: Bu çalışmanın amacı İstanbul Üniversitesi Diş Hekimliği Fakültesi Pedodonti Anabilim Dalı kliniğinde uygulanan fissür örtücülerin bir yıl sonundaki klinik başarısının değerlendirilmesidir. Gereç ve Yöntem: Bu çalışma derin pit ve fissürlere sahip, fissürlerinde herhangi bir restorasyon ya da çürük bulunmayan, yaşları 7 ile 13 (ort. 9.29.2±1.22).) arasında değişen 100 çocuk üzerinde gerçekleştirilmiştir. 322 adet birinci büyük azı dişine fissür örtücü uygulanmıştır. Fissür örtücüler tek bir hekim tarafından ayna ve sond yardımıyla 12. ayın sonunda değerlendirilmiştir. Her bir fissür örtücünün değerlendirilme kriterleri, Ryge kriterleri kulanılarak retansiyon (R), çürük varlığı (PC), kenar uyumu (MA), kenar renkleşmesi (MD) ve çatlak (C) olarak belirlenmiştir. Bulgular: Tüm çocuklar kontrollere çağrılarak fissür örtücülerin tamamı aşağıdaki şekilde incelenmiş, elde edilen bulgulara göre: R: Alpha 95 (%29.5), Bravo 143 (%44.4), Charlie 84 (%26); PC: Alpha 274; Bravo 48 (14.9) ; MD: Alpha 322; MA: Alpha 279, Bravo 43 (%13.3); C: Alpha 321 Bravo 1 (%0.3) olarak değer-lendirilmiştir. Sonuç: Fissür örtücülerin klinik başarısı, uygulandığı yüzeye retansiyonunu kaybetmediği sürece sağlanmaktadır. Fissür örtücü uygulamasından sonra hastalar düzenli aralıklarla muayene edilmeli, fissür örtücüler retansiyon ve kenar uyumu açısından değer-lendirilmelidir. Anahtar Kelimeler: Fissür örtücü, Ryge kriterleri, marjinal adaptasyon, retansiyon*

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Original research

Effect of fixed dental prosthesis on the brain functions of partially edentulous patients – pilot study with power spectrum density analysis

Purpose

This study was done to analyse the influence of fixed dental prosthesis (FDP) on brain function by analysing power spectral density of partially edentulous patients.

Materials and Methods

The study included unilateral missing mandibular molar replacement patients. The patients were restored with three-unit metal ceramic FDP restorations. The cognitive function was analysed with a mental state questionnaire. Power spectral density (PSD) analysis of EEG alpha waves was made pre- treatment, post treatment and 3 months after FDP treatment to analyse the brain function. The data in various phases were obtained before and after chewing. The results were statistically analysed.

Results

The mean pre and post treatment PSD was 0.0175 (SD ±0.0132) and 0.0178 (SD ±0.0135). The mean post treatment PSD after three months was 0.024 (SD± 0.019). The results were analysed with repeated ANOVA and were statistically significant. (p<0.01).

Conclusion

The study displayed improvement in brain function of partially edentulous patients with FDP rehabilitation.

Keywords: Brain activity; Electroencephalogram; Fixed dental prosthesis; Power spectral density; Cognition; Fast Fourier Transform

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Introduction

Efficient health care systems equipped with reliable diagnostic and treatment measures have improved the quality of life (QOL) (1). Average life expectancy of individuals has increased over the years and this occurrence is identified as "population ageing (2,3).

There are many underlying causes of neurodegenerative diseases, Alzheimer's disease (AD) being the most common one. Pathology of AD according to strong genetic and clinical evidence is due to cumulative neurotoxicity. In patients, symptoms start gradually but eventually develop severe enough to interfere with activities of daily life (4). Electroencephalographic (EEG) signals of neurodegenerative disease patients are generally less synchronous than in age matched control subjects. Researchers have described that tooth loss can be a risk factor for brain function deterioration and mild memory impairment which could progress to dementia in later life (5).

Researches had been done to analyse the effect of complete denture and dental implant on brain function improvement (6, 7, 8). But the effect of brain function on early interventional replacement of the missing teeth

with fixed dental prosthesis (FDP) has not been analysed. It is important to interpret the effect of FDP on brain function and to verify if early rehabilitation of missing teeth could depict any significant change in electro encephalographic reading. This study evaluated the effectiveness of FDP on brain function by studying its power spectral density (PSD).

Materials and Methods

The study proposal was approved by Institutional Review Board. The study was conducted in the Department after obtaining the patient consent. The study had a definitive inclusion and exclusion criteria in recruiting the participants. Power of the study was determined to be 95% power with 5% alpha error. 15 Healthy individuals between 25 to 35 years with missing right first molar in mandible for duration of two months with completely healed socket, requiring dental prosthesis for the first time were considered. On examination subjects were excluded if they demonstrated any prior systemic conditions with oral manifestations, already existing fixed dental prosthesis, complete edentulism, temporo-mandibular disorder, bruxism and prior use of removable partial denture. Patients suffering from diabetes, any neuromuscular disorder affecting the chewing efficiency and patients already suffering from cognitive disorders were also excluded from the study. EEG recordings had to be made for each patient before and after the prosthetic treatment. After the explanation of research procedure, fifteen patients were selected for the study and an informed consent was collected from each patient.

Before EEG recording hair-wash was advised for the patients with shampoo to keep the hair dry for EEG recording. Patients were advised sufficient sleep of at least 8 hours the night before the procedure. Patients were asked to maintain abstention from caffeinated product for eight hours before the test. Recordings were done with the subjects seated in a resting position. "10-20 electrode placement system" was employed for the procedure which is a standardisation for electrode placement. This standardisation was provided by the international federation in electroencephalography (IFCN) and clinical neurophysiology (9). EEG recordings were made in three stages. First part of EEG was taken before the treatment; second part one day after the cementation of the FDP and final EEG was recorded three months after the treatment completion. The subjects were seated in a resting position with their hands resting on the thighs and eyes closed. Stable EEGs were detected and recordings were made for 20 minutes. Each time same procedure was followed for all patients. EEG recordings were taken after chewing paraffin gum (saliva-check kit, GC Corporation, Japan) for three minutes followed by one minute of rest. Signal sampling was done at 256 samples per second with 16-bit resolution. The data obtained with this procedure was compared with the data attained one day after the FDP cementation and three months post cementation to analyse presence of any difference (8). (Figure 1 and 2)

3 Unit FDP with metal ceramic restoration was cemented for each patient. Algorithm testing was done using single channel (C3-P3) recording alpha waves of the greatest amplitude. The data were pre-processed computing average spectrum with 50% overlap in the epoch signal to find the peak
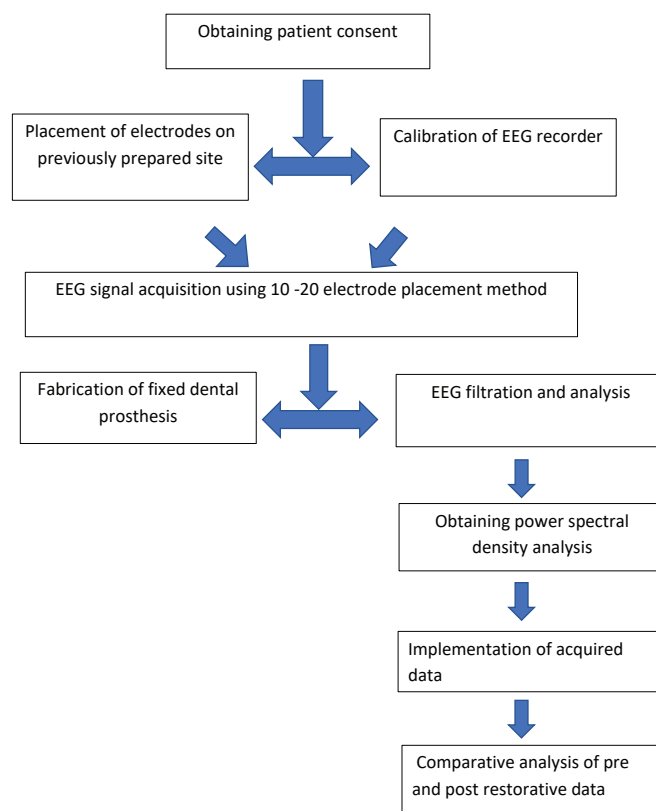
Figure 1. *Flow chart of study procedure.*
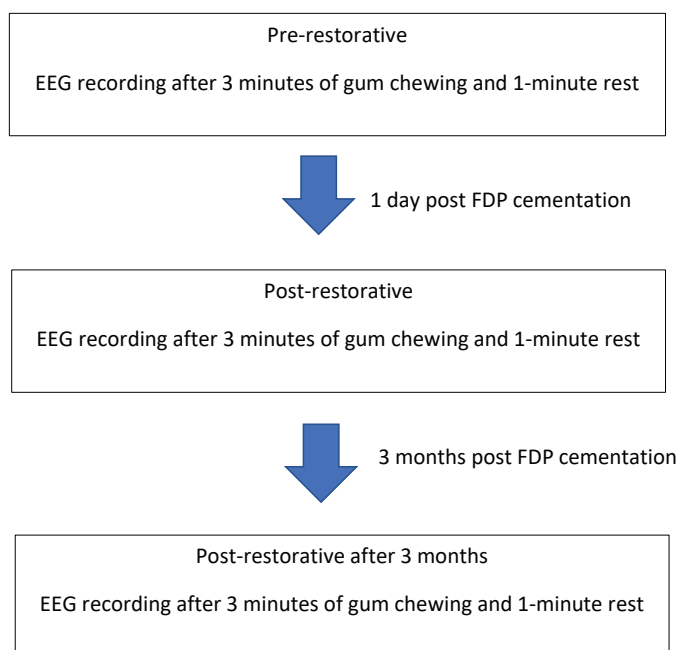
Figure 2. *Procedure of EEG data acquisition.*

of the spectrum. Power line noise and movements during EEG recording resulted in artefacts requiring filtration of the acquired data. EEG signal baseline wanders was corrected in the LAB VIEW platform and signal amplitude was quantified to micro volts. A digital low pass finite impulse response (FIR) filter was used to filter the EEG signal. Power line noises were removed using hamming window technique and filtered EEG segments were selected for analysis. Spectral analysis was approximation of power from the observation of the signal over time. Fast Fourier transformation (FFT) was used for every two second window with an overlap of one second

of the signal to achieve the power spectrum of the signal.

PSD portrays the signal power distribution over frequency. It expresses the variations of strong and weak frequency. The establishment of strong frequency in relation to time aids in further computation analysis. The computation of PSD is done through Fourier transformation. The equation for FFT is given in equation formula

$$X(k) = \sum_{k=1}^{N-1} x(n) W_N^{kn} : \quad k = 0,..., N-1$$

As,

$$W_N = e^{-j\frac{2\pi}{N}}$$

For one value of 'k' observe that the multiplication of x(n) and wkn as done for 'N' times, since n=0 to N-1. That is there are 'N' complex multiplications for one value of k. since, 'k' also has 'N' values (since k=0,1,...,N-1)

Spectral analysis is the distribution of power over frequency. EEG signals obtained from the patients provided for the spectral analysis of various signals. This resulted in useful materials for diagnosis. A random signal had finite average power and, therefore, could be characterized by an average power spectral density as in Eqn. $PSD_f(w) = \lim_{T\to\infty} \dfrac{\left|F_{X_T}(w)\right|^2}{2T}$

where F (w) XT represent the FFT output. T is the total duration of the input signal.

Digitalisation of the recorded EEG was done to collect the EDF (European data format) for further investigation. The data was transferred to the software (eeglab software, for pre-processing followed by selection of the suitable segment which was analysed to obtain the power spectral density value (PSD). For each patient three PSD values were made before treatment, one day after cementation of the FDP and three months after treatment. The PSD values were compared to observe the difference (Figure 3-8).

Result

The values for power spectral density were categorized as, "Pre-treatment EEG PSD value", "Post-treatment EEG PSD value one day after FDP cementation" and "Post-treatment EEG PSD Value after three months". The values increased with the post treatment phase in many patients (Table 1). The mean pre-treatment PSD was 0.0175 and post treatment PSD was 0.0178. The three months post-treatment PSD measure was 0.024. The mean PSD values increased with the post treatment with FDP treatments (Table 2).

A repeated measures ANOVA was conducted to analyse the influence of FDP on brain function by analysing power spectral density of partially edentulous patients. There was a significant effect of FDP on brain function, Wilks' Lambda =0.517, F (2,13) = 6.065, p=0.014 (Table 3). The Mauchly's test of sphericity showed that assumptions were met, χ2(2) = 66.313 (Table 4). There was a significant effect with post

Table 1. *Pre and Post treatment PSD values obtained from EEG analysis (relative units)*

Sl. No.	Pre-treatment PSD Value	Post-treatment PSD Value one day after Cementation	Post-treatment PSD Value three months after FPD Cementation
1	0.004	0.003	0.005
2	0.004	0.004	0.006
3	0.010	0.010	0.011
4	0.010	0.012	0.013
5	0.021	0.022	0.041
6	0.010	0.010	0.012
7	0.012	0.013	0.015
8	0.014	0.014	0.016
9	0.013	0.013	0.015
10	0.046	0.047	0.058
11	0.010	0.010	0.013
12	0.028	0.029	0.045
13	0.045	0.047	0.060
14	0.012	0.012	0.013
15	0.021	0.021	0.045

Table 2. *Descriptive statistics*

	Mean	Standard Deviation	N
Pre restorative EEG PSD Value	0.175	0.013	15
Post restorative EEG PSD Value one month after FDP Cementation	0.178	0.013	15
Post restorative EEG PSD Value three month after FDP Cementation	0.0245	0.018	15

Table 3. *Multivariate Tests*

Multivariate Tests					
Effect	Value	F	Hypothesis df	Error df	Sig.
factor 1 Pillai's Trace	0.483	6.065a	2.000	13.000	0.014
Wilk's lambda	0.517	6.065a	2.000	13.000	0.014
Hotelling's Trace	0.933	6.065a	2.000	13.000	0.014
Roy's Largest Root	0.933	6.065a	2.000	13.000	0.014

treatment FDP on brain function, Greenhouse-Geiser (F (2, 28) = 11.729, p = .004) (Table 5). The tests showed significant effect of brain function in post treatment (mean = 0.245, SD = 0.018) compared to pre- treatment (mean = 0.175, SD= 0.013). However, 1-month post treatment showed less significant effect (mean = 0.178, SD= 0.013) in comparison with

Table 4. *Mauchly's Test of Sphericity*

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
factor 1	0.006	66.313	2	0.000	0.502	0.502	0.500

Mauchly's Test of Sphericity

Table 5. *Tests of Within-Subject Effects*

Tests of Within Subjects Effects

Source	Type III Sum of squares	Df	Mean Square	F	Sig.
factor 1 Sphericity Assumed	0.000	2	0.000	11.729	0.000
Greenhouse-Geisser	0.000	1.003	0.000	11.729	0.004
Huynh-Feldt	0.000	1.004	0.000	11.729	0.004
Lower-bound	0.000	1.000	0.000	11.729	0.004
Error (factor 1) Sphericity Assumed	0.001	28	2.003E-5		
Greenhouse-Geisser	0.001	14.043	3.994E-5		
Huynh-Feldt	0.001	14.053	3.991E-5		
Lower-bound	0.001	14.000	5.006E-5		

pre-treatment. The results displayed improved brain function with FDP treatment in partially edentulous situation.

Discussion

Prosthodontic treatment and outcome have a direct influence on patient's satisfaction and expected to lay an impact for entire life time (10). Weijenberg et al (2) stated that index for QOL has a direct correlation between masticatory capability and cognitive disorder. The studies have revealed evidence of tooth loss and interference in mastication leading to memory loss, learning inability and eventual decline in QOL.

Morphological and physiological studies have proven that early tooth loss have greatly resulted in chronic stress and elevated levels of corticosterone. This eventually results alteration in the hippocampus and in due course leads to reduced capacity in spatial learning and memory. Tucha et al (11) observed the effect of gum chewing improved the cognitive functions, skill and memory. Allen et al suggested that duration of chewing could be a key moderator on health, attentiveness and reduction of chronic stress (12). Kamiya et al proposed that that prolonged rhythmic gum chewing causes improved function by suppressed nociceptive flexon reflex via serotonergic (5-HT) descending inhibitory pathway (13). Edentulous or partially edentulous state has a direct effect on cognitive impairment and early rehabilitation of defective teeth is required (14). Epidemiological data implicate a positive correlation between masticatory deficit and neurological diseases. Improved chewing capability has important implications for the mechanisms underlying certain cognitive abilities (15). The mean PSD in this study was 0.0175, 0.0178, and 0.024. It increased with pre to post treatment with FDP. The result of the study is indicative of improved brain function with the restoration of missing teeth with FDP.

Electroencephalographic (EEG) measurements are commonly used for brain function research. Loss of EEG synchronicity can be interpreted as early onset of AD (16). Tamura et al (17) studies with fMRIs resulted in major artefacts. Valipour et al (18), Vialatte et al (19) displayed the use of EEG and PSD in obtaining improved data when compared to other methods . PSD is an established method of evaluating EEG (9,19,20) and spectral parameters can be achieved from all available EEG machines. The use of spatial filters, canonical correlation analysis (CCA) and blind source separation technique (BSS) can effectively reduce the artefacts that might arise with this technique (21).

Hosoi et al (22) observed a positive connection between improved occlusal function and enhanced brain activity in complete denture. The analysis stated the brain functional activity improved of complete and partial denture prosthesis. De Cicco et al (23) explained that the implant-prosthesis therapy can reduce the unbalance of trigeminal proprioceptive afferents and the asymmetry in pupil's size, improving performance in a complex sensor motor task. Kamiya et al (24) elucidated that intrinsic prefrontal activation during chewing with a denture may prevent prefrontal depression induced by tooth loss in edentulous patients. This study had increase in post treatment PSD values in partially edentulous patients. Similar changes of increase were observed by Praveen et al (8) in brain function post treatment in edentulous patients with complete denture prosthesis. This study was supportive in accordance to earlier studies that the replacement of teeth can improve the PSD and the brain function activity.

This study makes a positive impact on QOL with teeth replacement (25). The importance of early replacement of teeth can be stressed with the result of this study. This study was limited to localised population, larger sample size and evaluation of multi-centric population is necessary to legitimate the findings. Rehabilitation of single missing molar with FDP followed

in this study can be considered as initial benchmark for comparative evaluation on brain. Additional investigations and studies in terms of multiple missing teeth rehabilitation with FDP, implants and removable prosthesis are required in future.

Conclusion

Within the limitations of the study, it can be concluded that, the mean power spectral density value of post treatment alpha waves recorded is higher in comparison with pre-treatment mean value. Early rehabilitation of missing teeth with FDP facilitate improved brain function.

Türkçe Özet: Sabit dental protezlerin parsiyel dişsiz hastaldın beyin fonksiyonlarına etkisi- spektral güç yoğunluğu analizi ile pilot çalışma. Amaç: Bu çalışma, sabit dental protezlerin (SDP) parsiyel dişsiz hastalardın beyin fonksiyonlarına etkisini analiz etmek için yapılmıştır. Gereç ve Yöntem: Çalışmaya tek taraflı alt çene azı eksikliği olan hastalar dahil edilmiştir. Hastalar, üç üye metal seramik SDP restorasyonları ile tedavi edilmiştir. Kavramsal fonskiyon mental durum anketi ile analiz edilmiştir. EEG alfa dalgalarınon spektral güç yoğunluğu (SGY) analizi tedaviden önce, tedaviden sonra v eve tedavişden 3 ay sonra beyin fonksiyonlarını analiz etmek için yapılmıştır. Değişik fazlardaki data, çiğneme öncesi ve sonrası elde edilmiştir. Sonuçlar istatistiksel olarak analiz edilmiştir. Bulgular: Tedavi öncesi ve sonrası ortalama SGY 0.0175 (SS ±0.0132) and 0.0178 (SS ±0.0135) bulunmuştur. Üç ay sonraki ortalama SGY 0.024 (SS± 0.019) bulunmuştur. Sonuçlar tekrar eden ANOVA ile analizedilmiştir ve istatistiksel olarak anlamlı bulunmuştur (P < 0.01). Sonuç: Bu çalışmada sabit dental protezlerin (SDP) parsiyel dişsiz hastalardın beyin fonksiyonlarını arttırdığı tespit edilmiştir. Anahtar kelimeler: Beyin aktivitesi, Elektroensefalogram, Sabit dental protez, spektral güç yoğunluğu, kavramsal, hızlı forier dönüşüm

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Original research

A new dental casting technique for production of void-free dental models

Purpose
An essential of successful dental prosthesis is dental models. Voids present in dental models decreases accuracy and strength. This study investigates void formation in models fabricated by a new technique. The technique described in the study was based upon increasing soaking time of gypsum powder in water.

Materials and Methods
Voids in hand mixed, hand mixed after a soaking time of 1.5 minutes and vacuum mixed samples were examined. The voids were counted via a stereomicroscope and diameters of voids were recorded in 2 categories (0.01-0.05mm, 0.051-0.1mm). The amounts of voids were compared between the samples prepared with 3 methods.

Results
The samples prepared by conventional hand mixing method had the highest total number of voids and smaller voids. There was no significant difference between the amount of voids in the samples prepared by soaking powder in water and by mixing under vacuum.

Conclusion
Soaking gypsum powder in water for 1.5 minutes before mixing may be an alternative to mixing gypsum under vacuum to avoid void formation in dental models.

Keywords: Dental model, Dental prosthesis, Void, Microscopy, Dental casting technique

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Introduction

Gypsum products has been the most widely material to produce diagnostic cast, working cast and dies. Desirable qualities for instance hardness, strength, accuracy, detail reproduction, resistance to abrasion, minimal solubility, stability, ease of handling, cost and color depend on the utilization of the product. Gypsum powder used in dentistry consists of calcium sulfate hemihydrate and forms a viscous material after being mixed with water. After the chemical reaction occurs, calcium sulfate hemihydrate turns into calcium sulfate dehydrate. The amount of water required to mix with powder is greater than the amount required for the reaction. This excess water vaporizes during stiffening and a mass of interlocking gypsum crystals is formed. Voids occur between these crystals after evaporation of the water. Strength, resistance to abrasion and hardness are affected from the amount and size of the voids (1). In addition to product of the reaction, voids are formed by the incorporation of air during mixing process and pouring mixture into an impression material.

Mixing dental stone with a motorized vacuum mixer that simultaneously extracts air and spatulates the mixture at a constant rate, minimizes air incorporation (2, 3). The impression pouring technique consists of carrying and placing the gypsum slurry to the impression. Carrying the

slurry can be performed by using a spatula or a syringe (4). A mechanical vibrator is suggested to enable the slurry to flow and spread into the impression. The rate of flow and spread depends on the frequency and amplitude adjustment of the vibrator (5,6). Excessive speed can incorporate air bubbles into the mixture. Gathering small increments of the slurry and placing at a posterior region of the impression, adding the increments till the anatomic indentations critical for the restoration are filled are the tips advised to avoid void formation (1). Type of impression material is another determinant of void formation. As the wettability of the impression material increases, the size and number of voids decrease (6-8).

In this study, a new technique of cast fabrication has been described. The purpose of this research was to compare number and size of voids in the models prepared by using this new technique with hand and vacuum mixed models.

Materials and Methods

A total of 18 dental stone specimens were prepared by pouring gypsum slurry into silicone model former molds by an experienced dental technician. Water/powder ratio was 0.26 and soaking time before mixing was 30 seconds as recommended by the manufacturer (Type III, Alston, Ata Alçı Sanayi ve Ticaret AŞ, Ankara, Turkey). The specimens were divided into 3 groups regarding mixing methods; hand mixed (H), powder soaked in water (S) and vacuum mixed (V). For group H, room temperature distilled water was placed in a rubber bowl and dental stone powder was added to water. After soaking time of 30 seconds, the slurry was mixed for 1.5 minutes with a steel blade spatula. For group S; room temperature distilled water and powder were placed in a bowl, waited for 1.5 minutes, and then spatulated for 30 seconds with a spatula. For group V, the slurry was mixed under vacuum for 1 minute by using vacuum mixing machine (EasyMix, BEGO Gmbh & Co KG, Bremen, Germany). All mixtures of dental stone was poured to the molds on a mechanical vibrator (Rotaks-Dent Dişçilik San. ve Tic. A.Ş. İstanbul, Turkey) for 25 seconds at a vibration frequency of 3000cycles/minute.

All casts were separated from the molds after a waiting time of 1 hour for setting. Thereafter, 2 mm thicknesses was cut from middle region of the casts by the use of a model trimmer (Rotaks Dent, İstanbul, Turkey). Four regions 7 mm to edge and 4 regions 10 mm to centre of the samples were marked on every 2 mm thick specimens and numbered (Figure 1). The marked regions of the specimens were examined with a stereomicroscope (Leica EZ4 HD, Leica Microsystems GmbH, Wetzlar, Gemany) under x35 magnification and x10 eyepieces for detection of air voids. Examples of the images captured with the microscope are shown in Figures 2-4. The voids having diameter 0.01-0.05 mm and 0.051-0.1 mm were counted and recorded. Localizations of voids were also recorded as edge or centric region to examine the relation between voids and localization.

Statistical analysis

The tendency of quantitative variables was determined using centralization and variance measures. Kruskal-Wallis H Test was used to compare the differences between the amounts of voids counted in 3 groups. The differences between the amounts of voids found in 2 different regions (center, edge)

were compared using Mann-Whitney U Test. All hypotheses were tested at 0.05 significance level. All analyzes were performed using IBM SPSS (Statistical Package for Social Sciences for Windows, Version 21.0, Armonk, NY, IBM Corp.).
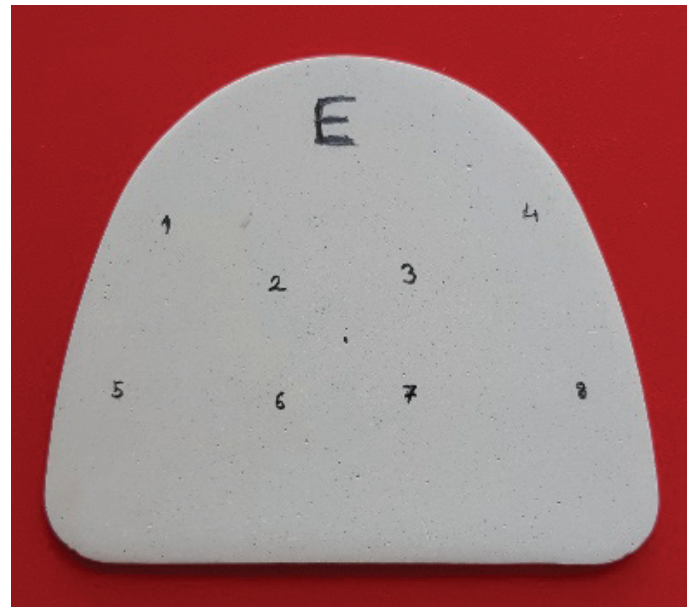
Figure 1. *Landmarking of a sample.*
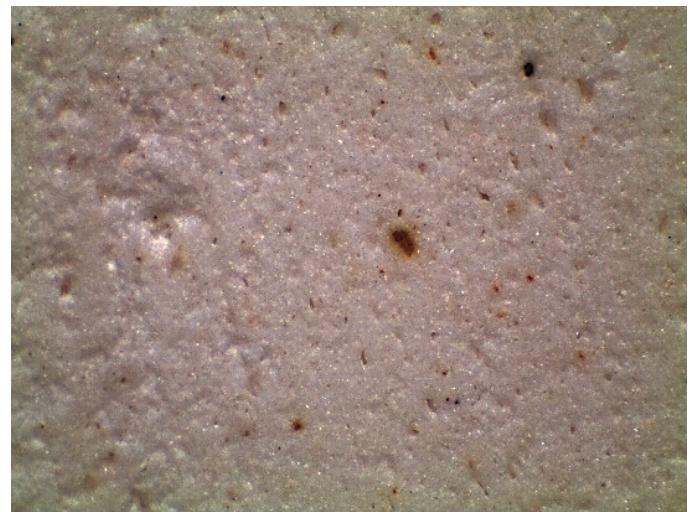
Figure 2. *Microscopic image of a hand mixed sample.*

Figure 3. *Microscopic image of a soaked sample.*

Figure 4. *Microscopic image of a vacuum mixed sample.*

Results

A statistically significant difference was found between the groups in terms of total number of voids (p<0.001). The number of voids in group H was higher than that of group S and group V. There was no statistically significant difference between total voids of the group S and V (Table 1, Figure 5).

Table 1. *Kruskal Wallis table*

Group	H (48)	S (48)	V (48)	p-value
	Mean ± SD			
	Median (Min–Max)			
Total void	9.4±4.52	4.67±1.94	4.17±2.68	<0.001
	9 (2-21)	5 (1-11)	4 (0-11)	
Large void	0.44±0.8	0.52±0.71	0.35±0.84	0.185
	0 (0-3)	0 (0-2)	0 (0-4)	
Small void	8.96±4.24	4.15±1.73	3.81±2.29	<0.001
	9 (2-20)	4 (1-10)	4 (0-8)	
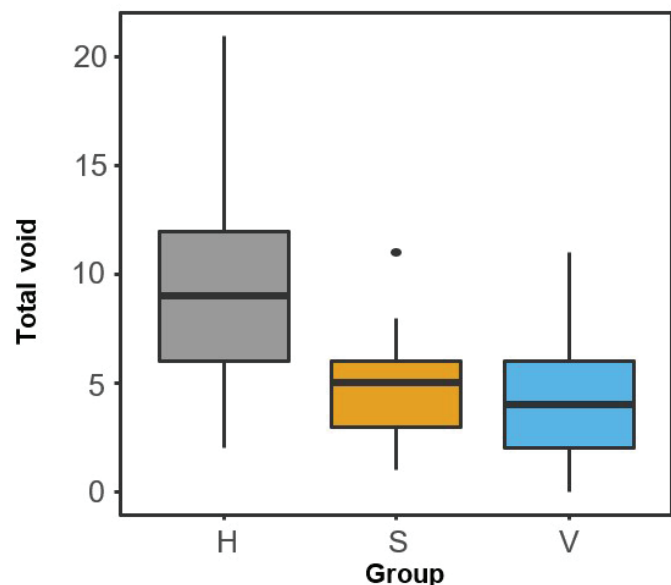
Figure 5. *Comparison of total voids.*

Difference between the amount of 0.051-0.1 mm voids were not significant (p=0.185). The groups showed significant difference with regard to smaller voids (0.01-0.05 mm, p<0.001). It was observed that the total number of small voids in group H was higher than that of group S and group V. There was no statistically significant difference between small voids of the group S and V (Table 1, Figure 6).

The number of total, large and small voids for 3 groups was compared by localization and no significant difference w found (Table 2).
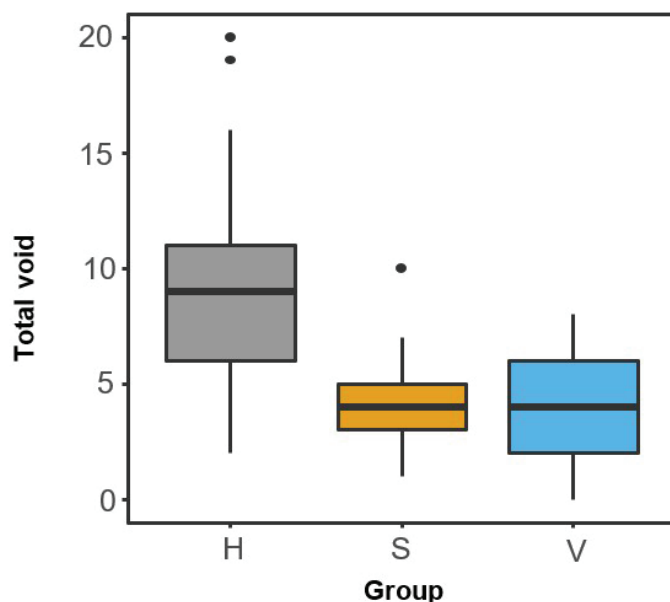
Figure 6. *Comparison of small voids.*

Table 2. *Mann Whitney U table*

Localization	Edge (72)	Center (72)	p-value
	Mean ± SD		
	Median (Min–Max)		
Total void	6.21±3.84	5.94±4.16	0.604
	5 (1-18)	5 (0-21)	
Large void	0.47±0.9	0.4±0.64	0.794
	0 (0-4)	0 (0-2)	
Small void	5.74±3.51	5.54±4.03	0.48
	5 (1-16)	5 (0-20)	

Discussion

Amount and size of voids effect mechanical properties of casts. One of the reasons of void formation is the gypsum mixing method (2). Soaking dental stone powder in water for 30 seconds before mixing is recommended for allowing particles to get wet (1). In this study wetting time was increased to 1.5 minutes. The amount and size of voids were compared with conventional hand mixing method and vacuum mixing method.

Mixing gypsum under vacuum is a known fact that it reduces air trapped in the mixture (9). Results of the study showed that dental stone samples fabricated with soaking method had same amount of voids with that of vacuum

method and less voids than hand mixed group. Spatulation disrupts precipitation centers forming new nuclei. Nuclei act as centers of crystalline growth (3). In the study, hand mixed group had longer spatulation time. Longer spatulation probably caused more crystalline growth forming more voids. The other possibility is that less spatulation caused less air incorporation in the soaked group.

Considering large pores causes less accuracy and strength for casts than small ones, the study included 2 categories of void size. Although there were no significant difference between the groups by means of 0.051-0.1 mm voids, amount of 0.01-0.05 mm voids were found higher in Group H than other groups. Small pores may result in decreased strength as large pores do if the amount is high.

In the literature, recent researches about pores of dental models seems to be limited with wettability of impression materials (10), effect of pre-impression procedures (11), comparison of dental stone types (12). There only few studies about the effect of mixing method on void formation after the superiority of the vacuum mixer had been proved. Akpınar et al. described a new method to decrease voids of the casts (13). They compared the amount of voids between mixed with hand, vacuum mixer and a vacuum cabin designed for the research. The vacuum cabin described in the study decreased the void formation.

Computer-aided design/computer-aided manufacture (CAD-CAM) system enables the fabrication of a prosthesis without a working model. However, a model is still required to carry out the fit test and modify the prosthesis. In addition to this, diagnosis and manufacture of orthodontic devices and surgical guides require models (14,15). Altough working models can be produced with CAD-CAM, low financial capability of dental laboratories and state dental clinics especially in developing countries may not enable to have a CAD-CAM equipment. In these circumstances, the technique of model fabrication described in this study may be used instead of conventional hand mixing or as an alternative to mixing under vacuum.

The amount of voids in the models produced with this new method may be compared with the ones produced with CAD-CAM in another study. This study was limited only with the models made of Type III dental stone. Another research should be carried out using Type IV dental stone which is used mostly for fixed partial denture. A further study testing compressive strength and hardness of the casts produced with this new method would support the results of this research.

Conclusion

According to the results of the present study, soaking powder in water for 1.5 minutes before mixing dental stone may be an alternative method to the vacuum mixing method especially in low financial conditions.

Türkçe Özet: *Boşluksuz dental model yapımında yeni bir model elde etme tekniği. Amaç: Dental modeler başarılı dental protezlerin bir gerekliliğidir. Dental modellerde bulunan boşluklar hassasiyet ve dayanıklılığı azaltmaktadır. Bu çalışma yeni bir teknik ile üretilen modellerde boşluk oluşumunu araştırmıştır. Çalışmada tarif edilen teknik, alçı tozunun suda bekletilme süresinin arttırılmasını temel almaktadır. Gereç ve Yöntem: Elle karıştırılmış, 1.5 dakika beletme sonrası elle karıştırılmış ve vakum ile karıştırılmış örneklerdeki boşluklar incelenmiştir. Bir stereomikroskop yardımıyla boşluklar sayılmış ve boşluk çapları 2 kategori altında (0.01-0.05mm, 0.051-0.1mm) kaydedilmiştir. Üç yöntem ile hazırlanan örnekler arasında boşluk miktarları karşılaştırılmıştır. Bulgular: Geleneksel el ile karıştırma yöntemi kullanılarak hazırlanan örneklerin en fazla toplam boşluk ve küçük boşluğa sahip olduğu belirlenmiştir. Tozun suda bekletilmesi ve vakum altında karıştırma yöntemleri ile hazırlanan örneklerdeki boşluk miktarları arasında istatistiksel olarak anlamlı fark saptanmamıştır. Sonuç: Dental modellerde boşluk oluşumunu önlemek için; karıştırma öncesi alçı tozunun suda 1.5 dakika bekletilmesi, alçının vakum altında karıştırılmasına alternatif olabilir. Anahtar Kelimeler: Dental model, Dental protez, Boşluk, Mikroskop, Dental model elde etme tekniği*

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Original research

Quality of communicating design features for cobalt chromium removable partial dentures in Riyadh, Saudi Arabia

Purpose
This survey aimed to investigate quality of communicating design features for the construction of cobalt chromium removable partial dentures (RPDs) among dentists in Riyadh, Saudi Arabia.

Materials and Methods
A survey of nine commercial dental laboratories located in Riyadh was carried out. In each visit, master casts for cobalt chromium RPDs and dentists' prescriptions were examined. A quality score for the provided instructions was developed and ranged from 0 to 4. A zero score means that no instructions were sent from the dentist for the design of the RPD. A score of 4 means that instructions were provided for the design of four main elements of the RPD, i.e., shape of major connector, type of direct retainers, position of direct retainers, position of dental rests.

Results
162 dentists' prescriptions for RPDs and related casts were assessed. The majority of RPD cases were designed by the dental technician alone (64.2%). Shape of the major connector was the most frequent element in dentists' prescriptions (35.8%). The mean quality score of dentists' instructions was 0.96 (sd=1.54). 18% of the provided instructions achieved quality score equal to 4. Prescriptions for Kennedy Class III cases achieved significantly higher mean quality score compared to Kennedy Class II cases (p<0.05). 16.7% of the evaluated casts had clearly defined rest seat preparation.

Conclusion
The results of this survey indicate inadequate quality of communicating the design features of cobalt chromium RPDs among practicing dentists in Riyadh, Saudi Arabia. The reliance on the dental technician to design the cast RPDs seems to be high.

Keywords: Quality; Design; Cobalt chromium; Removable; Partial dentures; Saudi Arabia

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Introduction

Although tooth/implant-supported fixed dental restorations are usually more preferred for the restoration of edentulous spaces, the removable partial denture (RPD) remains a viable treatment option for the replacement of missing teeth in partially edentulous mouths (1). This is mainly related to economic and technical factors (2). The RPD is, relatively, a conservative, simple and inexpensive type of treatment. It does not require high clinical or technical skills nor advanced technologies compared to implant-supported prostheses (3). Moreover, it is a reversible treatment option so in case of denture failure or patient's dissatisfaction a dentist in agreement with the patient can switch to tooth/implant-supported fixed dental restorations to restore the dental spaces. In addition, the RPD can be the single restoration option when various contraindications preclude the use of tooth/implant-supported fixed dental restorations (4). Furthermore, the findings of epidemiologi-

cal studies support the speculations of continuing demand for the RPDs in the upcoming future (5-10). Current adult dental health surveys have shown growing trend of retaining teeth later in life than ever before (5-7). The proportion of completely edentulous patients is in decline and the number of partially edentulous patients is in raise (8, 9). This comes in line with an increasing number of the elderly populations who are in need for dental and prosthodontic care (10).

In Saudi Arabia, the available epidemiological data cannot provide clear view regarding prevalence of partial edentulism and the need for RPD treatment on a national level. However, the existing evidence suggests that the proportion of partially edentulous subjects among the Saudi population is considerable and the need for treatment with RPDs should not be underestimated (11-16).

An essential step in the construction of the RPD is to evaluate the status of the oral and dental supporting structures and to plan the design features of the denture based on the clinical and radiological findings. Afterwards and following mouth preparation final impressions should be made. At this stage the dentist has to communicate the design features of the planned RPD to the dental technician so as to fabricate a prosthesis that has the potential to function in harmony with the soft and hard oral structures without causing damage to the surrounding/underlying tissues. Careful design of the RPD and writing adequate prescription pave the way for a successful outcome of treatment with RPDs. Such professional behavior is also a mark of standard care and quality practice (17). This issue was stressed by many international dental associations and health authorities. According to the Medical Devices Directive of the European Union (18) and the guidelines of the British Society for the Study of Prosthetic Dentistry (19), it is the responsibility of the dentist to design the RPD and to provide the dental technician with clear written instructions for the fabrication of the prosthesis. Provision of a standard dental care should be an inherent part of modern dental education and contemporary dental practice. Dental practitioners worldwide should recognize the ethical and legal implications of malpractice and its negative impact on oral health and patient's well-being. While quality of communicating design elements of RPDs has been investigated in many countries worldwide (20-29), the picture is not yet clear in Saudi Arabia. The aim of this survey is to investigate the quality of prescription and communicating design features for the fabrication of cobalt chromium RPDs among dentists in Riyadh, Saudi Arabia.

Materials and Methods

Twelve commercial dental laboratories located in Riyadh city, the capital of Saudi Arabia, were contacted and invited to take part in this survey. Two laboratories declined participation; one laboratory apologized due to lack of facility to construct cobalt chromium RPDs and 9 laboratories approved to participate. The geographical location of participating laboratories comprised the different sectors of Riyadh. Five laboratories were in the northern sector and one in each of the remaining sectors of Riyadh, i.e., east, west, middle and south. Five laboratories provide work for both private and governmental dental centers/hospitals and 4 laboratories provide work for only the private dental sector.

The nine participating commercial dental laboratories were surveyed over a period of more than 6 months. The aim of the survey was to target partially edentulous cases that were sent from dentists working in Riyadh for the fabrication of clasp-retained cobalt chromium RPDs. Arrangements were made with the designated laboratories to keep records for the all constructed RPDs and frequent visits were made by the second author to examine the collected cases. During each visit dentists' prescriptions were scrutinized, targeted casts were examined and a special data collection form was completed. The data collection form was a modified version of the one that was used in a previous investigation (30). Before the outset of the survey, the developed form was also distributed among 6 dental technicians to provide feedback about the clarity and feasibility of the contents. The noted remarks were considered in the final draft of the research form.

The study form sought information relating to:
- Laboratory address and location in Riyadh.
- Dental center address and location in Riyadh.
- Type of practice (governmental or private).
- Type of the examined cast (maxillary or mandibular).
- Kennedy classification (Class I, Class II, Class III and Class IV).
- Number of standing teeth.
- Number of dental spaces.
- Who made the RPD design? (the dentist alone, the technician alone, both the dentist and the technician).
- Methods of communicating the RPD design (verbal instructions, written instructions, diagram, drawing on the cast, none).
- Whether the design features of each component of the RPD was provided by the dentist (i.e. major connectors, direct retainers and rests)?
- Type of the major connector as provided by the dentist.
- Evidence of preparation of rest seats.

Prescriptions were examined following the fabrication of the metal framework. This is to ensure that no further design instructions could be provided by the dentist and one could be certain that no relevant information was missed. Photographs and digital records were made for the examined cases. When needed, dental technicians at the designated laboratories were consulted to clarify any confusing points upon scrutinizing dentists' prescriptions and associated casts. Both authors discussed and agreed the collected data.

Statistical analysis

Survey data were analyzed using the SPSS statistical package (IBM SPSS Statistics for Windows, Version 20.0, Released 2011, IBM Corp, Armonk, New York, USA). Descriptive statistics presented the characteristics of the examined cases and frequency tables were generated to illustrate the used methods for communicating design features of the prescribed RPDs as provided by the dentists. Also, a frequency table was made to demonstrate the quality of rest seat preparation among the surveyed cases.

In order to quantify the quality of instructions for the RPD design as provided by the dentist to the dental technician, a quality score was developed. The quality score was calculated according to the number of prescribed design elements as shown in Table 1.

Table 1. *Quality score of the provided instructions according to number of prescribed design elements of the RPD*

Number of prescribed elements	Quality score
None	0
Any one	1
Any two	2
Any three	3
All four	4

Quality scores: 0 = No instructions were provided by the dentist for the design of any element of the RPD. 1, 2 or 3= One, two or three elements of the RPD was/were prescribed by the dentist. 4 = Instructions were provided by the dentist for the design of the four main elements of the RPD, i.e. shape of the major connector, type of the direct retainer, position of the direct retainer, and position of the dental rests.

Results

Over the period of this survey, a total of 162 dentists' prescriptions for RPDs and associated casts were examined. The collected cases came from a variety of dental centers that were located in the different geographical areas of Riyadh city. The vast majority of the surveyed cases came from the private sector (92.6%). Number of mandibular casts slightly exceeded that of maxillary ones (52.5% compared to 47.5%). Kennedy Class I cases were the most frequent (53.7%) and Kennedy Class IV cases were the least frequent (3%). Characteristics of the examined cases are presented in Table 2.

Examination of dentists' prescriptions and related casts showed that most of the RPD cases were designed by the dental technician alone (64.2%). In these cases, the dentists did not send any instructions about the design of the requested RPD. Only 16% of the RPDs were designed by the dentist alone. The dentist and dental technician shared the design of the partial denture in almost 20% of the examined cases. Methods of communicating the design of RPD varied between dentists. Almost 12% of the dentists provided verbal instructions, a minority sent written instructions (8.6%) and 5.6% provided a diagram about the proposed design of the RPD. The design of the denture was drawn on the cast in 10% of the cases. Shape of the major connector was indicated by the dentist in 58 cases (35.8%). Type and position of the direct retainers were determined in about 20% of the cases and denture rests were prescribed by the dentist in 21% of the examined casts and prescriptions. The former results are illustrated in Table 3.

The mean quality score of dentists' instructions was approximately 1. Only 18% of the provided instructions achieved quality score equal to 4. The quality score was 0 among the majority of the examined cases (64.2%) and in 18% of the cases the quality score ranged between 1 and 3 indicating insufficient instructions for the design of RPD. No association was identified between type of cast, i.e. max-

The quality scores were presented according to type of cast and Kennedy classification. T-test for independent samples and the one-way ANOVA were utilized to examine the association between mean score of the quality of the provided instructions and type of cast/Kennedy classification. The significance level was set at $p < 0.05$.

Table 2. *Characteristics of the examined cases (No = 162)*

Variable		Number	Percent
Laboratory location in Riyadh	*North*	86	53.1
	South	1	0.6
	Centre	19	11.7
	West	28	17.3
	East	28	17.3
Practice location in Riyadh	*North*	39	24.1
	South	3	1.9
	Centre	10	6.2
	West	28	17.3
	East	82	50.6
Type of practice	*Governmental*	12	7.4
	Private	150	92.6
Type of cast	*Maxillary*	77	47.5
	Mandibular	85	52.5
Kennedy classification	*Class I*	87	53.7
	Class II	44	27.2
	Class III	26	16
	Class IV	5	3.1
		Mean	**SD**
Number of standing teeth		7.7	3
Number of edentulous dental spaces		2.1	0.7

Table 3. *Methods of communicating RPD design and design features as provided by the dentist*

RPD design

		Number	Percent
Who made the design?	*The dentist alone*	26	16
	The technician alone	104	64.2
	Both dentist and technician	32	19.8
Methods of communicating RPD design	*Verbal instructions (via phone or face to face)*	19	11.7
	Written instructions	14	8.6
	Diagram	9	5.6
	Drawing on the cast	16	9.9
	None	104	64.2

Design features as provided by the dentist

Shape of major connector		58	35.8
Direct retainers	*Type*	31	19.1
	Position	32	19.8
Rests		34	21

Total number of the examined cases = 162, RPD: Removable partial denture

illary or mandibular, and quality scores of the instructions (p>0.05). On the contrary, an association was found between Kennedy classification of the restored dentition and quality

scores of the provided instructions as Kennedy Class III cases achieved significantly higher mean quality score compared to Kennedy Class II cases (*p*<0.05) (Table 4).

When a major connector was prescribed by the dentist, the horseshoe design followed by the palatal plate design, were the most prescribed connectors for the maxillary RPDs. On the other hand, the lingual bar and lingual plate designs were the dominant connectors for the mandibular RPDs (Table 5).

The working casts of the RPDs were examined for an evidence of rest seats preparation. The results indicated that rest seat preparation was unpopular practice as only 16.7% of the evaluated casts had clearly defined rest seat preparation (Table 6).

Discussion

Research to investigate quality of current dental practice on an international level is still limited (17). Extensive research to underline the status of today's dental practice and development of guidelines for quality dental care is highly recommended. In Saudi Arabia, over the last three decades there has been wide expansion in dental education and growing number of dental graduates (31). This was coupled with rapid growth in the delivery of oral health services (32-33). Despite these facts, information about quality of present dental care in Saudi Arabia is quite scarce. So far, only few attempts have

Table 4. *Quality of instructions for RPD design according to type of cast and Kennedy classification*

Quality Score	Type of Cast		Kennedy Classification				Total
	Maxillary	Mandibular	Class I	Class II	Class III	Class IV	
0	52(67.5%)	52(61.2%)	53(61%)	35(79.5%)	14(53.8%)	2(40%)	104(64.2%)
1	9(11.7%)	13(15.3%)	16(18.4%)	4(9.1%)	0(0%)	2(40%)	22(13.6%)
2	1(1.3%)	3(3.5%)	3(3.4%)	0(0%)	1(3.8%)	0(0%)	4(2.5%)
3	2(2.6%)	1(1.2%)	3(3.4%)	0(0%)	0(0%)	0(0%)	3(1.9%)
4	13(16.9%)	16(18.8%)	12(13.8%)	5(11.4%)	11(42.4)	1(20%)	29(17.9%)
Total	77(100%)	85(100%)	87(100%)	44(100%)	26(100%)	5(100%)	162(100%)
Mean (SD)	0.9(1.53)	1.01(1.56)	0.91(1.43)	0.55(1.28)	1.77(1.99)	1.2(1.64)	0.96(1.54)
p	*0.634		**0.013				--

* p-value of the t-test for independent samples indicating no significant difference (p>0.05). ** p-value of the one-way ANOVA indicating significant difference at p<0.05. **Quality scores:** 0 = No instructions were provided by the dentist for the design of any element of the RPD. 1, 2 or 3= One, two or three elements of the RPD was/were prescribed by the dentist. 4 = Instructions were provided by the dentist for the design of the four main elements of the RPD, i.e. shape of the major connector, type of the direct retainer, position of the direct retainer, and position of the dental rests.

Table 5. *Major connectors as provided by the dentist*

Upper major connector	Number	Percent
Palatal plate	7	9.1
U-shaped or horseshoe	10	12.9
Anterior and posterior palatal bars	2	2.7
Anterior and posterior palatal strap	4	5.2
Single Palatal strap	1	1.3
Single palatal bar	0	0
Dentist did not design any major connector	53	68.8
Total number of examined maxillary casts	77	100
Lower major connector		
Lingual plate	10	11.8
Lingual bar	24	28.2
Sublingual bar	0	0
Double lingual bar	0	0
Cingulum bar	0	0
Labial bar	0	0
Dentist did not design any major connector	51	60
Total number of examined mandibular casts	85	100

Total number of the examined cases = 162 (77 *Maxillary casts and* 85 *Mandibular*)

Table 6. *Rest seats preparation (information derived from the master casts)*

Availability of rest seat preparation	Number	Percent
Cast with clearly defined rest seats preparation	27	16.7
Cast with no rest seats preparation	124	76.5
Cast with rest seats that are difficult to ascertain whether they have been prepared	8	4.9
Cast is not available	3	1.9

been made to address this important issue (34-35). While this study evaluates the quality of communicating design features for RPDs, it can be considered a starting point and call for researcher to investigate the standard of current dental services in Saudi Arabia on all levels. This is in order to achieve a national goal of standard dental care for all people.

The RPD is one of the prosthodontic treatment options for the replacement of missing teeth. Although RPDs have their limitations and contraindications, the RPDs have also certain advantages and indications (4, 36). General dental practitioners worldwide are still expected to possess the required clinical skills to offer their patients such simple treatment option. The superiority and attractiveness of tooth/implant-supported

fixed partial dentures do not justify low interest in learning the topic of RPDs or poor management of this treatment modality. Principles of construction RPDs should be respected to maximize the chance of success and any negligence on this part is, professionally and ethically, not accepted.

In a survey of commercial dental labs in Athens, Greece (37), the constructed RPDs were mostly for Kennedy Class I dentitions. In a recent Saudi study for the prevalence of missing teeth and type of provided prosthetic treatment (16), most of the patients with Kennedy class I or class II were treated with RPDs. In this survey, characteristics of the examined cases reveal clear predominance for Kennedy Class I and Class II in the study sample (Table 2). It appears that the higher need/demand for treatment with RPDs is associated with the presence of free-end saddles or missing posterior support.

Overall, the results indicate poor quality of communicating design features for RPDs among dentists in Riyadh, Saudi Arabia. This is consistent with the findings of previous international studies (24, 27, 28, 38-40). The quality scores of the provided instructions for RPD design were very low among the majority of the examined cases (Table 4). The reliance on dental technicians to perform the design of the RPD seems huge. This means a production of RPDs with no account to the clinical and biological findings. The final likely outcome, could be, a provision of faulty dentures with damaging effect and poor prognosis. This is clearly a mark of malpractice (17). In the UK and Ireland, the poor quality of written instructions for the design of cobalt chromium RPDs was attributed to educational factors (41). Major problems in teaching the design and construction of cobalt chromium RPDs during the vocational training of dental graduates were identified (41). Dental educators in Saudi Arabia should take the results of this survey into account when planning dental curricula and prosthodontic courses of continuing professional development. Further research, perhaps of qualitative nature, is warranted to understand the reasons behind such inappropriate professional behavior among practicing dentists in Riyadh, Saudi Arabia.

In an Irish survey (39), the authors used very similar criteria to that used in our survey to quantify the level of prescription for cobalt chromium RPDs. Four design variables were scrutinized in dentists' written instructions (39). These include: configuration of denture base, retention (design of clasps, material and position), support (position and distribution of rests), and design of the major connector. The four design variables were found in 10% of the examined written instructions. In 7% of the prescriptions there were three design variables, in 13% two design variables were found, in 17% one design variable was identified and 53% of the prescriptions were lacking any design variables (39). In the current survey the aforementioned figures are compared to 17.9%, 1.9%, 2.5%, 13.6% and 64.2% respectively (Table 4).

While no relation was established between quality of the provided instructions and type of dental cast for the treated case, an association was determined between Kennedy classification and quality of prescription (Table 4). The reliance of the surveyed dentists on the technicians to design cases with Kennedy Class II appears to be greater than the other Kennedy Classes. An explanation for this finding cannot be provided and it is recommended to search this point in future studies.

In this investigation, the design of cobalt chromium RPDs

was delegated entirely to the dental technician in 64.2% of the examined cases. This number is compared to 57% in the neighboring Kingdom of Bahrain (23) and 89.5% in the United Arab Emirates (26). However, this comparison cannot be claimed to be accurate as the examined samples for cobalt chromium RPDs in Bahrain and UAE were very small (n =14 and 19 respectively). In an earlier study in Saudi Arabia, a self-administered questionnaire was used to collect information about quality of written instructions in the work authorization form and the level of communication between dentists and dental technicians for fixed and removable prosthodontics (34). Data was obtained from dental technicians working in the Dental College at King Saud University. The results indicated that 49.6% of the examined written instructions were judged as clear and in 34% of the fixed and removable cases the dental technician had to communicate with the dentist to obtain more clarification regarding certain written instructions. With RPDs, the author reported that the design was made by the dentist in 95% of the evaluated work authorization. However, all these cases were made in a University environment by a specialist, a demonstrator, a postgraduate student, an intern or a dental student. As the design of that survey was different from the design of our survey, no valid comparison can be made between their findings.

Using a diagram or a drawing on the cast to communicate the design of the RPD seems to be uncommon method of communication among dentists in Riyadh, Saudi Arabia (Table 3). This also was the case in Ireland as only 7% of the dentists provided a diagram in their prescriptions for cobalt chromium RPDs (39). In the Kingdom of Bahrain, the proportion of dentists who provided a diagram in their prescriptions for the cobalt chromium RPDs was 43% (23). This is compared to 5.6% in the current survey. In the UAE, 36.85% of the dentists sometimes use a drawing for the RPD design and 63.2% never/rarely do that (26). In this survey, 10% of the dentists communicated the design of the RPD through a drawing on the cast. It should be remembered again that the number of the examined cases in Bahrain and UAE was very small and the validity of any comparison with the results of this survey can be questioned.

Table 3 illustrates that when instructions were provided, the shape of the major connector was the most frequent element to be prescribed by the surveyed dentists (35.8%). This is similar to the outcome of a UK survey where the design of the major connector was the most common component in dentists' prescriptions (59%) (30). The reason why dentists in this survey give more attention to the design of the major connector in comparison with the other elements of the cobalt chromium RPDs is not clear.

Despite the shortcomings of the horseshoe connector in terms of flexibility and wide coverage of dental and gingival tissues, this design of a major connector was the most prescribed for the maxillary RPDs (Table 5). This is in agreement with the results of a Greek survey (37). Unfortunately; the design of this study does not allow us to identify the reasons behind such practice. In the mandible, only two types of major connectors were noted in dentists' prescriptions. These comprise the lingual bar and lingual plate. Similarly, these types of mandibular major connectors were found to be popular among dentists in the UK (30, 38, 42). The biological and hygienic merits of the lingual bar are well-known

to practitioners (38). Although the lingual plate is the most rigid mandibular connector, it may encourage plaque accumulation and risk the health of the supporting dental and gingival tissues (43). However, the lingual plate is well tolerated by a majority of patients and may contribute to indirect retention of the RPD (38, 44).

The dependence of the surveyed dentists on the dental technician to design the direct retainers of the RPD is alarming. Prescription of the type and position of the denture clasps was recorded in almost 20% of the cases (Table 3). This is compared to 47.7% in an Iranian survey (28).

Preparation of rest seats is an essential part of mouth rehabilitation to receive a metal RPD. Adequate rest seat preparation is important for denture support and effective indirect retention. Nonetheless, the results of this survey underline poor practice with respect to rest seat preparation. Evidence of rest seat preparation was missing in the majority of the examined master casts (Table 6). In the UAE survey (26), rest seat preparation was identified in 13 out of the 19 assessed cast RPD cases (68.4%). However, such small sample may not reflect the current practice among UAE dentists in this respect. In the UK, Nassani et al., (30) reported that preparation of rest seats was encountered in 23% of the studied RPD cases and Rice et al., (45) recognized rest seat preparation in 30% of the assessed casts for cobalt chromium RPDs.

A limitation for this survey is related to the surveyed dental laboratories. The choice of the laboratories was on the basis of practicality and availability of facilities for the fabrication of cobalt chromium RPDs. However, an account was made for the participation of laboratories from the different sectors of Riyadh.

It can be noted that the surveyed cases present a random sample of the constructed RPDs in Riyadh city and were included in the study due to their presence in the participating laboratory at the time of the study. Moreover, the examined cases in this survey came from the different geographical areas of Riyadh and probably present the current practice of general dental practitioners working in Riyadh with regard to communicating design features of cobalt chromium RPDs. However, the results cannot necessarily be generalized to the whole Kingdom of Saudi Arabia. Nevertheless, Riyadh city is the capital of the Kingdom. It hosts the largest turnover of medical and dental services across the country (32). Hence, one could argue that the outcome of this survey provide considerable insight on the current status of prescription for the construction of metal RPDs among dentists working in Saudi Arabia. A future national survey is recommended to confirm the findings.

Conclusion

The final outcome of this survey indicates poor quality of communicating the design features of cobalt chromium RPDs among practicing dentists in Riyadh, Saudi Arabia. The reliance on the dental technician to perform the design of the cast RPDs seems to be high. This finding is a sign of malpractice with ethical, legal and clinical implications. Further research, perhaps of qualitative nature, is recommended to understand the reasons behind such inappropriate professional behavior.

Türkçe Özet: Suudi Arabistan Riyad'da kobalt krom hareketli parsiyel protezlerin dizayn özelliklerinin yaylaşılma kalitesi. Amaç: Bu araştırmada, kobalt krom hareketli parsiyel protezlerin (HPP) dizayn özelliklerinin Suudi Arabistan Riyad'daki diş hekimleri arasında paylaşılmasının incelenmesi amaçlanmıştır. Gereç ve Yöntem: Riyad'daki dokuz ticari dental laboratuvar araştırılmıştır. Her ziyarette, kobalt krom HPP için hazırlanmış ana modeler ve diş hekimlerinin yönergeleri incelenmiştir. Belirtilen yönergelerin kalite skoru 0-4 arasında notlanmıştır. Sıfır skor diş hekiminden laboratuvara hiçbir yönerge gelmediği anlamına gelmektedir. Skor 4 ise ana bağlayıcının şekli, direk tutucu elemanların tipi, direk tutucuların poziyonu ve tırnakların yeri gibi HPP'nin ana elemanlarının dizaynı için talimatlar verildiği anlamına gelmektedir. Bulgular: 162 diş hekimi talimatı ve ilgili modeler incelenmiştir. Vakaların büyük çoğunluğunun diş teknisyenleri tarafından planlandığı tespit edilmiştir (%64,2). Diş hekimlerinin talimatlarında en sık olarak ana bağlayıcı şekli belirtilmiştir (%35,8). Diş hekimlerinin kalite sokr ortalaması 0,96'dır (SS=1,54). Talimatların %18'inde 4 skoru belirlenmiştir. Kennedy Sınıf III vakalarda, Kennedy Sınıf II vakalara oranla daha yüksek kalite skorlarına rastlanmıştır (p<0.05). İncelenen modellerin %16,7'si açıkça tırnak yeri hazırlamayı belşrtmiştir. Sonuç: Bu araştırmanın bulguları Suudi Arabistan Riyad'da kobalt krom HPP dizayn özelliklerinin paylaşılmasında yetersiz bir kalite göstermektedir. Diş teknisyenlerinin HPP modeler üzerinde yaptıkları planlamalara olan güven büyüktür. Anahtar kelimeler: Kalite, dizayn, kobalt krom, hareketli, parsiyel protezler, Suudi Arabistan

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Turkish adaptation and implementation of the modified infection control questionnaire in intraoral digital imaging

Purpose
There are very few studies evaluating the knowledge of dentists about infection precautions in oral radiology. The aim of this study was to assess the psychometric properties of the Turkish version of the modified form of a developed questionnaire and to apply this questionnaire to Turkish dentists.

Materials and Methods
The questionnaire was applied to a sample of 250 dentists for the scale development [200 for confirmatory factor analysis (CFA) and 50 for control] and 173 dentists for the implementation of the scale. The scale was applied to 200 dentists and construct validity was examined with CFA. For model fit; chi square to df ratio, RMSEA (Root Mean Square Error of Approximation), TLI (Tucker-Lewis Index), CFI (Comparative Fit Index), GFI (goodness of fit index), AGFI (adjusted goodness of fit index) and NFI (normed fit index) were obtained. Also, reliability analysis was applied and item-total correlations and Cronbach's alpha values were given. Adapted scale scores using a different sample of 173 dentists were compared according to demographic characteristics.

Results
CFA showed good fit statistics (X^2/df=1.511, RMSEA=0.057, TLI=0.942, CFI=0.953, GFI=0.926, AGFI=0.900, NFI=0.928) for the scale. Item-total correlations were over 0.30 and Cronbach's alpha was calculated as 0.877. In addition, experienced dentists had higher scores in the dimension of personal hygiene (p<0.05).

Conclusion
The Turkish version of the modified infection control questionnaire in oral radiology showed adequate psychometric properties. This indicated that it could be a valid and reliable tool for the assessment of infection control in oral radiology among Turkish dentists.

Keywords: Infection control, Cross infection, Dentistry, Radiology, Questionnaires

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Introduction

The passage of infectious agents from person to person is referred to as 'cross-infection'. Dentists, dental assistants, and patients are faced with various microorganisms in their dental practice, among them hepatitis B virus, hepatitis C virus, *herpes simplex* type 1 and type 2 viruses, human immunodeficiency virus, *streptococcus, cytomegalovirus, mycobacterium tuberculosis* are some of these microorganisms (1-3).

Cross-infection may occur during all dental procedures (4). One of these procedures is intraoral digital imaging (5,6). As radiology clinics see many patients in a short period, infection control precautions must be taken in a strict manner (2). It is emphasized that each patient should be considered to be infected and infection control precautions should be performed for all patients during radiography (2,7).

Due to saliva contamination, dental staff and patients are at high risk for cross-infection in intraoral radiography (2,5). Since saliva is difficult to

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discriminate, the risk of infection in intraoral radiography procedures is ever-present (8).

Dental personnel and patients are at high risk of developing tuberculosis, herpes viruses, upper respiratory tract infections, and hepatitis viruses. To prevent cross-infection between dental staff and patients, infection control procedures are performed. During dental radiographic procedures, the performer's hands, the patient's mouth, sensors, tube, exposure button, keyboard, and mouse may be contaminated with saliva. The risk of cross-infection is high in dental radiology. Thus, radiographic infection control precautions must be applied to all patients (3).

To the best of our knowledge, there are very few studies (9,10) in the literature evaluating the knowledge of dentists about infection precautions in oral radiology through the use of a dedicated questionnaire.

The first aim of this study was to assess the psychometric properties (internal consistency and structural validity) of the Turkish version of the modified form of a questionnaire developed by da Costa et al. (9); the second was to apply this questionnaire to Turkish dentists.

Materials and Methods

Before beginning the study, ethical approval was obtained from Pamukkale University Medical Ethics Committee (Research Code No: 60116787-020/77263, Date of approval: 20/11/2017). This work was done in accordance with the principles defined in the Declaration of Helsinki, including all revisions.

A questionnaire developed by Da Costa et al. (9) was used in our study. In the questionnaire of that study, 31 items in nine domains were created. The domains were handwashing, gloves, clothing, accessories, radiographic sensors, protection of radiography equipment, overgloves, overgloves (in digital imaging) and cleaning.

For our study, initially, the questionnaire used in the study of Da Costa et al. (9) was translated from English to Turkish and then re-translated into English by a native Turkish and fluent English speaking dentist who did not participate in the other parts of the study. The infection control questionnaire, consisting of 18 items, was formed according to this revision (Table 1). Thus, the validity was obtained, and the adapted questionnaire was finalized.

The dentists who used digital intraoral imaging were invited to answer the translated Turkish version of the modified infection control questionnaire by e-mail. Also, members of the Turkish Dental Association were invited to do so by their e-mail group.

Study sample

In scale development studies, it is mentioned that the sample size should not be less than 100 and should be at least five times the number of items (11-13). Thus, the questionnaire was applied to 250 dentists for the scale development [200 for confirmatory factor analysis (CFA) and 50 for control] and 173 dentists for the implementation of the scale. 200 dentists completed the survey for CFA. Fifty others completed the questionnaire to provide a control group.

For the second part of the study, the adapted questionnaire was filled in by 173 dentists. The demographic features of the dentists were documented. The dimensions of the

Table 1. *Modified infection control questionnaire*					
Questions	**1: Never**	**2: Rarely**	**3: Sometimes**	**4: Mostly**	**5: Always**
1: I wear a mask during radiography.					
2: I wash my hands before wearing gloves.					
3: I wash my hands after removing my gloves.					
4: I cover the sensor with a disposable barrier.					
5: I use the disposable barrier (stretch film, aluminum foil, etc.) of the patient's seat used during radiography after each patient.					
6: I cover the x-ray tube head with a disposable barrier.					
7: I cover the exposure button with a disposable barrier.					
8: I cover the computer keyboard with a disposable barrier.					
9: I cover the computer mouse with a disposable barrier.					
10: I use gloves when placing the sensor to the mouth.					
11: I use gloves when dressing the patient lead aprons and thyroid protectors.					
12: I use gloves when setting the x-ray tube head.					
13: I use gloves when pushing the exposure button.					
14: After every patient I disinfect the patient's chair.					
15: After every patient I disinfect the exposure button.					
16: After every patient I disinfect the x-ray tube head.					
17: I regularly disinfect the contact surfaces of the radiographic process.					
18: I disinfect the contact surfaces in the radiography process after individuals with infectious diseases, like hepatitis.					

questionnaire were compared with age, gender, education level (general dentist or specialist dentist) and experience in dentistry (1−5 years, 5−10 years, 10 years and above) with multi-comparison tests. Figure 1 is a flowchart outlining the steps of the method used.
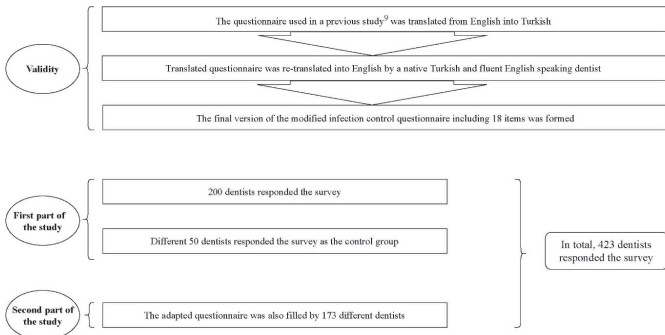
Figure 1. *Flow-process diagram for the preparation and implementation of the survey.*

Data analysis

For construct validity, CFA was used. For model fit; X^2/df ratio, RMSEA (Root Mean Square Error of Approximation), TLI (Tucker-Lewis Index), CFI (Comparative Fit Index), GFI (goodness of fit index), AGFI (adjusted goodness of fit index) and NFI (normed fit index) were obtained. For reliability analysis, item-total correlations and Cronbach's alpha values were given. Adapted scale scores using a different sample of 173 dentists were compared according to demographic characteristics. The normality assumption of the data was examined by the Kolmogorov-Smirnov test before comparing according to demographic characteristics and it was seen that the normal distribution assumption was provided (p>0.05). Therefore, t-test was used to compare the two groups and one-way ANOVA was used to compare more than two groups. Tukey test was used for pairwise comparisons after ANOVA. The upper limit of the significance level was accepted as 0.05 for all analyzes. The LISREL 10.2 (Scientific Software International; Lincolnwood, IL, USA) and SPSS 22 package programs (SPSS, Inc.; Chicago, IL, USA) were used to analyze the data.

Results

In total, 423 dentists responded to the survey; 250 for the first part and 173 for the second part of the study.

Validity and reliability analysis

A questionnaire consisting of three dimensions was applied to a group consisting of 200 dentists and its validity examined by CFA. As can be seen in Figure 2, the standardized loads were 0.33 and above.

The fact that the chi square to df value is less than 2 in the model fit coefficients indicates a good fit, and that it is between 2 and 3 indicates an acceptable fit. According to Brown (14), TLI and CFI values being 0.90 or above indicate model fit. GFI values between 0.90 and 0.95 are acceptable,
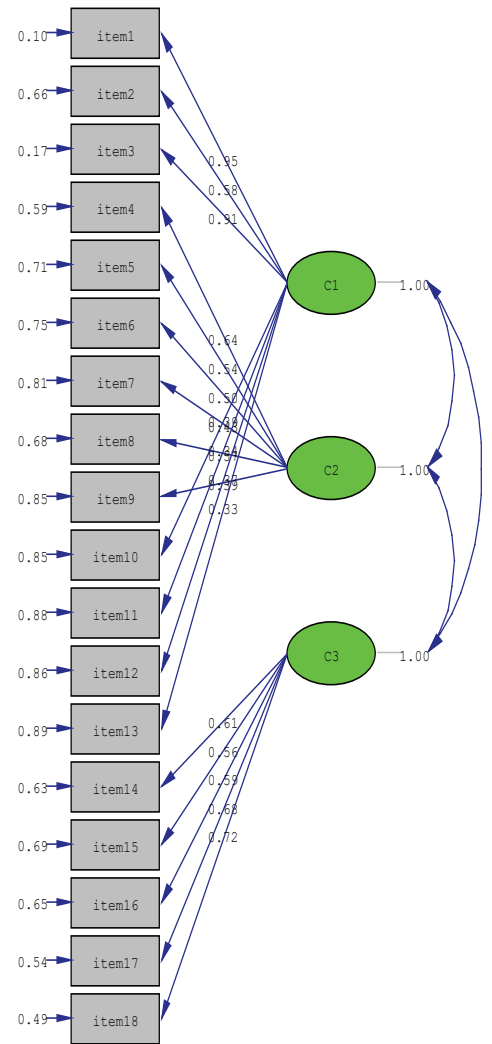
Chi-Square=175.25, df=132, P-value=0.00000, RMSEA=0.057

Figure 2. *Confirmatory factor analysis graphic.*

and greater than 0.95 indicates a good fit. (15,16). Values greater than 0.85 are acceptable for AGFI values (17-19). Similar ranges are applicable for NFI (20). According to Browne and Cudeck (21), RMSEA value below 0.08 is another indicator for model fit. In our study, model fit indexes were calculated as: $X^2/df=1.511$, RMSEA=0.057, TLI=0.942, CFI=0.953, GFI=0.926, AGFI=0.900 and NFI=0.928.

Item-total statistics belonging to the items are given in Table 2. Total correlations of the items were over 0.30. The reliability coefficient for the complete questionnaire was $X^2/df = 0.877$.

Comparison of the scales in the questionnaire

For the second part of the study, 173 dentists (86 females and 87 males) with a mean age of 36.4 responded to the survey. Table 3 shows the details of the demographic features and comparison of three dimensions. There was no statistically significant difference according to age, gender and education level in the 95% confidence level (p>0.05). On the other hand, it was observed that the mean averages were not the same according to professional experience (p<0.05). Multi-comparison test results showed that the mean for the first dimension of the individuals with more experience was significantly higher than the others. Besides, it can be said

that the averages of the second and third dimensions did not show a significant difference according to age, gender, education level, and experience, at 95% confidence level (p>0.05).

Table 2. *Item-total statistics of the 18 items*

Dimension	Items	Mean	SD	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Dimension 1 (personal hygiene) (α=0.824)	M1	3,29	,973	,595	,867
	M2	3,73	1,401	,411	,874
	M3	3,53	,834	,400	,874
	M10	2,33	1,474	,525	,869
	M11	1,88	1,344	,556	,863
	M12	2,27	1,543	,581	,860
	M13	1,99	1,404	,559	,868
Dimension 2 (precautions during radiographic procedures) (α=0.876)	M4	3,55	1,548	,521	,865
	M5	1,92	1,497	,504	,870
	M6	3,90	,450	,519	,864
	M7	3,35	1,534	,501	,865
	M8	3,25	1,384	,494	,871
	M9	3,93	1,599	,481	,872
Dimension 3 (precautions after radiographic procedures) (α= 0.859)	M14	3,33	1,503	,572	,861
	M15	3,28	1,507	,688	,854
	M16	3,16	1,541	,625	,857
	M17	3,91	1,361	,522	,869
	M18	3,69	,911	,464	,872

Discussion

Digital imaging in dentistry is rapidly spreading (6). Despite the advantages of lower radiation doses by comparison with conventional film-based radiography – the elimination of chemical processing and the need for storage, for instance – traditional methods remain the norm, and infection control has become a substantial problem (22). According to a Centers for Disease Control and Prevention (CDC) report, digital imaging sensors are categorized as semi-critical devices (5). These devices come into contact with the oral mucosa and should be covered with a barrier and cleaned after each x-ray exposure, in order to reduce cross-contamination.

Few studies (9,10) have been carried out into infection control in oral radiology. In Da Costa et al.'s first study (9), the researchers aimed to create a valid questionnaire for the assessment of infection control in oral radiology. The final version of the questionnaire of Da Costa et al (9), consisting of 31 items in 9 domains, showed good psychometric properties for determining infection control. There were 18 items in our modified version of the Turkish questionnaire. There were three dimensions in our study, compared to nine in the other (9). In our study, item-total correlations were found to be greater than 0.30 and Cronbach's alpha was calculated as 0.877, as in the other study. In construct validity, all the questions in our study had good agreement, while in the other study, most of the questions had a good agreement. The reason for achieving better agreement in our study may be the lower number of questions, compared to Da Costa et al.'s study (9).

After Da Costa et al.'s study (9) of the development and validation of the infection control questionnaire in oral radiology, the researchers applied that questionnaire to 1,006 dentists and 1,203 dental students (10). According to the results of that study, there was no significant association

Table 3. *Demographic features and comparison of the dimensions in terms of the demographic characteristics of the 173 dentists who participated in the second part of the study.*

Variable	Category	f	%	Dimension 1 Mean	SD	Test	p	Dimension 2 Mean	SD	Test	p	Dimension 3 Mean	SD	Test	p
Age	20-29	61	35,3	4,17	,69	1.69[F]	0.17	2,08	,96	1.87[F]	0.32	3,72	,81	0.01[F]	0.99
	30-39	56	32,4	4,09	,66			2,07	1,14			3,70	1,00		
	40-49	27	15,6	4,28	,76			2,07	1,31			3,70	,96		
	50 and above	29	16,8	4,35	,68			1,67	,82			3,69	,97		
Gender	Female	87	50,3	4,20	,65	0.77[t]	0.44	2,00	1,06	-0.10[t]	0.92	3,79	,94	1.25[t]	0.21
	Male	86	49,7	4,12	,68			2,02	1,07			3,62	,89		
Education level	General dentist	140	80,9	4,17	,64	0.72[t]	0.47	1,94	1,05	-1.78[t]	0.08	3,69	,87	-0.44[t]	0.66
	Specialist	33	19,1	4,08	,75			2,30	1,09			3,77	1,10		
Experience	1–5 years	56	32,4	4,06[a]	,58	3.06[F]	0.04*	1,97	,90	0.62[F]	0.54	3,66	,76	0.11[F]	0.90
	5–10 years	39	22,5	4,02[a]	,69			2,17	1,09			3,74	,97		
	10 years and above	78	45,1	4,29[b]	,68			1,95	1,16			3,72	1,00		

*p<0.05; [F] F value; [t] t value; Different letters at mean indicate statistical significance at p<0.05.

with respect to experience in the profession, age, specialty, or working institution, although male dentists had lower scores in infection control than females (10). In the present study, experienced dentists had higher scores regarding personal hygiene. However, no differences were detected according to age, gender and education level. In Da Costa et al.'s study, infection control of the keyboard and mouse was found to be poor (10). Controversially, the results of our survey showed that the barrier protection of the keyboard and mouse had high scores. Also, the protection of the patient chair and radiographic equipment had higher scores in our study. The number of our respondents was lower than in Da Costa et al.'s study (10). This may be explained by the inclusion criteria of our study: we only invited the dentists who took intraoral x-rays themselves.

Gamoh et al. (8) published a survey study about the infection control awareness of dentists and dental hygienists in a university hospital in Japan. According to the results of that study, nearly half of the dentists stated that they washed their hands before putting on gloves. One in four said that they washed their hands sometimes, and one in four that they did not wash them at all. In Gamoh et al.'s study (8), hand hygiene before donning gloves was found to be better in males than in females. Our results were different in this respect, with no significant difference between the genders being found for the personal hygiene dimension.

To the best of our knowledge, our questionnaire-based study is the first systematic attempt to investigate the infection control of Turkish dentists in oral radiology. However, the perceptions and attitudes of 135 Turkish dentists about cross-infection in general dental procedures had previously been studied by Yuzbasioglu et al. (23). According to the results of that study, almost all participants reported that all patients should be considered infectious, and precautions taken in every patient (23). However, they found that only 18.5% of the participants favored barrier protection or cleaning of the dental radiographic equipment. In that study, it was not reported whether the radiographic systems were conventional or digital, intraoral or extraoral imaging systems (23).

Conclusion

The results of the present study showed that the Turkish version of the modified infection control questionnaire in oral radiology showed adequate psychometric properties. This indicated that it could be a valid and reliable tool for the assessment of infection control in oral radiology among Turkish dentists. The study also showed that experienced dentists had higher scores in the dimension of personal hygiene.

Türkçe Özet: *İntraoral Dijital Görüntülemede Modifiye Enfeksiyon Kontrol Anketinin Türkçe'ye Uyarlanması ve Uygulanması. Amaç: Oral radyolojinde enfeksiyon kontrol önlemleri konusunda diş hekimlerinin bilgilerini değerlendiren çok az çalışma vardır. Bu çalışmanın amacı, geliştirilmiş bir anket formunun Türkçe versiyonunun psikometrik özelliklerini değerlendirmek ve bu anketi Türk diş hekimlerine uygulamaktır. Gereç ve Yöntem: Anket, ölçek geliştirme için 250 diş hekimine [doğrulayıcı faktör analizi (CFA) için 200, kontrol grubu için 50 hekim], ölçeğin uygulanması için ise 173 diş hekimine uygulanmıştır. Ölçek, 200 diş hekiminden oluşan örnekleme uygulanmış ve yapı geçerliği CFA ile incelenmiştir. Model uyumu için, x^2/df oranı, RMSEA (ortalama karesel yaklaşım hatası), TLI (Tucker-Lewis indeksi), CFI (karşılaştırmalı uyum indeksi), GFI (uyum iyiliği indeksi), AGFI (ayarlanmış uyum indeksi) ve NFI (normlu uyum indeksi) ölçüleri elde edilmiştir. Ayrıca güvenirlik analizi uygulanmış ve madde-toplam korelasyonları ve Cronbach alfa değerleri verilmiştir. Daha sonra, 173 diş hekiminden oluşan farklı bir örneklem kullanılarak uyarlanmış ölçek puanları demografik özelliklere göre karşılaştırılmıştır. Bulgular: CFA, ölçek için model uyum iyilikleri ($x^2/df=1.511$, RMSEA=0.057, TLI=0.942, CFI=0.953, GFI=0.926, AGFI=0.900, NFI=0.928) göstermiştir. Madde-toplam korelasyonları 0.30'un üzerindedir ve Cronbach alfa 0.877 olarak hesaplanmıştır. Ayrıca, kişisel hijyen boyutunda tecrübeli diş hekimleri daha yüksek puanlara sahipti (p<0.05). Sonuç: Oral radyolojide modifiye edilmiş enfeksiyon kontrol anketinin Türkçe versiyonu yeterli psikometrik özellikler göstermiştir. Bu sonuçlar, anketin Türk diş hekimleri arasında oral radyolojide enfeksiyon kontrolünün değerlendirilmesi için geçerli ve güvenilir bir araç olabileceğini göstermiştir. Anahtar Kelimeler: Enfeksiyon kontrolü, Çapraz enfeksiyon, Diş hekimliği, Radyoloji, Anketler*

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Original research

Evaluation of third molar agenesis associated with hypodontia and oligodontia in turkish pediatric patients

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Purpose
To evaluate the association between third molar (M3) agenesis and hypodontia and oligodontia in pediatric patients by using panoramic radiography.

Materials and Methods
Panoramic radiographs of 1,471 patients (899 females; 572 males) and 5,884 teeth were retrospectively evaluated. The age and gender of the patients were recorded. Patients ages 9-15 years old were included in the study. The mean age was 12.76. The agenesis of M3 teeth and the relationship between M3 agenesis and hypodontia and oligodontia were recorded according to findings from the upper and lower jaw, in both the right and left locations, along with the number of M3 with agenesis. Data were analyzed using chi-square and McNemar tests (p<0.05).

Results
A total of 1,319 (89.7%) patients had all M3 teeth present in the mouth, while the other 152 (10.3%) had congenital agenesis in one or more teeth. The number of teeth in which M3 agenesis was seen, in order of the number of missing M3 teeth, the percentages were 2.6% for one, 2.4% for two, 1.0% for three and 4.3% for four missing teeth.Hypodontia was detected in 37 patients and oligodontia was detected in 3 patients.

Conclusion
The prevalence of M3 agenesis varies from one population to another. Two of the dental anomalies associated with M3 agenesis are hypodontia and oligodontia. In this study, M3 agenesis varied in terms of region and gender; hypodontia was also significantly higher in patients with missing mandibular M3.

Keywords: *Hypodontia; Oligodontia, Panoramic radiography, Third molar agenesis, Tooth loss*

Introduction

Tooth agenesis is defined as congenitally missing one or more teeth in deciduous or permanent dentition. These teeth are unerupted and radiologically invisible (1). Currently, about 50% of the third molar (M3) teeth have some form of anomaly that may be impacted or partially erupted. However, they may be absent in the oral cavity (2). Formation time, crown and root morphology of each are widely variable (3).

Tooth agenesis is one of the dental anomalies that is most commonly observed in dentition. Hypodontia is defined as the absence of one to five teeth, excluding the M3. Oligodontia is defined as the absence of six or more teeth, excluding the M3. Anodontia is an extraordinary situation presenting the total absence of teeth (4-6). The most commonly observed tooth agenesis is M3 agenesis which can occur idiopathically or with a syndrome (7). Habitual eating changes in human evolutionary development can cause structural changes to the teeth and jaw (8). To explain the congenital absence of different tooth groups, several hypotheses have been proposed for many years.

However, in the etiology of congenital tooth absence, environmental, local, systemic and genetic factors can be efficient (9). Reports have been made about mutations in some genes which are effective in the growth and development process; reports have also been made about non-syndromic or familial cases of congenital tooth agenesis (10).

The time of development, calcification and eruption of M3 are highly variable. The minimum age of the development germ formation of M3 teeth is 6 years according to the literature although the mean age of development is 8 or 9 years (11,12). Calcification can begin at the age of 7 years in some cases and up to 16 years. The formation of enamel is generally finalised between the age of 12 and 18 years while root formation is generally finalised between the age of 18 and 25 years (13).

In most of studies, the eruption criteria was the emergence of any crown part through the oral cavity. This can reveal incorrect results because many of the M3 don't continue to erupt but remain impacted as a partially erupted situation (14). However, the M3 is the last to erupt and is seen in the intra-oral cavity within the permanent dentition. Additionally, it is reported that the most common congenital tooth agenesis is detected in M3 in about 15-20% of cases (15).

On the other hand, the agenesis of M3 may be associated with some numerical dental and morphological anomalies (16). In the literature there are widely variable results about the frequency of M3 agenesis. It was reported that the agenesis of other teeth was observed 13 times more with the agenesis of M3 (17).

There may also be characteristic differences in societies as well as individuals in terms of congenital dental anomalies. Tooth agenesis varies from one continent to another and between genders. In this context, given the large population of young individuals who live in the Thrace region of Turkey, detection of whether there are significant deficiencies with respect to the development of M3' germs and identification is important. This is especially true regarding the association of M3 agenesis with other permanent teeth that are missing and the variations of agenesis localizations. The use of radiological evaluations is important for gaining epidemiological insights. The aim of this study was to evaluate the prevalence and distribution of M3 agenesis and the relationship between M3 agenesis and hypodontia and oligodontia in a population of Turkish pediatric patients.

The null hypotheses investigated were (1) the prevalence of M3, hypodontia and oligodontia, regardless of the distributions of teeth, would present with significantly different rates in terms of gender and (2) there would not be a significant relationship between M3 and other congenital permanent tooth agenesis.

Materials and Methods

After the ethical committee approval of the Trakya University Medical Faculty (Protocol number: TÜTF-BAEK 2018/134), the study was started. The patients who were referred to the Faculty of Dentistry for various reasons during the years 2015 through 2017 were randomly selected. Panoramic radiographs of 1,471 patients (899 females; 572 males) were retrospectively evaluated. Patients' gender and age were noted. Patients over 15 years old, patients with systemic and congenital disease, or any pathology in the jaws and poor quality of radiographs were excluded from this study.

M3 agenesis, hypodontia and oligodontia were evaluated as missing teeth that had no detectable germs on panoramic radiographs. The panoramic radiographs of healthy children who presented for routine dental examinations were obtained. All radiographs were taken using a panoramic radiography machine (PaX-Flex; Vatech Inc., NJ) (50–90 kV, 4–10 mA and 10.1 s exposure time) by the same technician for standardization.

Each radiograph was digitally analyzed. One observer was responsible for evaluation of the panoramic radiographs. One observer checked 50 radiographs twice during a period of two weeks to estimate Intraclass Correlations (ICC).

Statistical analysis

The Statistical Package for Social Science (SPSS) 20.0 software program (SPSS Inc., Chicago, IL, USA) was used for evaluation of the study data. The percentage distribution, mean (±) and standard deviation were studied for the descriptive statistics. The chi-square test was applied for the analysis of categoric variables, but for comparisons of maxilla-mandible and right-left side agenesis, chi-square test was not suitable because these groups belonged to same patients, so they were dependent. For these comparisons the McNemar test was applied. Independent samples T-test was used to test the relationships of hypodontia and oligodontia with the number of missing M3 teeth. A p value above 0.05 was considered as not significant.

Results

The reliability was estimated by ICC for all observations. ICC indicated excellent reliability for intra-observer evaluations.

In this study, 1,471 patients in the age range of 9 to 15 (12.76±1.72) years and the panoramic radiographs of 5,884 teeth were examined; 899 of the patients (61.1%) were females and 572 (38.9%) were males. As shown in the panoramic radiography, 1,319 (89.7%) patients had all M3 teeth present in the mouth, while the other 152 (10.3%) had congenital agenesis in one or more teeth. The number of teeth that M3 agenesis was seen in, in order of the number of missing teeth, was one (2.6%), two (2.4%), three (1.0%) and four (4.3%) (Graph 1). When M3 missing teeth were analyzed by gender, despite congenital agenesis being seen more in males than females, the difference was not significant
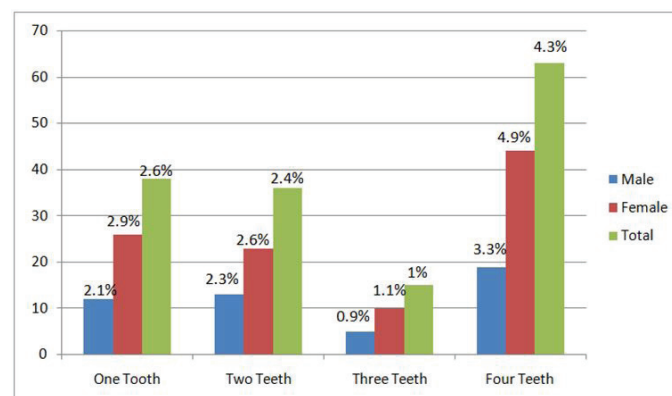
Figure 1. *Distribution of M3 agenesis by gender according to the number of missing teeth.*

(p=0.076). Also, when analyzed separately for the number of missing M3 teeth (one, two, three or four) by gender, the differences were not significant (p=0.943) (Table 1).

The most common M3 tooth agenesis was observed in the upper left region (7.2%), followed by the lower-right (7.1%), upper-right (6.9%) and lower-left (6.5%). With regard to the relationship between gender and these teeth, the differences were not significant (p>0.05) (Table 2).
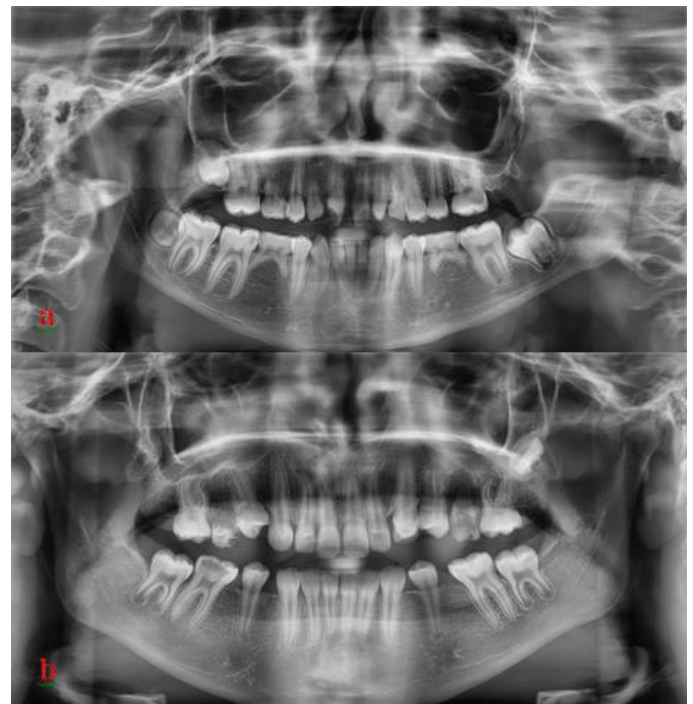
The state of missing M3 teeth was examined according to maxilla and mandible; agenesis was slightly higher in the maxilla compared to the mandible.The difference was not statistically significant (p=0.640) (Table 2).

The total numbers of missing teeth in the maxilla and mandible were found 207 (7.0%) and 200 (6.8%), respectively. The total number of missing M3 teeth was 205 (7.0%) in the lower and upper-right side of the jaws, while it was 202 (6.9%) in the lower and upper-left side.The difference was not statistically significant (p=0.871).

One-hundred fifty-two patients who had congenital agenesis of M3 teeth were evaluated for hypodontia and oligodontia (Figures 1, 2). Hypodontia was detected in 37 (24.3%) pa-

Table 1. *Distribution of M3 tooth agenesis according to teeth, gender, and age. The numbers in parentheses indicate percentages*

		18	28	38	48	Total number of M3 teeth agenesis
		M3 teeth agenesis n(%)				
Age	**Gender**					
9	Male	5	5	5	5	20
	Female	7	8	7	7	29
	Total	12 (24.5)	13 (26.5)	12 (24.5)	12 (24.5)	49 (12)
10	Male	3	3	3	3	12
	Female	2	2	2	2	8
	Total	5 (25.0)	5 (25.0)	5 (25.0)	5 (25.0)	20 (4.9)
11	Male	6	4	3	5	18
	Female	4	5	6	6	21
	Total	10 (25.6)	9 (23.1)	9 (23.1)	11 (28.2)	39 (9.6)
12	Male	3	2	2	2	9
	Female	11	10	13	12	46
	Total	14 (25.5)	12 (21.8)	15 (27.2)	14 (25.5)	55 (13.5)
13	Male	6	8	10	9	33
	Female	20	21	17	21	79
	Total	26 (23.2)	29 (25.9)	27 (24.1)	30 (26.8)	112 (27.5)
14	Male	6	6	8	6	26
	Female	16	15	11	13	55
	Total	22 (27.2)	21 (25.8)	19 (23.5)	19 (23.5)	81 (19.9)
15	Male	3	4	1	3	11
	Female	9	13	8	10	40
	Total	12 (23.5)	17 (33.3)	9 (17.7)	13 (25.5)	51 (12.6)
9-15	Male	32 (24.8)[a]	32 (24.8)[b]	32 (24.8)[c]	33 (25.6)[d]	129 (31.7)
	Female	69 (24.8)[a]	74 (26.6)[b]	64 (23.0)[c]	71 (25.6)[d]	278 (68.3)
	Total	101 (24.8)	106 (26.0)	96 (23.6)	104 (25.6)	407

[a,b,c,d]Differences between gender. p[a]=0.124, p[b]=0.057, p[c]=0.248, p[d]=0.121.

Figure 1. *Hypodontia with M3 agenesis on panoramic radiographs.*

Figure 2a,b. *Oligodontia with M3 agenesis on panoramic radiographs.*

Table 2. *The rates of M3 agenesis in the maxilla–mandible and on the right-left sides of the jaws. The numbers in parentheses indicate percentages*

Gender	Maxillary (18-28)		Mandibular (38-48)		Right side (18-48)		Left side (28-38)	
n (%)	Present	Absent	Present	Absent	Present	Absent	Present	Absent
Male	1080 (36.7)	64 (2.2)	1079 (36.7)	65 (2.2)	1079 (36.7)	65 (2.2)	1080 (36.7)	64 (2.2)
Female	1655 (56.3)	143 (4.8)	1663 (56.5)	135 (4.6)	1658 (56.3)	140 (4.8)	1660 (56.4)	138 (4.7)
Total	2735 (93.0)	207[a] (7.0)	2742 (93.2)	200[a] (6.8)	2737 (93)	205[b] (7)	2740 (93.1)	202[b] (6.9)

[a,b]Differences between total number of absence of M3. `a` for maxilla and mandibula, `b` for right and left side. p[a]=0.640, p[b]=0.871

tients and oligodontia was detected in 3 (2%) patients. We didn't find a significant relationship between oligodontia and missing individual (18,28,38,48), maxillary (18-28), mandibular (38-48), right (18-48) or left (28-38) M3 teeth (p>0.05).

There was no significant relationship between hypodontia and missing upper left or upper right M3 teeth (p>0.05) but we found that hypodontia was significantly higher in patients with missing lower left (p=0.003) or lower right (p<0.001) M3 teeth.

There was no significant relationship between hypodontia and missing right (18,48), left (28,38), maxillary(18,28) M3 teeth (p>0.05). However, we found that hypodontia was significantly higher in patients with missing mandibular (38,48) M3 teeth (p=0.001) (Table 3).

The percentages on how many hypodontia/oligodontia cases were observed when one, two, three or four M3 were congenitally absent were shown in Table 3. As the number of missing M3 teeth increased, the probability of hypodontia increased as expected (p = 0.004), but no significant relationship was found with the presence of oligodontia (p = 0.653).

Table 3. *The rates of hypodontia and oligodontia according to M3 tooth agenesis. The numbers in parentheses indicate percentages*

	Hypodontia	Oligodontia
Missing 18	25 (24.8)	2 (2)
Missing 28	27 (25.5)	3 (2.8)
Missing 38	31 (32.3)*	2 (2.1)
Missing 48	34 (32.7)**	3 (2.5)
Missing Maxillary (18-28)	28 (23.7)	2 (1.8)
Missing Mandibular (38-48)	35 (31.0)***	1 (2.6)
Missing Right side (18-48)	35 (26.5)	2 (1.5)
Missing Left side (28-38)	35 (26.1)	3 (2.2)
1 missing M3	4 (10.5)	1 (2.6)
2 missing M3	7 (19.4)	0 (0)
3 missing M3	5 (33.3)	0 (0)
4 missing M3	21 (33.3)	2 (3.2)
*(p=0.003), **p<0.001, ***p=0.001.		

Discussion

In this study based on panoramic radiographs, we attempted to describe the prevalence of M3 agenesis and to evaluate the relationship between M3 agenesis and hypodontia and oligodontia. Different results were found in the literature about the prevalence of M3 agenesis (Table 4).

Contrary to the findings from our study, in the studies of Mishra et al. (18), Kaur et al. (19) and Upadhyaya et al. (20), M3 agenesis was found more frequently in males. The female predilection was similar to that reported by Sandhu and Kaur (21) and Sujon et al. (16). There was no statistically significant difference between genders and this finding from our study is in concordance with other reports (22-26). Therefore, the first null hypothesis could be rejected regarding M3 agenesis.

Celikoglu et al. (27) and Mishra et al. (18) reported that the missing of all M3 teeth was more frequently found than the

presence of M3 teeth, similar to the findings of this study. In the study of Mishra et al. (18), upper right M3 agenesis had the highest prevalence while lower left M3 agenesis had the lowest prevalence. But, in this study, lower right M3 agenesis had the highest prevalence. Sujon et al. (16) reported the frequency order of M3 agenesis as 1>2>4>3 while Endo et al. (28) reported the number order of M3 agenesis as 2>1>4>3. Moreno et al. (29) reported that the frequency order of M3 agenesis as 1>2>3>4. In our study, the frequency of number of M3 agenesis were noted as 4>1>2>3.

Sandhu and Kaur (21), Kaur et al. (19), Sujon et al. (16), John et al. (7) and Singh et al. (30) reported that M3 agenesis was significantly more frequent in the maxilla than in the mandible. Singh et al. (30) reported that instances of M3 agenesis were more frequent on the right side. In our study, maxillary M3 agenesis was slightly frequent. Slightly lower than the results from our study (right: 13.9%; left: 13.7%), Kilinç et al. (31) reported that the rate of M3 tooth agenesis was 12.7% and 11.2% on the right side and left side, respectively and M3 agenesis was more frequently observed in the upper-right tooth (15.1%), followed by the upper left (13.5%), lower-right (10.2%) and lower-left (8.9%) M3 teeth. It can be said that these rates were higher than those of this study. In the study of Mishra et al. (18), there were higher results compared to our study. It was reported that upper right, lower right, upper left and lower left M3 agenesis was 57.8%, 64.1%, 62.5% and 68.1%, respectively.

In the study of Sujon et al. (16), hypodontia prevalence was reported as 3.1%. This result was lower than ours. Garn et al. (17) reported that one or more instances of M3 agenesis increased the incidence of other missing teeth by 13 times. Endo et al. (28) also reported a study presenting significant increases in the occurrence of oligodontia and M3 teeth agenesis except only one M3 agenesis compared with the control group. Contrary to this study, in our study, no significant increase was observed between oligodontia and the number of missing M3 teeth.

Tompson et al. (32) found that M3 agenesis in females is significantly associated with the agenesis of the hypodontia. Endo et al. (28) reported that the prevalence rates of hypodontia cases were increased as the severity of M3 agenesis increased. Celikoglu et al. (27) also observed that the prevalence of hypodontia cases was significantly higher in patients with agenesis of three or four M3 teeth. Our study supports the idea of higher number of missing M3 teeth was associated with the presence of hypodontia.

Gulati et al. (33) reported that hypodontia cases had a higher prevalence rate in the M3 agenesis than the control group which included the patients without M3 agenesis. Similarly, in our study, hypodontia was significantly higher in patients with missing lower left or lower right and mandibular M3 teeth. But, there was no significant relationship between oligodontia and missing individual (18,28,38,48), maxillary (18-28), mandibular (38-48), right (18-48) or left (28-38) M3 teeth. Therefore, the second null hypothesis could be confirmed only regarding the relationship between M3 agenesis and oligodontia.

Panoramic radiography can exhibit not only the missing and impacted teeth, but also the size and morphologic changes and the other anomalies of the teeth (34). Panoramic radiography is important in the diagnosis of real

Table 4. *The previous studies about M3 agenesis*

Author name	Country	Year	Sample size	Population	Prevalence	Predilection
Nanda (35)	America	1954	200	White women	9.1%	Maxilla
Levesque et al. (36)	Canada	1981	4640	French-Canadian (Only mandibular M3)	9% (bilateral M3 prevalence)	-
Mok and Ho (22)	Singapore	1996	786	Singoporean-Chinese patients aged 12-16	28.5%	Maxilla
Rozkovcová et al. (37)	Czech Republic	2004	1000	Patients aged 12-21	22.5%	Male
Lee et al. (38)	Korea	2009	1129	Patients aged 16-24	41%	Female
Celikoglu et al. (8)	Turkey	2010	351	Orthodontic patients aged 20-26	17.3%	Female
Kazanci et al. (39)	Turkey	2010	2579	East Anatolian patients aged 12-16	23.8%	Maxilla
Celikoglu and Kamak (25)	Turkey	2012	1046	Orthodontic patients aged 13–17	22.7%	Maxilla
John et al. (7)	Malaysia	2012	734	Patients aged 10-19	26.2%	Female/Right maxilla
Kaur et al. (19)	India	2012	500	Patients aged 18-25	35.4%	Male/Right maxilla
Sujon et al. (16)	Malaysia	2016	5923	Patients aged 10-50	38.4%	Female/Maxilla
Kilinç et al. (31)	Turkey	2017	772	Patients aged 12-18	23.3%	Right maxilla
Mishra et al. (18)	India	2017	301	Patients aged 9-15	36.8%	Male/Maxilla
Singh et al. (30)	India	2017	300	Patients aged 18-25	46.7%	Female/Maxilla
Moreno et al. (29)	Chile	2019	535	Patients aged 14 and older	12.89%	Female/Right Maxilla
Gulati et al. (33)	India	2019	472	Patients aged 13-28	19.2%	-
The present study	Turkey		1471	Patients aged 9-15	10.3%	Maxilla

hypodontia and oligodontia cases. At the M3 teeth evaluations, the main advantages of panoramic radiography are easily observed in the situation of developing M3 teeth, the relationship between it and the mandibular canal, impaction type and M3 region (19). So, this modality was preferred because radiographic evaluation provided more accurate results than clinical examination and it could be sufficient by itself. In our study, panoramic radiographs were taken in the routine examination for diagnostic purposes in order to prevent patients from receiving extra doses.

Conclusion

There are different results from different populations and also different regions of Turkey about M3 agenesis reported in the literature. With this study, further research may provide significant contributions for the studies involving M3 agenesis and accompanying dental anomalies.

Türkçe Özet: *Türk Pediatrik Hastalarda Hipodonti ve Oligodonti ile İlişkili Üçüncü Molar Agenezisinin Değerlendirilmesi. Amaç: Pediatrik hastalarda üçüncü molar (M3) agenezisi ile hipodonti ve oligodonti arasındaki ilişkiyi panoramic radyografi kullanarak değerlendirmektir. Gereç ve Yöntemler: 1.471 hastanın (899 kadın; 572 erkek) ve 5.884 dişin panoramic radyografileri retrospektif olarak değerlendirildi. Hastaların yaşları ve cinsiyetleri kaydedildi. Çalışmaya 9-15 yaş arası hastalar dahil edildi. Ortalama yaş 12,76'idi. M3 diş agenezisi ve M3 agenezisi ile hipodonti ve oligodonti arasındaki ilişki, hem sağ hem de sol lokasyonda üstve alt çene bulgularına göre M3 agenezisi olan diş sayısı ile birlikte kaydedildi. Veriler Ki-Kare ve McNemar testleri kullanılarak analiz edildi (p <0.05). Bulgular: Toplam 1.319 (% 89,7) hastanın tüm M3 dişleri ağızda varken, diğer 152 (% 10,3) hastanın bir veya daha fazla dişinde konjenital agenezisi vardı. M3 agenezinin görüldüğü diş sayısı, eksik M3 diş sayısı sırasına göre yüzdelik olarak bir diş için %2,6, iki diş için %2,4, üç diş için %1,0 ve dört diş için %4,3'idi. 37 hastada hipodonti, 3 hastada oligodonti tespit edildi. Sonuç: M3 agenezisinin prevalansı bir popülasyondan diğerine değişmektedir. M3 agenezisi ile ilişkili diş anomalilerinden ikisi hipodonti ve oligodontidir. Bu çalışmada, M3 agenezisi bölge ve cinsiyete gore farklılık göstermektedir; hipodonti, eksik mandibular M3 olan hastalarda anlamlı olarak daha yüksek bulunmuştur. Anahtar Kelimeler: Hipodonti, Oligodonti, Panoramik radyografi, Üçüncü molar agenezis, Diş kaybı*

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The effect of pain intensity levels and clinical symptoms on the treatment preferences of patients with endodontically involved teeth: A preliminary cross-sectional study

Purpose
This study aimed to evaluate the effect of pain intensity levels and clinical symptoms on the treatment preferences of patients with endodontically involved teeth in a local Turkish population.

Subjects and Methods
A total of 30 patients with symptomatic teeth requiring non-surgical root canal treatment were included in the study. The patients' demographic (age, gender, and education level) and diagnostic data (tooth type, pain intensity, response to percussion and palpation, presence of referred pain, and diagnosis) were analyzed. Data on the patients' explicit preferences (requested treatment, whether they are willing to accept a proposed extraction, choice of treatment if an anterior tooth was involved, and choice of treatment if the pain was not severe) as well as previous root canal treatment experiences were also analyzed. Pain intensity levels were evaluated using the Visual Analog Scale.

Results
Pain intensity levels had a significant effect on the treatment requested by the patient (p=0.001). Among the patients who requested extraction upon referral to the clinic, the rate of those who reported that they would not accept extraction if the pain was located in an anterior tooth was significantly lower than that of patients stating that they would refuse (p=0.039). The presence of referred pain also had a significant effect on the requested treatment (p=0.001).

Conclusion
The intensity of pain and the presence of referred pain influence patients' treatment preferences.

Keywords: Decision-making, Dental pain, Ethics, Informed consent, Treatment preference

Introduction

Dental pain is one of the most prevalent pains affecting social life and is associated with a loss of productive time and treatment costs (1,2). Dental pain may result in peripheral and central sensitization due to an increase in noxious stimuli. The clinical symptoms of peripheral sensitization are a decrease in firing thresholds, which triggers discharges from non-noxious stimuli (allodynia); occurrence of after-discharges, which increases the perceived intensity of pain caused by noxious stimuli (hyperalgesia) (3,4); and spontaneous pain due to spontaneous firing (5,6). Peripheral sensitization is restricted to the injury site and persists only as long as a peripheral pathology is present. Further, it appears to play a major role in altered heat but not mechanical sensitivity, which is a distinctive feature of central sensitization (7,8).

Central sensitization, on the other hand, is the manifestation of changes in the properties of neurons in the central nervous system (CNS) that co-

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opt novel inputs for noxious stimuli for transduction purposes. By changing the interpretation of normal inputs, central sensitization causes pain hypersensitivity in non-inflamed tissue that persists long after the peripheral pathology or the initiating cause has disappeared. Central sensitization alters the CNS response to sensory inputs and, is therefore, not contingent on ongoing peripheral noxious stimuli. This makes it a distinct aspect of a major functional shift in the somatosensory system (8,9). Referred pain and mechanical allodynia are two distinctive features of central sensitization (8). Referred pain is the perception of pain in a part of the body that is not the source of the pain such as the transmission of pain from a tooth to the opposite arch or the periauricular area. Mechanical allodynia is perceived as pain triggered by non-noxious mechanical stimuli such as sensitivity to percussion and palpation (10).

One of the important aspects of patient autonomy is "consent," which is affected by the assessment capacity of a patient after they have been informed about the medical issue at hand. Therefore, the main component of consent is "to be informed," which is why it is often referred to as "informed consent." Excessive pain for which patients may be urgently seeking medical assistance coupled with panic means that a patient's participation in the decision-making process regarding treatment, and therefore their consent, may be affected, causing defective intention during the consent process. This is a potential legal issue due to the patient's reduced assessment capacity (11-13).

"Capacity" refers to the assessment of an individual's psychological ability to understand the relevant information, appreciate the situation and its likely consequences, compare the benefits and risks of various treatment options, and make rational decisions. Legal assessments of capacity are necessarily time- and decision-specific (14,15). An individual's capacity to make decisions can fluctuate or be temporarily affected by factors such as pain, fear, confusion, or the effects of medication (16).

Therefore, the aim of this study was to evaluate the effects of pain intensity levels, referred pain, sensitivity to percussion and palpation, and aesthetic concerns on the treatment preferences of individuals with endodontically involved teeth in a local Turkish population.

Subjects and Methods

Inclusion and exclusion criteria

This cross-sectional study was approved by the Ethics Committee of Istanbul Medipol University (No. 404) and registered in ClinicalTrials.gov with ID number NCT03553641. A total of 30 patients who had symptomatic teeth requiring non-surgical root canal treatment were included in the study. Patients under 18 and over 60 years of age, patients diagnosed with systemic diseases, and patients who had used an analgesic up to 12 hours prior to the appointment were excluded. All enrolled patients participated voluntarily and signed written informed consent forms.

Data collection

A datasheet including patients' demographic data, diagnostic data, and data regarding explicit preferences was filled out (Table 1). All pain scores were recorded according

to the Visual Analog Scale (VAS) as used by Turk (16). The patients' demographic data, including age, gender, and education level, were recorded. Diagnostic data regarding tooth type, pain intensity, response to percussion and palpation, presence of referred pain (transmission of pain to the opposite arch or the periauricular area), and final diagnosis were recorded after clinical and radiographic examinations (Table 1). All patients were explicitly informed that their answers to questions regarding their explicit preferences would not affect their diagnosis or treatment. Neither the diagnosis nor the indicated treatment was disclosed to the patients prior to the completion of the data sheet to avoid defective intention and false responses.

Statistical analysis

Statistical analysis of the data was performed using NCSS (Number Cruncher Statistical System) 2007 software (NCSS LLC, Kaysville, UT, USA). Descriptive statistical methods (mean and standard deviation, median, frequency, and ratio) were used to describe sample measures. The normal distribution of continuous variables was examined using the Kolmogorov-Smirnov test. The Mann-Whitney U test was used for the comparison of non-normally distributed variables with respect to VAS pain scores. The chi-square test and Fisher's exact test were used for the comparison of categorical data along one dimension. All results were reported with a 95% confidence interval, and a value of $p < 0.05$ was considered statistically significant.

Results

The demographic and clinical characteristics of the patients are displayed in Table 1.

Of the 30 participants, 43.3% were male and 57.6% were female. The patients' mean age was 36.03 ± 12.74 years, ranging between 18 and 57 years.

Among the patients, 10% were primary school graduates, 10% were secondary school graduates, 33.3% were high school graduates, 43.3% were university graduates, and 0.4% had no formal education.

Regarding the included teeth, 13.3% were anterior teeth, 23.3% were premolars, and 63.4% were molars.

With regard to diagnosis, 40% of the patients were diagnosed with acute periradicular abscess, 33% were diagnosed with acute periradicular periodontitis, and 27% were diagnosed with symptomatic irreversible pulpitis.

Twenty-six patients, or 86.7%, responded positively to percussion. The same rate was observed in terms of palpation. Referred pain was observed in 73.3% of the patients.

The mean VAS score was 8.43 ± 1.50, ranging between 5 and 10.

Upon referral to the clinic, 63.3% of the patients requested extraction, and 36.7% requested root canal treatment (Table 2). Only one (9.1%) of the patients who had requested root canal treatment accepted the dentist's extraction proposal. The other 10 (90.9%) insisted on having a root canal treatment (Table 3). All the patients who initially requested extraction stated that they would consider root canal treatment if the pain would be less severe than they were experiencing at the time. Nineteen (63.3%) patients had previously undergone a root canal treatment.

Table 1. *Distribution of subjects regarding demographic data, diagnostic data and data on explicit preferences*

	Demographic data			Diagnostic data								Explicit preferences				
Patient	Age	Sex	Education level	Teeth type	Diagnosis	Pain score	Percussion	Palpation	Referred pain	Required Treatment		Requested Treatment	Would you accept if the extraction is proposed?	Would you choose extraction if it were your anterior teeth?	If you were not in excessive pain would you consider other options than extraction?	Have you ever had a RCT before?
1	20	M	HSG	46	APA	9	+	+	+	RCT		Ext	Y	Y	Y	Y
2	46	F	UG	36	APA	9	+	+	+	RCT		Ext	Y	N	Y	Y
3	56	F	UG	37	APA	8	+	+	+	RCT		Ext	Y	N	Y	Y
4	42	M	MSG	17	APA	8	+	+	+	RCT		Ext	Y	N	Y	Y
5	35	F	UG	16	SIP	10	-	-	+	RCT		Ext	Y	N	Y	Y
6	46	F	HSG	31	APA	10	+	+	+	RCT		Ext	Y	Y	Y	N
7	19	M	HSG	47	APP	7	+	+	-	RCT		RCT	N	N/A	N/A	N
8	20	F	UG	46	SIP	8	+	+	+	RCT		Ext	Y	N	Y	N
9	57	M	UG	32	APP	7	+	+	-	RCT		RCT	N	N/A	N/A	Y
10	27	M	MSG	26	APP	7	+	+	-	RCT		RCT	N	N/A	N/A	Y
11	40	F	UG	26	APP	7	+	+	-	RCT		RCT	N	N/A	N/A	Y
12	49	F	PSG	21	APA	5	+	+	-	RCT		RCT	N	N/A	N/A	Y
13	24	F	HSG	46	APA	6	+	+	-	RCT		RCT	N	N/A	N/A	Y
14	25	F	UG	36	APP	8	+	+	+	RCT		Ext	Y	N	Y	N
15	38	M	UG	44	APA	10	+	+	+	RCT		Ext	Y	N	Y	Y
16	22	M	MSG	46	APA	8	+	+	+	RCT		Ext	Y	N	Y	N
17	27	M	UG	15	APA	6	+	+	-	RCT		RCT	N	N/A	N/A	Y
18	25	M	HSG	38	SIP	9	+	+	+	RCT		Ext	Y	N	Y	Y
19	25	M	HSG	26	APA	10	+	+	+	RCT		Ext	Y	N	Y	Y
20	35	F	UG	14	APP	10	+	+	+	RCT		Ext	Y	N	Y	Y
21	57	F	PSG	45	APP	10	+	+	+	RCT		RCT	N	N/A	N/A	Y
22	35	F	HSG	47	SIP	10	-	-	+	RCT		Ext	Y	N	Y	N
23	23	M	HSG	46	APP	6	+	+	-	RCT		RCT	N	N/A	N/A	N
24	53	F	UG	27	APA	10	+	+	+	RCT		Ext	Y	Y	Y	Y
25	52	F	NE	15	APP	10	+	+	+	RCT		Ext	Y	N	Y	N
26	33	F	UG	45	SIP	8	+	+	+	RCT		RCT	Y	N/A	N/A	Y
27	37	F	UG	24	SIP	9	-	-	+	RCT		RCT	N	N/A	N/A	N
28	18	F	HSG	36	SIP	10	-	-	+	RCT		Ext	Y	N	Y	N
29	51	M	HSG	47	APP	9	+	+	+	RCT		Ext	Y	Y	Y	N
30	44	M	PSG	23	SIP	9	+	+	+	RCT		Ext	Y	Y	Y	Y

M: male, F: female, PSG: Primary school graduate, MSG: Middle school graduate, HSG: High school graduate, UG: University graduate, NE: No education, APA: Acute periradicular abscess, APP: acute periradicular periodontitis, SIP: Symptomatic irreversible pulpitis, RCT: Root canal treatment, Ext: Extraction, Y: Yes, N: No, N/A: Not available

Table 2. *The effect of pain intensity on requested treatment and acceptance of the proposed treatment*

| | | VAS Scores | | p | Post-hoc power |
		Min–Max (Median)	Mean±Std Dev.		
Requested treatment (n=30)	Extraction (n=19)	8–10 (9.0)	9.21±0.85	ª**0.001****	**0.998**
	RCT (n=11)	5–10 (7.0)	7.09±1.144		
Proposed extraction by dentist (n=30)	Yes (n=20)	8–10 (9.0)	9.15±0.87	ª**0.001****	**0.999**
	No (n=10)	5–10 (7.0)	7.00±1.49		

ª*Mann–Whitney U Test (** p<0.001)*

Table 3. *The comparison of requested treatment modalities with respect to the acceptance of proposed extraction and referred pain*

| | | Requested treatment | | p | Post-hoc power |
		Extraction (%)	Root canal treatment (%)		
Acceptance of proposed extraction; n (%)	Yes	19 (100)	1 (9.1)	ª**0.001****	**0.999**
	No	0	10 (90.9)		
Referred pain; n (%)	Yes	19 (100)	3 (27.3)	ª**0.001****	**0.991**
	No	0	8 (72.7)		

ª*Fisher's Exact test (**p<0.001)*

Pain intensity levels had a significant effect on the requested treatment (p = 0.001; Table 2). Moreover, they had a significant effect on patients accepting the treatment proposed by the dentist (p = 0.001; Table 2).

Sensitivity to percussion and palpation was 84.2% (n = 16) among the patients who requested extraction and 90.9% (n = 10) among the patients who requested root canal treatment. A positive response to either palpation or percussion had no significant effect on the requested treatment.

The presence of referred pain, on the other hand, had a statistically significant effect on the requested treatment (p = 0.001; Table 3). All the patients who requested extraction presented with referred pain. Of the 11 patients who requested root canal treatment, only 27.3% (n = 3) presented with referred pain.

Among the patients who requested extraction upon referral to the clinic, the rate of those who reported that they would accept extraction if the pain was located in an anterior tooth (16.7%, n = 5) was significantly lower than that of patients stating that they would refuse (83.3%, n = 14; p = 0.039).

In contrast, age, gender, education level, and previous root canal treatment experience had no significant effect on the requested treatment and the acceptance of the proposed extraction.

Discussion

This preliminary study evaluated the effects of pain intensity levels, referred pain, sensitivity to percussion and palpation, and aesthetic concerns on the treatment preferences of patients with endodontically involved teeth. Pain intensity levels and the presence of referred pain had significant effects on the requested treatment by patients.

Excessive levels of pain have been shown to have a debilitating effect on patients' decision-making process, which is a strong indication of defective intention (14,15). Patients undergoing medical emergency surgery had been found to have poorer recollection of the consent process and details of the consent form than patients undergoing elective surgery due to pain, analgesic medications, and fatigue (17).

The reason that pain has a devastating effect on patients' decision-making might be an ongoing major shift in the somatosensory system because of central sensitization (18), which can best be described as a complete physiological change in transmission, modulation, and regulation of pain due to pathological stimuli (8,9). In central sensitization, an expansion of the receptor field and a change in the interpretation of physiological inputs occur. Therefore, referred pain and mechanical allodynia (sensitivity to percussion and/or palpation) become the two major components of central sensitization (secondary hyperalgesia) (8,9). This makes central sensitization rather easy to diagnose with a clinical examination.

In this study, referred pain had a significant effect on the treatment requested by patients. In contrast, a positive response to palpation or percussion showed no significant effect, which suggests that mechanical allodynia does not affect patients' decision-making. In other words, although both are considered components that differentiate central from peripheral sensitization, referred pain and mechanical allodynia appear to have different effects.

Another parameter investigated in this study was the effect of pain intensity on the decision-making process. Pain levels had a significant effect on treatment preferences. Patients who requested extraction upon referral to the clinic had higher pain scores than those who did not. These patients were asked whether they would choose the same treatment if the involved tooth was an anterior tooth. This was done to determine whether the pain could affect patients' decision-making to the extent that they are willing to overlook aesthetic priorities, which are usually a major dental concern (19), in order to be relieved of the pain. The significant difference in favor of root canal treatment for anterior teeth is indicative of the importance of aesthetic priorities compared to pain in patients with central sensitization, highlighting their role in preferences (13,15,19). Many studies have demonstrated the relationship of an aesthetic smile, which is closely linked to the presence of anterior teeth, with a perception of greater intelligence and better chances of finding a job (19-21), which could also explain our patients' responses.

The patients' previous root canal treatment experiences and education levels were also analyzed for any effect on the requested treatment. Although it has been reported that there is no correlation between socioeconomic factors and the presence/absence of apical periodontitis (22), age, education level, socioeconomic status, and gender have

been found to have a significant impact on felt needs, dental awareness and, dental attendance (23). Nevertheless, in this study, neither previous root canal treatment experiences nor the education levels showed any significant effect on the requested treatment, corroborating the finding that pain intensity plays a central role in the decision-making process.

It is conceivable that the intensity of pain might affect patients' consent to a study and a patient's consent to participate might also be compromised. A previous study on patients experiencing acute pain found no correlation between pain intensity and their capacity to consent to participate in research (24). Giving consent to participate in a study that will not affect the treatment plan is not the same as giving consent to a certain treatment procedure (14,15). In this study, patients were explicitly informed both before and during the process that they were not obligated to take the poll to receive proper treatment.

To better understand the reasons behind their choice, patients who requested extraction were asked to consider treatment options other than extraction if there was not an excessive level of pain involved. All patients reported that they would change their choice if they would not be in excessive pain, disregarding other concerns, such as cost, time, or other complex human behaviors affecting the utilization of dental care (25).

Although a dentist should inform and advise patients with their best interests in mind, there is always a risk of recommending a treatment plan that is less complex and is more profitable than a root canal treatment (26), such as extraction and subsequent implant placement. A patient in excessive dental pain might agree to these options due to reduced consent capacity and disturbance of the decision-making process under the existing circumstances. This implies that ethical and legal responsibilities of a dentist, including obtaining a valid informed consent should be highly emphasized as very critical aspects of decision-making during dental education. Furthermore, pre- and post-graduate educational programs can also integrate a guideline that describes a witnessed interaction with the patient to assess his/her capacity to make treatment decisions. A useful alternative may also be the development of a two-step consent process. With such an approach, alleviation of pain prior to the final decision may improve a patient's judgement (27) and the informed consent process.

To the authors' knowledge, this is the only study to date investigating the impact of pain intensity levels and other diagnostic factors on the treatment preferences of patients with endodontically involved teeth. As this is a pioneering and preliminary study, multicenter studies with larger sample sizes are required to gain a better understanding of the factors that influence a patient's decision-making process. Further studies may confirm the necessity of modifying the informed consent procedures or incorporating guidelines when managing dental patients in severe pain.

Conclusion

Under the limitations of this study, we can conclude that pain intensity and referred pain significantly influence the treatment preferences of patients with endodontically involved teeth, whereas sensitivity to percussion and palpa-
tion does not. Careful consideration of the effects of these factors on patients' participation in the decision-making and consent processes is required.

Türkçe Özet: *Ağrı Şiddeti ve Klinik Semptomların Endodontik Tedaviye Gereksinimi Olan Hastaların Tedavi Tercihlerine Olan Etkisi: Kesitsel Bir Ön Çalışma. Amaç: Bu çalışmanın amacı, bir Türk popülasyonundaki bireylerde ağrı şiddetinin ve klinik semptomların hastanın tedavi tercihi üzerine olan etkisini değerlendirmektir. Gereç ve Yöntem: Kök kanalı tedavisi endikasyonu olan semptomatik bir dişe sahip toplam 30 hasta çalışmaya dâhil edilmiştir. Hastaların demografik özellikleri (yaş, cinsiyet ve eğitim düzeyi), tanı verileri (diş tipi, ağrı şiddeti, perküsyon ve palpasyona yanıt, yansıyan ağrının varlığı, gereksinim duyulan tedavi ve tanı), tercihleri (talep edilen tedavi, hekim tarafından sunulan diş çekimi tedavi seçeneğine yaklaşım, ilgili dişin ön diş olması halinde tedavi tercihi, ağrı şiddetli olmasa idi tedavi tercihi) ve önceki kök kanalı tedavisi deneyimleri kaydedilmiştir. Ağrı şiddeti skorları, Görsel Analog Skala kullanılarak kaydedilmiştir. Bulgular: Ağrı şiddetinin hastanın talep ettiği tedavi üzerinde anlamlı bir etkiye sahip olduğu saptanmıştır (p=0,001). Kliniğimize başvururken diş çekimi talep eden hastalar arasında ağrı ön dişte olsa idi diş çekimini kabul eden hasta sayısının kabul etmeyenlere oranla istatistiksel olarak anlamlı derecede daha az olduğu belirlenmiştir (p=0.039). Yansıyan ağrı varlığının, hastaların talep ettiği tedavi üzerinde istatistiksel olarak anlamlı bir etkiye sahip olduğu saptanmıştır (p=0.001). Sonuç: Ağrının şiddeti ve yansıyan ağrının varlığı hastaların tedavi tercihlerini etkilemiştir. Anahtar Kelimeler: Bilgilendirilmiş onam, Diş ağrısı, Etik, Karar verme, Tedavi tercihi*
Klinik Önem: *Şiddetli diş ağrısı hastanın karar verme yeteneğini etkileyebilir ve bu nedenle bilgilendirilmiş onamın geçerliliğini tehlikeye atabilir.*

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Original research

The effect of the Er: YAG laser on the clinical success of hydrophilic fissure sealant: a randomized clinical trial

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Purpose
The aim of this study was to assess the effect of the Er:YAG laser on the clinical success of a hydrophilic fissure sealant over 12 months.

Subject and Methods
This study was conducted on 132 permanent first molars from 44 (19 girls and 25 boys) patients aged 7-11 years. The teeth were divided into three groups. The first group (Group A-control) of teeth were etched with phosphoric acid, the second group of teeth (Group L) were etched with an Er:YAG laser, and the third group of teeth (Group A+L) were etched with both the Er:YAG laser and phosphoric acid. Clinical evaluations were performed at baseline and at 3-, 6-, 9- and 12-month follow-up visits. The data were analyzed with Pearson chi-square tests, Cochran Q tests and Kaplan-Meier analysis.

Results
At the end of the 12 months, total retention rates were 72.7%, 59.1%, and 65.9% in the acid group, the laser group and the laser and acid group, respectively. Although there was no statistically significant difference between group retention rates (p>0.05), the lowest retention rate was found in the laser group at the end of the 12-month follow-up period. No new caries were observed in any group during the study period.

Conclusion
Etching with the Er:YAG laser, phosphoric acid or a combination of both methods provided similar results for the clinical success of hydrophilic based fissure sealant.

Keywords: *Pit and fissure sealant, UltraSeal XT® hydro™, Er:YAG laser, Phosphoric acid, Preventive dentistry*

Introduction

The term fissure sealant is used to describe a material that is applied to pits and fissures that are susceptible to caries, forming a micromechanically bonded layer on the enamel and preventing the growth of cariogenic bacteria. Traditionally, the retention of the sealant is maintained by etching the enamel using various concentrations of phosphoric acid (1). Cueto and Buonocore (2) published their first paper on the successful application of sealants for pits and fissures in 1967. According to their study, at the end of one year, caries incidence was decreased by 87%, and 71% of the sealants were fully retained.

The efficacy of sealants for caries prevention depends on the long-term retention of the material (3). Retention rates show variation due to proper isolation of the working field, viscosity of the sealant, roughening of the enamel surfaces, and use of the adhesive system.

The most widely used enamel conditioning procedure is acid etching that selectively erodes the hydroxyapatite rods prior to resin based fissure sealant application. However, there are some disadvantages of acid

etching, such as the removal of superficial enamel, formation of various etching depths, and high sensitivity to water or saliva contamination and demineralization, which cause the enamel to be susceptible to caries and produce unsatisfactory bonding (4-6). Therefore, alternative methods have been proposed for the preparation of the enamel.

Laser etching has been suggested as a pretreatment method to roughen the enamel. It has the advantage of cleaning, conditioning and decontamination of barely accessible fissures only in one step, and it is a painless procedure that does not involve vibration or heat (6,7). Studies confirmed that, the use of a laser changes the calcium/phosphorus ratio, making the tooth structure more stable and resistant to acid attacks (8).

Contamination by saliva is often experienced in pediatric patients, which deteriorates the quality of adhesion between the enamel and fissure sealant in pediatric dentistry (9). Hydrophilic sealants were introduced that bond effectively to moist enamel surfaces to overcome this problem. UltraSeal XT® hydro™ is a new moisture-tolerant, self-adhesive, light-cured hydrophilic pit and fissure sealant. This material is reported to chase moisture into the pits and fissures, eliminating moisture related failures (10). There are many in vitro studies investigating the effect of Er:YAG lasers on hydrophilic fissure sealants. The number of clinical studies comparing the retention rates of fissure sealants applied using conventional acid etching, laser etching or the combination of laser and acid etching are limited (11-13). The results of the studies still have the conflicting results if Er:YAG laser is a useful tool for enamel surface conditioning prior to placement of fissure sealants. While some authors reported that acid and laser etching provided similar results in terms of sealant retention rate (14,15), some of them suggested the use of acid after laser application and reported that the application of laser did not eliminate the need for acid etching (16). Moreover, a recently published in-vitro study showed that bond strength of a sealant to phosphoric acid etched enamel was significantly higher than that Er:YAG laser etched enamel (17).

The aim of this study was to evaluate the effect of the Er:YAG laser on the clinical success of a hydrophilic fissure sealant over 12 months. The null hypothesis tested herein was that the Er:YAG laser had not improve the clinical success in terms of retention rates and caries development rates of a hydrophilic fissure sealant.

Subject and Methods

The protocol and consent form for this study were reviewed and approved by the Aydin Adnan Menderes University Faculty of Dentistry Clinical Investigations Ethics Committee (ADUDHF2018/048-2017/089). The study was registered (Protocol Registration Receipt NCT03718689) at http://www.clinicaltrial.gov. Written informed consent was obtained from the parents of the participants.

The participants were selected from the patients attending the Adnan Menderes University Faculty of Dentistry. The treatment procedures, possible side effects and benefits were explained to the participants/caregivers. Written informed consent was obtained from participants/caregivers, who signed the informed consent prior to participation.

Patients eligible to participate were healthy individuals aged 7-11 years with at least three non-carious first permanent molars requiring fissure sealant. The inclusion criteria for the study were as follows:

* Good general health and having a high caries risk with a dmft (decayed, missed and filled tooth) value between 4 to 6
* Fully erupted permanent first molar teeth with deep, narrow fissures
* No detectable occlusal or proximal caries
*Children with satisfactory cooperative behaviour (18) (Frankl score 3 or 4)

The exclusion criteria for the study were as follows:
* The presence of systemic pathology or history of allergic reaction to the materials used in the study
* Having hypomineralized areas, such as fluorosis or molar incisor hypomineralization

The plaque and debris were removed using a polishing brush and pumice. Caries status was assessed using a DIAGNOdent pen (DIAGNOdent 2190, KaVo, Biberach, Germany) at the occlusal and proximal sites. Teeth having DIAGNOdent readings of 12 or less at the occlusal site and 7 or less at the proximal site were included in the study.

Sample size determination

The sample size required was determined to be 132 teeth (44 teeth per group) using G-power software based on a study by Karaman et al (14) for a power of 95% (α=0.05, 1-β=0.95).

Randomization

A total of 132 permanent first molars from 44 patients, three in each patient, were included in the study. They were randomly assigned using block allocation. A table of random numbers was used to assign the teeth for the groups.

Groups and procedures

In the acid group (Group A-control), teeth were etched with 35% phosphoric acid (Vococid®, Voco Products, Cuxhaven, Germany) for 20 seconds, rinsed and lightly air-dried as suggested by the manufacturer. UltraSeal XT® hydro™ (UltraSeal XT ® hydro ™, Ultradent Products, South Jordan, Utah, USA) was then applied by a previously calibrated operator and light-cured for 20 seconds with an LED curing unit (Monitex Ti-Lite Gt 1500, New Taipei, Taiwan). Then, the sealants were clinically checked for adequacy, and the occlusion was checked with an articulation paper.

In the laser group (Group L), teeth were etched with an Er:YAG laser system (LightWalker STE-E, Fotona Medical Lasers, Ljubljana, Slovenia) using a noncontact handpiece (R02) with the following settings: the wavelength was 2.94 µm, the power was 3.6 W, the energy output was 180 mJ, a short pulse duration, the frequency was 20 Hz, and the beam spot size was 0.6 mm. The Er:YAG laser applied to fissures at a working distance of 1-2 mm aligned perpendicularly to the target area with water cooling (air/water ratio of 6/4). The duration of exposure depended on the time needed to guide the laser beam evenly across the pits and fissures to be irradiated (14). During the laser application, the operator, patient and parent wore protective glasses. The teeth were then air-dried, and UltraSeal XT® hydro™ that is a moisture-activated, self-adhesive, acrylate-based hydrophilic fissure sealant was applied as described for group A.

In the acid and laser group (Group A+L), teeth were etched with an Er:YAG laser and phosphoric acid, and the fissure sealant was applied as described above.

Follow-up

An examiner who was unaware of which etching protocol was used independently evaluated the sealants at baseline and at 3-, 6-, 9-, and 12-month follow-up visits. At the beginning of the study, the kappa value was calculated to test intra-examiner reproducibility. The kappa value was high (0.93) and showed strong intra-examiner agreement. The teeth were assessed using a mouth mirror and explored for new caries formation and retention of the fissure sealants. Sealant retention was recorded according to Simonsen's Criteria as follows: 1 was total retention (TR), 2 was partial retention (PR), and 3 was total loss (TL) (15). Partial retention or total loss was noted as failure and total retention was noted as success for survival analysis.

Each sealant was evaluated for the presence or absence of caries formation. Loss of enamel translucency along the margins and softness at the base of the exposed fissures were noted as caries presence. In case of a partial or total loss of the sealants were observed, they were noted as failure and we evaluated the teeth found to be successful in the follow-up periods. However, when partial or total loss of the sealant was observed , such sealants were repaired or replaced in the same appointment and those teeth excluded from the study.

Statistical analysis

Data were analyzed with SPSS 24.0 (SPSS 24.0 for Windows, SPSS Inc., Chicago, IL, USA). Pearson's chi-square tests were used to evaluate differences in the retention rates of sealants applied with different etching techniques for each evaluation period at a 5% level of significance. The total retention rates at baseline and all recall times for each group were compared using Cochran's Q test and Dunn's Multiple Comparison test. The intra-examiner reproducibility was determined using Cohen's kappa statistics by re-examining 10 patients one week after the examination period. Additionally, Kaplan-Meier survival analysis and log-rank tests were used to estimate the probability of the etching protocol's success.

Results

A total of 132 teeth were sealed in 44 patients (19 girls and 25 boys) and all patients attended all visits, resulting in a re-call rate of 100%. An equal number of fissure sealants were applied to the maxillary and mandibular teeth. There was no statistically significant difference in retention rates of the sealants in terms of jaw type (p>0.05). The mean age of the participants was 8.97±1.62. The age distribution of the sample was as follows: 7 years old (27.3%), 8 years old (20.5%), 9 years old (9.1%), 10 years old (13.6%), 11 years old (29.5%).

Figure 1 represents the flow chart of the patients and first permanent molars included in this study. Caries were not observed in any of the sealed teeth throughout the 12-month follow-up period, and none of the teeth exhibited total loss of sealant. Retention rates of the groups at baseline and 3-, 6-, 9-, 12-, month recalls and comparison of the sealant retention rates of the groups at each time interval and intragoup comparisons with baseline for total retention rates for each group is displayed in Table 1. Figure 2 shows the sealant retention distribution along with total retention and partial and total loss of sealants at all follow-up periods.
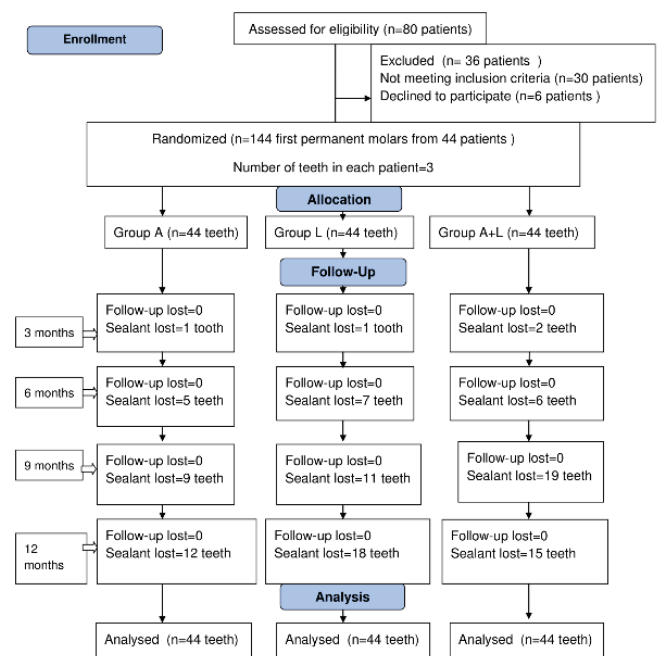
Figure 1. *The flow chart of the patients and first permanent molars included in this study.*

Table 1. *Retention rates of the groups at baseline and 3-, 6-, 9-, 12-, month recalls and comparison of the sealant retention rates of the groups at each time interval and intragoup comparisons with baseline for total retention rates for each group*

	Baseline, n (%)			3-Months, n (%)			6-Months, n (%)			9-Months, n (%)			12-months, n (%)		
Group	A	L	A+L	A	L	A+L	A	L	A+L	A	L	A+L	A	L	A+L
TR	44 (100)	44 (100)	44 (100)	43 (97.7)	43 (97.7)	42 (95.5)	39* (88.6)	37* (84.1)	38* (86.4)	35* (79.5)	33* (75)	35* (79.5)	32* (72.7)	26* (59.1)	29* (65.9)
PR	0 (0)	0 (0)	0 (0)	1 (2.3)	1 (2.3)	2 (4.5)	5 (11.4)	7 (15.9)	6 (13.6)	9 (20.5)	11 (25)	9 (20.5)	12 (27.3)	18 (40.9)	15 (34.1)
TL	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
p value	1.00			0.77			0.82			0.83			0.40		

TR, total retention; PR, partial retention; TL, total loss; A, acid; L, laser; A+L, acid and laser. *Significant difference in comparison with baseline according to Cochran's Q test for total retention rates in each group (p<0.05)

At the 3-month follow up, the total retention rate of sealants in Group A and Group L was 97.7%, which was not significantly different from Group A+L with a total retention rate of 95.5% (p>0.05). At the 6-month follow up, the total retention rates of sealants in Group A, Group L and Group A+L were 88.6%, 84.1%, and 86.4%, respectively, and the difference between the groups was not statistically significant (p>0.05).

At the 9-month follow up, the retention rate of sealants in Group A and Group A+L were 79.5%, while it was 75% for Group L. There were no significant differences in the retention rates among the three groups at any of the evaluation times (p>0.05).

At the 12-month follow up, the total retention rates of sealants in Group A, Group L and Group A+L were 72.7%, 59.1%, and 65.9%, respectively, and the differences among groups were not statistically significant (p>0.05).

Differences between baseline and each recall time within each group are displayed in Table 1. There were no statistically significant differences between the baseline and 3-month recall for the groups (p>0.05). For all groups, significant differences were observed between the baseline and 6-month recall, 9-month recall and between the baseline and 12-month recall (p<0.05) (Table 1).

Figure 3 shows cumulative survival analysis of the groups. The Kaplan-Meier survival analysis and log-rank (Mantel-Cox)

Figure 2. *The sealant retention distribution along with total retention and partial and total loss of sealants at all follow-up periods.*

Figure 3. *Cumulative survival analysis of the groups.*

test revealed that there were no significant differences in retention rates of the sealants among three groups (p>0.05).

Discussion

The present study compared the clinical performance of hydrophilic fissure sealant applied using conventional acid etching, an Er:YAG laser or a combination of an Er:YAG laser and acid etching in terms of the retention rate and caries formation over a 12-month period.

Fissure sealant applications are considered as effective method for preventing caries formation on occlusal surfaces of newly erupted posterior teeth (19). The fissure sealant material should penetrate to the roughened enamel surface for successful retention. Penetration of resin material depends on the etching and wetting ability of the enamel, the surface tension of the fissure sealant material and the degree of (20) . Newly erupted teeth are less mineralized and have less resistance to acid attacks because maturation is not completed (19). Poor behaviour of child during the sealant application may interrupt the sealant retention rates. In this study, we used rubberdam isolation to eliminate the saliva contamination and Er:YAG laser for etching procedure. The complicated study protocol could not be tolarated in the younger age group. Moreover, the caries risk evaluation in terms of dmft value (dmft:4-6) was an inclusion criteria for the study. Therefore, patients with high caries risk aged 7-11 years who could cope with this study protocol were selected for the study.

In vivo and in-vitro studies confirmed that DIAGNOdent pen in noncavitated occlusal lesions indicate that the device can diagnose caries lesions with high sensitivity (21-23). Therefore, the DIAGNOdent pen was used in this study to detect caries at the beginning of the study.

The success of fissure sealants increases with the quality of adhesion between sealant and enamel. The adhesion and retention of sealant are provided mainly from micromechanical interlocking that exists between the resin and enamel (24). The enamel surface is then roughened to increase the surface area for the micromechanical interlocking of the sealant (14).

Lasers have been introduced as an alternative to acid etching for surface preparation for use with fissure sealants (9). There are controversial findings in the literature on the effectiveness of lasers in conditioning the enamel before fissure sealant application. Baygın *et al.* (25) and Shahabi *et al.* (26) reported that laser conditioning may be an alternative to conventional acid etching but does not eliminate the need for acid etching prior to placement of a fissure sealant. According to the results of the present study, the retention rate was 72.7% in Group A, 59.1% in Group L and 65.9% in Group A+L. Our study agrees with Baygın et al.'s and Shahabi et al.'s studies because the highest retention rate was seen in the acid etching group, and the lowest retention rate was observed in the laser group without statistically significant difference. Moreover, when the laser was used in combination with acid etching, the retention rate increased from 59.1% to 65.9%. Contrary to our study, Durmus *et al.* (27) stated that fissure sealants placed with the Er:YAG laser combined with acid etching showed significantly higher retention rates than those placed acid etching alone. The different results might have been due to different laser output characteristics, types of fissure sealant material and experimental designs.
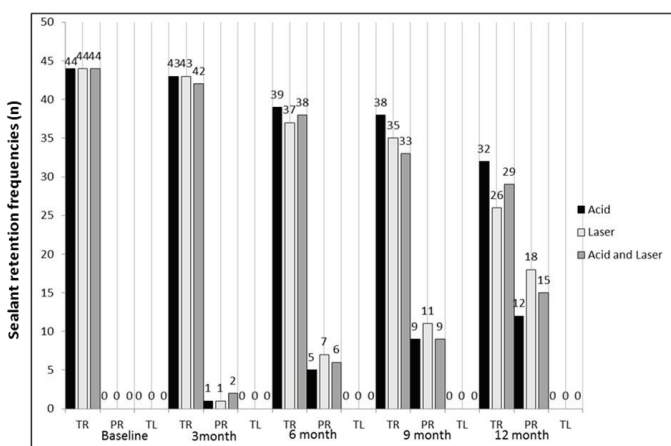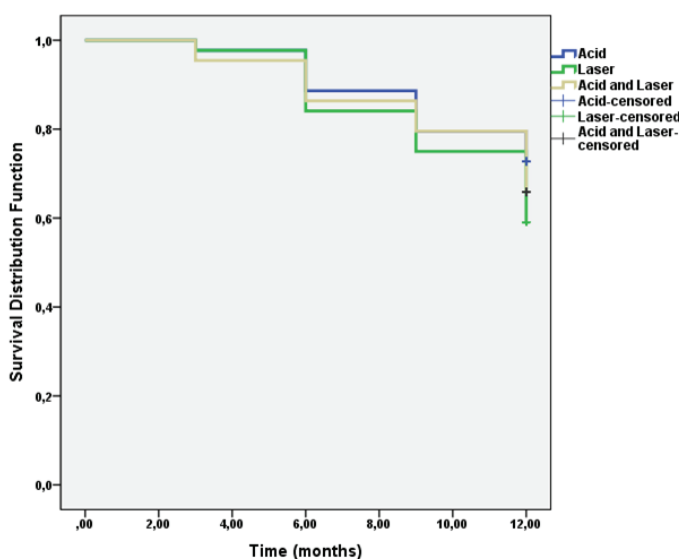
SEM images of the Er:YAG laser-conditioned permanent enamel revealed uneven areas and modified hydroxyapatite crystals. The superficial microroughness of the laser-conditioned enamel is due to the microexplosive ablation process, which characterizes the nonselective thermal effect of the Er:YAG laser (28). The fact that the laser beam is pulsed and does not have a continuous structure creates areas that are not exposed to laser radiation between the pulses. This irregular structure is thought to adversely affect the bond strength of the fissure sealant (29,30). For this reason, etching the surfaces with phosphoric acid after laser applications is recommended for roughening the areas that are not exposed to the laser, thus forming a regular structure (31).

Energy parameters used for laser conditioning (power, pulse velocity, working distance, tip diameter) have a significant effect on bond strength. However, there is no consensus on the optimal laser parameters. In this study, the parameters determined by the laser manufacturer for enamel etching were used (wavelength: 2.94 μm , power: 3.6 W, energy: 180 mJ, frequency: 20 Hz, and pulse time: 50 μs). Üsümez *et al.* (32) evaluated the shear bond strength of orthodontic brackets for conditioning with different energy parameters of an Er, Cr: YSGG laser and 37% orthophosphoric acid. In the study, the bond strength values obtained with 1 W were found to be significantly lower than the values obtained with acid etching. There was no statistically significant difference between the bond strength values obtained with 2 W and those obtained from acid etching.

Prabakar *et al.* (33) placed UltraSeal XT® hydro ™ to fissures of mandibular first permanent molars following acid etching and they stated that the retention rate was 78.3% of The UltraSeal XT® hydro ™ at three months follow-up. In this study, retention rate of the acid etch group was 97.7% at three months follow up.

Laser conditioning techniques have gained popularity in recent years. The laser conditioning process has several advantages, such as being less time consuming, removing debris more effectively, reaching narrow fissures and increasing acid resistance of the enamel (6,25,34). However, the disadvantage of this method is that the type of laser and the energy parameters have not yet been optimized. In addition**,** many commercial resin based fissure sealants are produced for applying on acid-etched enamel surfaces. The development of specific materials for laser-conditioned surfaces may be suitable for increasing the longevity of fissure sealants. The present study found no significant differences between the three enamel conditioning methods. Therefore, the null hypothesis should be accepted.

Conclusion

Etching with the Er:YAG laser, phosphoric acid or a combination of both methods provided similar results on clinical success rate of hydrophilic fissure sealant.

Türkçe Özet: *Er:YAG lazerin hidrofilik esaslı bir fissür örtücünün klinik başarısı üzerine etkisi: Randomize klinik çalışma. Amaç: Bu çalışmanın amacı, Er: YAG lazerin hidrofilik bir fissür örtücünün 12 aylık klinik başarısı üzerine etkisinin değerlendirilmesidir. Gereç ve Yöntem: Bu çalışma 7-11 yaşları arasındaki 44 (19 kız ve 25 erkek) hastanın 132 adet daimi birinci büyük azı dişi üzerinde gerçekleştirilmiştir. Dişler üç gruba ayrılmıştır. Fissür örtücü uygulaması öncesinde, birinci gruptaki dişler (Grup A-kontrol) fosforik asit, ikinci gruptaki dişlere (Grup L) Er: YAG lazer ve üçüncü gruptaki dişlere (Grup A + L) önce Er: YAG lazer daha sonra fosforik asit uygulanmıştır. Klinik değerlendirmeler, başlangıçta, 3, 6, 9 ve 12 aylık periyotlarda yapıldı. Veriler, Pearson ki-kare, Cochran Q testleri ve Kaplan-Meier analizi ile analiz edilmiştir. Bulgular: Oniki aylık takip süresinin sonunda fissür örtücü retensiyon oranları A, L ve A + L gruplarında sırasıyla % 72,7, % 59,1 ve % 65,9 olarak belirlenmiştir. Grupların retansiyon oranları arasında istatistiksel olarak anlamlı bir fark bulunmamasına rağmen (p> 0,05), 12 aylık takip süresi sonunda en düşük retansiyon oranı lazer grubunda bulundu. Çalışma süresince hiçbir dişte yeni çürük gözlenmedi. Sonuç: Er: YAG lazer, fosforik asit veya iki yöntemin kombinasyonu ile pürüzlendirme, hidrofilik esaslı fissür örtücünün klinik başarısı üzerinde benzer sonuçlar sağlamıştır. Anahtar Kelimeler: Pit ve fissür örtücü, UltraSeal XT® hydro™, Er:YAG lazer, Fosforik asit, Koruyucu diş hekimliği*

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