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ORIGINAL RESEARCH ARTICLE

Investigation of Water Absorption and Color Change of Indirect Composite Resins

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Abstract

Purpose: Since conventional composite resins have some disadvantages such as polymerization shrinkage and secondary caries formation, indirect restorations are preferred in cases where tooth tissue loss is high. The aim of this study is to examine the water absorption and color change of indirect composite resins in different beverages.
Materials & Methods: In the study, 40 specimens (10×2 mm) were arranged from each composite using three indirect (Signum Composite, Signum Ceramis and Gradia Plus) and one conventional (GrandioSO) composite resin. After the specimens were polished, they were used for water absorption and color change test. The water absorption test was performed through keeping them in water for 7 days as specified in ISO 4049:2009. Samples were kept in coffee, tea and distilled water for 7 days in order to examine color differences. The water absorption and color change values of the composite resins at the end of the 7th day were appraised using one-way analysis of variance (ANOVA) and Tukey's test ($p<0.05$).
Results: While there was no statistically considerable difference between the water absorption data of the indirect and traditional composite resin materials we used in the study ($p>0.05$). When the color changes of resin-containing composites in water, coffee and tea were examined, traditional composite resin (GrandioSO) showed statistically less color change than indirect composites in water, coffee and tea ($p<0.05$).
Conclusion: Although indirect composite resins showed similar water absorption with conventional composite, they showed more color change than conventional composite. The highest color change in indirect composites was seen in coffee solution. Particle size of the indirect composites do not affect water absorption, but the decrease in particle size of composites shows less color change.

Key words: color stability; indirect composite resins; water absorption

Introduction

In recent years, esthetic restoration applications in the posterior regions have become popular with growing demand for higher esthetics in dental treatments. Numerious materials and techniques have been introduced in this field. Light-cured direct composites are preferred in posterior cases where tissue loss is less.[1] Because they have some disadvantages such as polymerization shrinkage, difficulty in adaptation to cavity walls, microleakage, development of secondary caries, indirect restorations are preferred in cases where excess tissue is lost.[2] Indirect composite and ceramic based materials are used in the production of indirect restorations.[2,3]

The indirect composites were first introduced in 1982[4] and provided the ease of fabrication, better establishment of anatomical form, marginal adaptation, interproximal contact and contour formations and good wear resistance and a reduced polymerization shrinkage compared to direct composites.[5] Besides, indirect composites do not carry the disadvantages of inlay ceramics such as abrasion of opposing teeth, absorption of a small part of the masticatory forces due to their high elasticity modulus,[6] being more fragile and not being able to be repaired safely in the mouth, and also are cheaper than inlay ceramic alternatives.[7]

However the first produced indirect composites displayed low mechanical features because of a low percent of inorganic

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filler particles and a high percent of displayed resin.[8] By 1990s several new indirect composite resins came into the market that including higher percentage of inorganic fillers and exhibited better mechanical properties[9] and since than indirect laboratuary composite systems are continuously featured with newer formulations of resins and fillers and different curing mechanisms.[10] Although many improvements have been made in the composite materials, water sorption and discoloration of the composite resins still appear to be significant problems and are thought to affect the clinic succsess of the dental restorations.[11,12]

Water sorption has some negative effects such as reduction in wear resistance[13,14] and strenght,[15–17] release of monomers which do not react, and hydrolytic breakage of bonds at the resin-filler interface[18] of restorations. It is also accepted that water sorption affects the volume of resin materials by hygroscopic expansion,[19] which can cause microcracks or even cracks in restored teeth.[20]

Color stabilitiy of the composite resins is crucial in determining restoration sucsess.[21] In composite resins, discoloration may result from internal factors like chemical dissociaton of the resin matrix and/or the resin matrix filler and external factors like surface sorption due to colored foods-beverages and/or smoking.[22–24] Although some studies have reported that indirect composite resins show sufficient color stability,[11,25,26] some other studies have reported clinically unacceptable color changes.[27,28]

It can be concluded that there are conflicting results in the literature about discoloration of indirect composites. In addition, although there are several researchs about the water sorption charactersitcs of dental composites, actual number of studies examining these properties of indirect composites and their relationship with discoloration is limited.

Since indirect composites are polymerized in the laboratory environment, it is thought that they will absorb less water and be more resistant to extrinsic stains than conventional composite resins. The aim of this study is to examine the water absorption and discoloration of indirect composites in different solutions.

Materials and Methods

Preparation of samples

Signum Composite (Kulzer, Germany), Signum Ceramis (Kulzer, Germany), Gradia Plus (GC, Japan) indirect composite and GrandioSO (Voco, Germany) conventional composites were used in the study (Table 1). Composite specimens were prepared using a silicone mold with a diameter of 8 mm and a height of 2 mm. A total of 160 samples were prepared, 40 from each composite. Prepared samples were used for water absorption (n=8) and color change (n=8) experiments. In the preparation of the specimens, composite resins were placed in the cavity on the silicone mold with a mouth spatula and a 1 mm glass (coverslip) was placed on the mylar strip. Conventional composite resins were polymerized for 20 seconds using a LED light device (DTE Lux-E, Germany). Labolight DUO (GC, Germany) was used for the polymerization of indirect composite resins and indirect composite resins were polymerized for 3 minutes. The finishing and polishing processes of the composite resin specimens were carried out under water cooling with the diamond finishing and polishing system (Clearfil Twist Dia, Kuraray) at 10,000 rpm for 20 seconds.

Water absorption

Water absorption and solubility values of specimens were determined according to ISO 4049:2009. The arranged specimens were embedded in a desiccator including anhydrous calcium chloride and held on (37 ±1) °C for 22 h and then in a similar desiccator at (23 ±2) °C for 2 h. The specimens taken from the desiccator were weighed (Mettler AT201, Switzerland) until they came to constant weight (M1). After the measurement, the specimens were kept in the incubator (Heraeus D-6450 Hanau) in 10 mL of distille water (Veolia, England) at (37 ±1) °C for 7 days and then they were taken from the water and the moisture on their surfaces was removed with blotter paper and they were weighed again (M2).

The weighed specimens were embedded in a desiccator containing anhydrous calcium chloride and at (37 ±1) °C for 22 h, then in the desiccator at (23 ±2) °C for 2 h. The specimens taken from the desiccator were weighted (within 15 sec) with Mettler AT201, Switzerland (M3).

Water absorption = M2 - M3 / V

- M2 = Weight of specimens weighed after placing in water (µg/mm3)
- M3 = Weight of specimens weighed after drying (µg/mm3)
- V = Volume of specimens (mm3)

Color change

After finishing and polishing processes, composite specimens which would be used for color change were kept in incubator (FN 500, Nüve, Turkey) for 24 h in distilled water at 37°C. After the composite specimens were immersed in distilled water for 24 h, the initial color of the specimens belonging to each group was measured using a spectrophotometer device (Vita Easyshade; VITA Zahnfabrik, Germany). After determining the initial color of the specimens, they were kept in coffee (Nescafe Classic, Turkey) in the incubator (FN 500, Nüve, Turkey) for 7 days at 37°C. Color measurements of the specimens at the end of 7 days were made and L*, a* and b* values were recorded. The coffee solution was prepared by dissolving 2 g of coffee powder in 200 ml of boiled distilled water. Tea solution (Lipton, Turkey) was prepared by dissolving 20 g pack in 200 ml of boiled distilled water. Distilled water was used as the control group. The prepared coffee and tea solution added onto the specimens at 37 °C. It was also replaced with a new coffee solution every 24 h. In the calculation of color changes in composites, the formula (ΔE_{00}) in the formula CIEDE2000 was used over the parameters L*, a* and b*.

$$\Delta E_{00} = \sqrt{\left(\frac{\Delta L'}{K_L S_L}\right)^2 + \left(\frac{\Delta C'}{K_C S_C}\right)^2 + \left(\frac{\Delta H'}{K_H S_H}\right)^2 + R_T \left(\frac{\Delta C'}{K_C S_C}\right)\left(\frac{\Delta H'}{K_H S_H}\right)} \quad (1)$$

Statistical analysis

Statistical analysis was realized using SPSS 22.0 Statistical Program (SPSS Inc., Chicago, IL, USA). The water absorption and color change values of the composite resins at the end of the 7th day were evaluated using (ANOVA) and Tukey's test. The statistical significance level was considered as $p<0.05$.

Results

As a result of this study in which was examining the water absorption and color change of resin-containing restorative materials, there was no statistically remarkable difference

Table 1. Restorative materials containing resin used in the study

Composites	Type	Matrix type	Filler type	Filler ratio	Particle size	Lot number
Signum composite (Kulzer, Germany)	Indirect Composite	TEGDMA, dodecan-di-oldimethacry-late	Prepolimers	%74	1µm (micro size)	K010520
Signum ceramis (Kulzer, Germany)	Indirect Composite	BAGDE-DA TEGDMA	Dental glass	%73	0.6-1µm (micro size)	K010304
Gradia Plus (GC Europe, Germany)	Indirect Composite	UDMA,EDMA	-	%71	300 nm (ultrafine)	190917A
GrandioSO (Voco, Germany)	Conventional Composite	TEGDMA, Bis-GMA, Bis-EMA	Baryum glass	%89	1 µm and 20-40 nm	2005147

Table 2. Examination of water absorption and color change (ΔE_{00}) of resin-containing restorative materials at the end of the 7th day

Composites	Water Absorption	Color Change Water	Color Change Coffee	Color Change Tea
Signum ceramis	4.38±1.6	1.41±0.4[a]	8.98±1.6[a]	3.92±0.7[a]
Signum composite	4.48±1.4	1.66±0.2[a]	11.20±1.6[b]	5.24±0.9[b]
Gradia Plus	3.88±1.7	1.47±0.4[a]	7.17±1.2[a]	3.16±0.9[a]
GrandioSO	4.08±1.2	0,94±0.3[b]	3.46±1.1[c]	2.11±0.5[c]
p	0.804	0.001	0.000	0.000

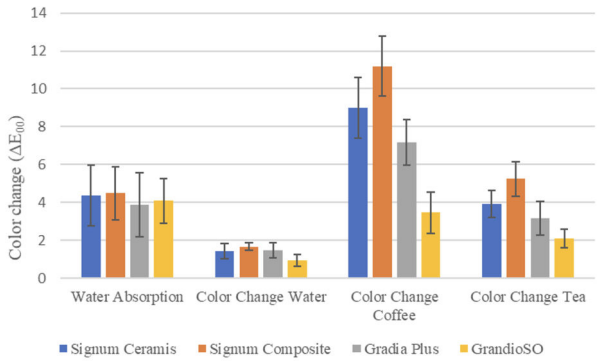

Figure 1. Examination of color change (ΔE_{00}) of resin-containing restorative materials at the end of the 7th day

between the water absorption data of the materials ($p>0.05$), while there was a statistically remarkable difference between the color changes ($p<0.05$) (Figure 1).

Among indirect composite resins, the indirect composite Gradia Plus was the lowest in water absorption, while the indirect composite Signum composite was highest. Although traditional composite resin (GrandioSo) showed less water absorption than indirect composite resins (Signum Ceramis and Signum Composite), it showed more water absorption than the other indirect composite resin Gradia Plus.

When the color changes of resin-containing materials in water, coffee and tea were examined, conventional composite resin (GrandioSO) showed statistically less color change than indirect composites ($p<0.05$). No statistically remarkable difference was found between the color changes of indirect composite resins in water ($p>0.05$). While indirect composite (Signum Composite) with composite content showed the highest color change in tea and coffee, no statistically remarkable color difference was observed among other indirect composites (Gradia Plus and Signum Ceramis) (Table 2).

Discussion

Indirect composite resins are shown as an alternative to direct composite resin and ceramic inlays in restorations of posterior teeth. Although it is suggested that they have superior physical and mechanical properties compared to composite resins, [28,29] studies have reported that these materials also have water absorption properties and can change color. [27,28]

The standard limit for water absorption of restorative materials is reported as 40 µg/mm3.. [11] It was determined that the water absorption values of all resin materials evaluated in this study after 1 week of water storage ranged from 3.88 to 4.48 µg/mm3 and were below this limit. Water absorption into the polymeric material is a phenomenon controlled by diffusion and is explained by two different theories. The first of these is the free volume theory and expresses the solvent absorption through the gaps in the polymer. [30]

The high level of polymerization of the composite resin reduces the number of unreacted carbon-carbon double bonds, resulting in less water absorption of the material. It is suggested that polymerization will be at a higher rate in indirect composites. [9] However, there was no statistical difference in water absorption between indirect and direct composites examined in this study. When indirect composites are compared with direct composites, it was reported that indirect composites show higher water absorption. [10] However, the water absorption values determined by the researcher at the end of 1 week range between 13.83 and 24.06 and are above the values of this study. It was stated that water absorption is a weak predictor in showing the degree of conversion. [31] Therefore, it is suggested that the second theory in water absorption, the interaction theory, is of greater importance. [32] According to this, water is bounded to some ionic groups in the polymer structure, depending on the affinity of these groups to water (whether they are hydrophilic or hydrophobic). [33] Bisphenol A glycidyl methacrylate (Bis-GMA), urethane dimethacrylate (UDMA), and triethylene glycol dimethacrylate (TEGDMA) methacrylic monomers are the main components of resin-based filler materials and water absorption from highest to lowest is ordered as TEGDMA> Bis-GMA > UDMA> Bis-EMA. [34]

In this study, the indirect composite Gradia Plus showed the lowest water absorption. This composite resin is the only material with UDMA among all the materials evaluated in this study, and the fact that UDMA is a hydrophobic monomer may have played a role in the lower water absorption of Gradia Plus. When the water absorption of different composite resins was evaluated, the lower water absorption of Durafill resin attributed to its content of UDMA monomer.[35] On the other hand, the direct composite GrandioSO was the second least water absorbent resin material, and it is thought that containing the most hydrophobic monomer Bis-EMA may have been effective in this result. Signum composite, on the other hand, contained TEGDMA, which showed the highest water absorption. However, TEGDMA is also one of the monomers in the structure of GrandioSO and Signum Ceramis and it should be taken into account that other factors may also be effective in explaining the slightly high-water absorption of the Signum composite.

Studies show that there is a negative correlation between the water absorption of composite resins and the amount of filler.[11,36] As the weight % of the fillers increases, water absorption decreases together with the polymeric matrix.[36] GrandioSO, the only direct a larger surface area composite in this study, has a very high filler rate of 89%, and this filler ratio may be one of the important reasons why there is no statistical difference between it and indirect composites in terms of water absorption.

Particle amount as well as the particle size is reported to play an important role in a larger surface area water absorption.[37] Micro filler particles with larger surface areas have higher rates of water absorption. While particle sizes of Signum ceramics and Signum composites vary between 0.6-1 µ, Gradia Plus's ultrafine particles with the size of 300 nm may be another factor that played a role in lower water absorption compared to these two materials.

One of the most significant esthetic characteristics in dentistry is color, and the discoloration of restorative materials is one of the main causes for restoration renewal. In this work, the color changes in composites were calculated using the CIEDE2000 formula (ΔE_{00}). Color is one of the most important esthetic parameters in dentistry and the coloring of restorative materials is one of the most important reasons for restoration renewal. In this study, the formula (ΔE00) in the CIEDE2000 formula was used to calculate the color changes in composites. In studies examining the color stability of resin composites, it is seen that the CIELab difference formula is mostly used, and the number of studies done with the CIEDE2000 formula is more limited. In addition, it is seen that there have been some changes in the perceptibility and acceptability thresholds of both CIEDE2000 and CIELab formulas over the years. It was reported that perceptible match values for[38] ΔE values were 3.3, and many studies were evaluated the clinical suitability of the examined materials based on these values. Again, for ΔE_{00}, the acceptable match value is reported as 2.25. However, in another study[39] ΔE_{00} acceptable match values were determined as $0.8 \leq 1.8$ and values between $1.8 \leq 3.6$ were expressed as moderately unacceptable, $3.6 \leq 5.4$ as clearly unacceptable, and values above 5.4 as extremely unacceptable. According to this more current value, it was determined that the in-water color changes (0.94-1.66) of all resin-containing materials included in this study was in the acceptable match range at the end of 1 week. However, as a result of immersion periods of 1 week in both tea and coffee, all resin-containing materials failed to stay below acceptable limits. Despite the fact that much longer waiting times were applied in colorant solutions, in this study, it was found that acceptable values were exceeded even within a week. These values are compatible with the color change values determined in a study examining[40] the color changes of indirect lab and CAD-CAM composites at the end of 1 week. Also, the color stability of some indirect composites by thermal cycle was evaluated and stated that the obtained color change values above clinically acceptable values were found in all composite resins.[41]

In this study, direct composite resin (GrandioSO) showed statistically less color change than indirect composites. These results were surprising as indirect composites were generally thought to have better color stability due to their higher conversion degree. Also, no difference was reported between the color stability of indirect and direct composites.[26] These results suggest that other factors such as filler types, matrix types, filler ratios, particle size of composites may have a more in study evaluating the color stability and surface roughness of indirect composites that the composite resin with the lowest filler showed the highest color change. GrandioSO had the highest filler content among the materials tested, and this rate of filler may be one of the important factors in the low color change.

On the other hand, it is seen that the indirect composites in this study have close filler ratios. However, Signum Composite showed statistically significantly higher color change in tea and coffee than other indirect composites. Signum composite was also the resin that showed the highest water absorption in this study, this result can be considered consistent with studies reporting a significant relationship between water absorption and ΔE.[42] In addition, the fact that the color change of this composite in water is not different from other indirect composites suggests that it is more affected by the structure of tea and coffee. Tea has a rich structure of tannin and tannin has a property that increases the ability of chromogens to adhere to the surface of materials. Coffee contains high amounts of chromogen. Both of beverages that contain color pigment causes discoloration on the surface of the materials. Fillers of Signum Composite are composed of prepolymerized composites, while fillers (dental glass) of Signum Ceramis may be more resistant to color pigments.

Conclusion

Although indirect composite resins showed similar water absorption with conventional composite after 7 days, they showed more color change than conventional composite. The most color change in indirect composites was seen in coffee. Therefore, it will be useful to evaluate the color change of indirect composite resins with clinical studies.

Author Contributions

N.I., B.E. and N.A. participated in designing the study. S.K. and N.A. participated in generating the data for the study. N.I., N.A. and B.E. participated in gathering the data for the study. N.A. participated in the analysis of the data. N.I. and B.E. wrote the majority of the original draft of the paper. N.I., S.K., N.A. and E.A.O. participated in writing the paper.

Conflict of Interest

The authors declare no competing interests.

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ORIGINAL RESEARCH ARTICLE

The Internal and Marginal Adaptation of Zirconia Based Fixed Dental Prostheses in the Posterior Region

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Abstract

Purpose: Long-term clinical success is closely related to the internal and marginal adaptation of the restorations. The purpose of this study was to evaluate the internal adaptation of zirconia-based fixed dental prostheses in the posterior region.
Materials & Methods: Four-unit porcelain-fused to zirconia fixed dental prostheses were fabricated with CAD-CAM system in 20 patients. For the evaluation of the restorations' internal fit, conventional silicone replicas were used with the optical microscope. The obtained silicone impression was cut to obtain two cross-sections from buccolingual and 3 from mesiodistal. Fifty different measurements were taken from every tooth by taking 10 from each cross- section; 2 from the margin, 6 from the axial surfaces and 2 from the occlusal by the optical microscope.
Results: There were statistically significant differences in internal discrepancy in terms of area and tooth type. The average internal discrepancy on the axial surfaces of the molars was 142.39±47.42µm. In premolars, the mean was 139.53±46.80µm. The average of the internal discrepancy values obtained from occlusal surfaces of the molar teeth was 164.39±53.61µm, whereas the same average for the premolar teeth was 161.92±60.54µm.
Conclusion: Within the limitations of this study, restorations fabricated by CAD/CAM and internal and marginal discrepancies were at clinically acceptable intervals.

Key words: CAD/CAM; internal discrepancy; marginal discrepancy

Introduction

Development of computer-aided design (CAD)/computer-aided manufacturing (CAM) technology, various dental restorations are beginning to be formulated digitally. The presence of technicians continues in CAD/CAM technology, is preferred to process different porcelains on a substructure to obtain more esthetic results.[1]

Cement dissolution is one of the most critical factors causing secondary caries. The sensitivity of the restorations at the laboratory stage affects the cement thickness due to its internal and marginal fit.[2,3] The success of all restoration types used in dentistry is highly related to the marginal fit of the restorations, and it has been reported that a 50-200 µm marginal gap is clinically acceptable.[2-9]

The factors affecting the internal and marginal adaptations indicate that fit of the selected restoration with the tooth structure and wear resistance is effective.[10] Another factor is the location of the teeth, which determines the tooth preparation. It has been reported that restorations in the mandibular posterior region require more tooth preparation. Although it is recommended to provide at least 2-6 degrees of taper, it has been stated that the desired durability is maintained at 6-12 degrees.[11-14] Depending on the impression material and the precision of the impression technique, better fit will be achieved in restorations based on obtained models.[15] In CAD/CAM systems, however, a higher number of measured points which are transferred to the system, will result in a more precise restoration plan.[16]

Various techniques have been used to determine marginal and internal gaps as follows; direct view, cross-sectional technique after cementation and embedding, impression technique, weighing the light-body additional silicone, and explorer com-

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Figure 1. Silicone model which were obtained before cementation

bined with visual examination. Marginal discrepancies can be detected on the model by microscopic examination. Another method is to section the samples after cementation and examine their inner surfaces under a microscope or micro-CT can be used as a non-sectional method.[1,8,17–19]

The purpose of this study was to determine the internal and marginal gaps of 4-unit zirconia-based fixed partial dentures that were applied to the posterior region by using an impression technique (replica method) and non-invasive method. The null hypothesis of the study was that the internal and marginal gaps would be within clinical limits in both teeth type, and also gaps in the margin, axial and occlusion would be similar.

Materials and Methods

This study was conducted upon the approval of the Marmara University Health Science Department Ethics Board under protocol number MAR-YÇ-2005-0082. Tooth preparations involved chamfer finish lines. The restoration process included impression taking, coping design by dental technician, coping fabrication with CAD/CAM technology, and porcelain layering by dental technician. Four-unit zirconia-based fixed partial dentures (CERCON Smart, DeguDent GmbH, Germany) were fabricated. To determine the marginal and internal fit of the mentioned fixed partial dentures, impression were taken from the inner surfaces of the restorations, and the cement gaps were identified under an optical microscope. To check the internal discrepancy of the zirconia-based fixed partial dentures, all extraneous material of the temporary fixed partial dentures were removed before the cementation stage. The surfaces of the teeth were cleaned by brushs. An addition-type thin consistency silicone material (Affinis, Coltène, Switzerland) was applied on the prepared teeth. After the restorations were placed over the teeth, the patient was asked to bite. After the impression material had set,[2,8,9] the restoration was removed. An addition-type medium-consistency silicone impression material (Affinis, Coltène, Switzerland) was applied to internal surface of the restoration over the thin-consistency impression material left inside the restoration to support the thinner layer. After the medium-consistency silicone material was set, an addition-type thick-consistency silicone (Affinis, Coltène, Switzerland) was applied in order to help remove the replica from the restoration in one piece (Figure 1).

The set silicone impression was crosscut to obtain two buccolingual and three mesiodistal cross-sections (Figure 2). Fifty different cement thickness measurements were taken from each tooth by taking 10 measurements from each cross-section; 2 from the margin, 6 from the axial surface and 2 from the

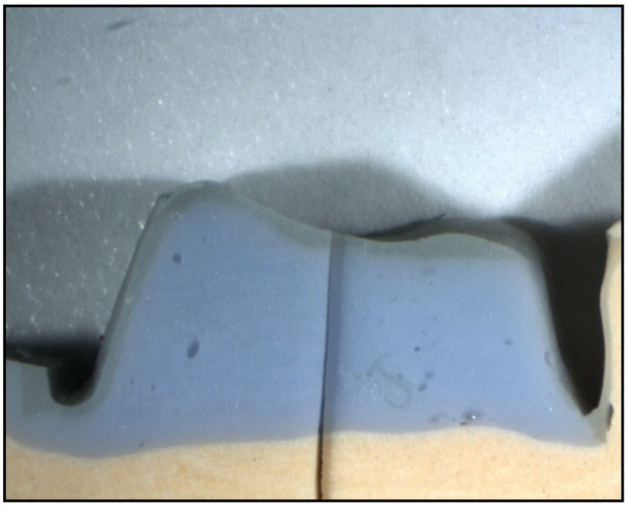

Figure 2. Internal measurements were shown in details, **a:** margin, **b:** axial, **c:** occlusion

occlusal surface with an optical microscope with a 3.2x optical scanner, 48x microscopic magnification, and 102.81x screen magnification. Average occlusal, proximal, and marginal adaptation values were obtained by calculating the mean of the three times measurements in the internal silicone replicas.

Statistical Analyses

For evaluating the findings obtained during the study, a commercially available software (IBM SPSS Statistics 22 IBM, Turkey) was used for statistical analyses. Data was tested for normality using Kolmogorov-Smirnov (Shapiro Wilks) test, and was found to be normally distributed. Two-way ANOVA was used to identify the effect of the marginal gap and the tooth type (α=0.05). One-way ANOVA (post hoc Tamhane's T2 test) and Student t test were used as attendance tests. Significance was evaluated at the α=0.05 level.

Results

There was a significant difference between the tooth type and internal adaptation (p=0.003; p<0.05). There was not a significant difference between the location of the gaps and the internal adaptation (p=0.113; p>0.05). There was a significant difference between the tooth type and gap regions (p=0.000; p<0.05). Teeth type and gap regions had an effect on the internal adaptation values (Table 1).

Internal adaptations of the molar teeth were larger than premolar teeth and were statistically significantly higher than the premolar teeth (p=0.010; p<0.05) (Table 2). There was not a statistically significant difference between the axial gaps of the molar and premolar teeth (p=0.198; p>0.05). There was a statistically significant difference between the occlusal gaps of the molar and premolar teeth (p=0.000; p<0.05). There was a statistically significant difference between the marginal gaps of the molar and premolar teeth (p=0.000; p<0.05). Marginal gaps of the premolar teeth were larger than the marginal gaps of the molar teeth. There was a statistically significant difference between the gap regions and the molar teeth (p=0.000; p<0.05). Post hoc Tamhane's T2 test indicated that occlusal gaps were larger than the axial and the marginal gaps (p1=0.000; p2=0.000; p<0.05). Axial gaps were significantly larger than the marginal gaps (p1=0.000; p<0.05). There was a statistically significant difference between the gap regions

Table 1. Internal adaptation of tooth type and gap regions by 2-Way ANOVA test.

Source	Type III Sum of Squares	df	Mean Square	F	P
Tooth type	21511.76	1	21511.76	9.123	0.003*
Gap regions	10284.99	2	5142.492	2.181	0.113
Tooth * Gap regions	687778	2	343889	145.839	0.000*

*p<0.05

Table 2. Mean internal gap widths according to tooth type and region

		Internal Adaptation		
		n	Mean±SD	p
Tooth type	Molar	1500	[x]142.70±50.59	[1]0.010*
	Premolar	1500	[y]137.90±51.15	
Region	Axial	1800	[a]140.97±47.12	[2]0.138
	Occlusion	600	[a]136.67±54.05	
	Margin	600	[a]141.92±58.07	

[1]Student t test [2]Oneway ANOVA Test *p<0.05
[x-y] show the differences between the molar and premolar
[a] show the both teeth's measurements.

Table 3. Mean gap widths according to the region in tooth

	Tooth Type				
	Molar		Premolar		
Gap region	n	Mean±SD	n	Mean±SD	[1]p
Axial	900	[ax]142.40±47.43	900	[ax]139.54±46.8	0.198
Occlusion	300	[bx]164.39±53.62	300	[by]108.94±37.89	0.000*
Margin	300	[cx]121.91±47.81	300	[cy]161.93±60.55	0.000*
[2]p		0.000*		0.000*	

[1]Student t test [2]Oneway ANOVA Test *p<0.05
[a,b,c] show the region differences
[x-y] show the differences of the tooth type

and the premolar teeth (p=0.000; p<0.05). Post hoc Tamhane's T2 test indicated that marginal gaps were larger than the axial and the occlusal gaps (p1=0.000; p2=0.000; p<0.05). Axial gaps were significantly larger than the occlusal gaps (p1=0.000; p<0.05) (Table 3).

Discussion

The null hypothesis of the study was the internal and marginal gap would be within clinical limits was accepted but the other null hypothesis about the gaps in the margin, axial and occlusion would be similar was rejected. It has been reported that the involvement of multiple steps and technique sensitivity of laboratory procedures can affect marginal adaptation and internal fit, which is clinically essential for the longevity of a restoration.[8,18] In this study, impression technique (replica method) was used for evaluating marginal and internal fit, which is considered a reliable and non-invasive method for measuring fit of the restoration. In this technique, the cement is replaced with the impression material, and the restoration is placed on the abutment tooth. The restoration and impression material are separated from the abutment, and the thickness of the cement layer analogue is measured. However, the impression replica technique has certain limitations such as tearing of the elastomeric film upon removal from the crown and errors in sectioning which would eventually lead to overestimated measurements. Too much marginal gap could lead to increased cement thickness, secondary caries risk, and pulpal irritation.[20,21] On the other hand, incorrect fit of the internal adaptation may cause axial walls and occlusal surfaces to not be in ideal contact with the restoration, thereby reducing the retention and leading to restoration farcture.[22]22 Before the cementation of the restorations in our study, we identified internal and marginal discrepancies with the help of measurements on sectioned silicone . The number of measurements made in the internal adaptation studies were significant. Only accurate number of the section could inform on the internal structure of the entire restoration be obtained. Therefore, the number of sections should be increased as much as possible.[23] In our study, we took a total of 50 measurements from each tooth.

It is possible to perform standard crosscuts for internal fit evaluations and be ensured that the operator can observe every surface in the best way when cutting in vitro; whereas it is not possible to achieve outcome in vivo.[1] It has been reported that 50-200 µm marginal gap width is clinically acceptable.[2,3,5-9] When the total internal fit was examined in our study, an average of 139.16 ±49.01 µm was found, which was within the clinically acceptable range.

In a study using a different CAD/CAM system, it was observed that gap width was increased from the marginal edge to the occlusal surface.[19,22,24,25] It was reported that abovementioned result was due to the intraoral scanner being unable to detect some curved surfaces because of the length of the scanner tip's diameter. In our study, the highest internal discrepancy values (164.39 ±53.62 µm) were measured on the molar occlusal surface, and the lowest values (108.94 ±37.89 µm) were measured on the premolar occlusal surface. Inclined surfaces on the molar teeth occlusions were affected the abil-

ity of the scanner to scan the crown or fixed partial dentures perfectly in the CAD/CAM.

If the scanner is able to detect the surfaces clearly, gaps would be lower than 100 µm.[5,26] Boening et al. reported an average marginal gap width of 80-95 µm in anterior teeth and 90-145 µm in posterior teeth. It has been stated that the Procera AllCeram system showed clinically acceptable values.[2] In our study, when the molar teeth and premolar teeth were compared, the sum of the internal discrepancy values for premolar teeth was 137.90 ±51.15 µm, whereas it was 142.70±50.59 µm for molar teeth. It could be said that the internal discrepancy of the molar teeth was higher since the preparation of the molar teeth is more complicated than that of the premolar teeth; in particular, the distal part was not clear, and the marginal region was harder to scan.

In the study by de Paula Silveira et al.[4] the mean axial integrity value was 138 µm in different restorations, and a similar result was reported by Tabata et al.[1] In our study, the mean axial integrity value was 140.97±47,12 µm in ceramics, similar to the Paula Silveira et al and Tabata et al results. Tabata et al. also reported that ceramic restorations have a maximum integrity of 232 ±29 µm, and in this study, the occlusal integrity was 164,39±53,62 µm, which was the largest of all gaps.

Conclusion

As a result of the internal adaptation evaluation of zirconia-based fixed partial dentures, the broadest gap was measured in the occlusal surface and the narrowest was measured in the margins. When the abutment teeth were examined, internal and marginal discrepancies were found in the molar teeth compared to the premolar teeth. Internal and marginal discrepancies in zirconia-based fixed partial dentures prepared by CAD/CAM technology were acceptable for clinical service.

Author Contributions

Research concept and design: A.K.B, A.S. Collection and/or assembly of data: A.K.B. Data analysis and interpretation: A.K.B, A.S. Writing the article: A.K.B, A.S. Critical revision of the article: A.K.B. Final approval of article: A.K.B.

Conflict of Interest

Authors declare that have no conflict of interests.

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ORIGINAL RESEARCH ARTICLE

Evaluation of Undergraduate Dental Students' Perspective on Distance Education Model in the Coronavirus (Covid-19) Pandemia

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Abstract

Purpose: The aim of this study is to question and evaluate the perceptions of 3rd, 4th and 5th year undergraduate dental students towards distance education practices and the roles of faculty members in the implementation of education during the Covid-19 pandemic.
Materials & Methods: An online survey was applied to 149 volunteers, consisting of 3rd, 4th and 5th year undergraduate dental students. The survey composed of 12 questions about distance education and shared from "Google Forms" application. Data analysis was done with SPSS 22.0 Packet Data Program.
Results: One hundred forty-nine undergraduate dental students, including 54 third-year students, 60 fourth-year students and 35 fifth-year students, answered the survey on a voluntary basis. Upon this, each answer was examined separately, and efforts were made to reach conclusions about the distance education model. When results were evaluated, the majority of the students (40.9%) who participated in the survey reported that the distance education model contributed to the theoretical lessons, when adequacy of the practical training was assessed, it was concluded that distance education was "Absolutely Inadequate" at with a 79.9 percentage
Conclusion: As a result of the study, most of the students found the distance education model sufficient for theoretical courses, but insufficient for practical education and found traditional practical education more advantageous.

Key words: covid-19; dentistry; distance education.

Introduction

COVID-19 infection (SARS-CoV-2) emerged as a new type of acute respiratory disease in China in December 2019 and spread all over the World.[1] The new coronavirus outbreak was declared as an "International Public Health Emergency"[2], which is the highest alert level of World Health Organization (WHO), and as pandemic on March 11.

Turkey is included in many countries that began to take extraordinary preventions and restriction applications with the declared pandemic. In addition to all economic, social and travel restrictions, certain preventions have been taken in the field of active education and training due to the pandemic. To prevent the spread of the pandemic by breaking the chain of transmission of the Covid-19, as in many countries, in Turkey, it was decided to temporarily shut down educational institutions starting from 25 March. For the education and training activities to continue in Turkey, the Council of Higher Education took quick action and decided to switch to distance education for the 2020 spring term. With the start of distance education applications in many countries around the world, the definition of education has started to be discussed again, and the needs of the current generation to measure and evaluate the gains from these distance education applications have come to the fore. The definition of distance education, according to the United States Distance Education Association (USDLA), is the delivery of education to distant students with the help of electronic devices such as satellite, video, sound graphics, computers and multimedia technology.[3] In distance education practices, since the educator and the student are geographically distant from each other, electronic tools or written materials and printed materials should be used in the education program. Therefore, with distance education, many factors such as buildings, classrooms, teachers, and educational materials that limit student capacity can be prevented.[4] Many universities in Turkey with various associate degree, undergraduate,

graduate, and certificate programs have been implementing distance education for many years. The rapid transition to distance education in all educational institutions due to the pandemic has shown that there are some inadequacies of online education. Furthermore, it has been observed that not only text-based contents (electronic book, lecture notes, etc.), but also content that can attract students' attention visually and aurally (video, sound, animation, simulation, etc.) should be developed.

Dentistry education generally consists of three parts, these are theoretical courses, simulation laboratory courses, and clinical skills training.[5] It is easier to teach theoretical courses online, and activities can be carried out within the scope of distance education with applications such as internet-based communication, video conference applications, and educational blogs.[6] The second part, preclinical laboratory practices, is a simulation laboratory training where the student practices on models after a demo application traditionally performed by instructors. In this section, where student work should be controlled step by step by the instructors, there has been a rapid transition to online education without the necessary infrastructure due to the pandemic. Third and most importantly, clinical skills training is the most risky training in terms of COVID-19 transmission, where the undergraduate dental student is in close contact with the patient and the trainer5, as the virus can be transmitted directly through coughing, sneezing and droplets, or indirectly through oral, nasal and eye mucosa contact.[7,8] Therefore, internship training has been postponed until a later date.

With the integration of distance education into dental education, various methods have begun to be applied in faculties. These applications are mostly online interview applications and theoretical lectures, demo videos of practical applications, and various homework-forum applications.

To determine the quality, contributions, and limitations of this education, students' opinions and ideas are very important in addition to the theoretical exams and homework given to students remotely. With the feedback received from students, the quality of distance education, which is thought to continue, can be increased and a distance education model can be developed with more qualified applications. In this context, the perceptions of undergraduate dental students towards distance education practices and the roles of faculty members in the implementation of education were questioned through a survey, and it was aimed to make new suggestions and improvements for dentistry education.

Materials and Methods

This research, was conducted with the approval of the Non-Interventional Clinical Research Ethics Committee (2020/24 decision number) which was planned as a survey study, was carried out with the voluntary participation of students from the Faculty of Dentistry at XXX University. Since they received both theoretical and practical education within the distance education program, the survey was applied to the 3rd, 4th and 5th year undergraduate dental students. Before the survey, students were informed about the survey, and a voluntary basis was sought.

Survey Design

In this survey prepared by considering the literature9, in the first part, the period of students (3rd, 4th or 5th grade) is questioned, while in the second part, there is a section consisting of twelve questions about distance education (Figure 1). The entire survey application was prepared using the "Google Forms" application, and students who volunteered to participate in the study were reached by sharing the survey link. The survey link remained active for 2 months and volunteer students were asked to respond in a timely manner. In the second part, the participants were asked about the contribution of distance education to students' theoretical and practical knowledge, the adequacy of the faculty in terms of theoretical and practical courses in the distance education model, and the technical problems experienced. In addition, students were asked to compare the advantages of distance education and face-to-face education in the process of participating in distance education and participating in exams. In the questions consisting of six answer options, the first five options contain graded answers to the question asked (I strongly disagree, I disagree, I am not sure, I strongly agree, I agree), while the last option was prepared as a suggestion option that enables the participants to state their suggestions.

Statistical Analysis

A data set was created in line with the answers given by the survey participants, and frequencies were measured on the data set. SPSS 22.0 Software Package Program (SPSS 22.0 Software Package Program, Inc. Chicago, IL, USA) was used as statistical software in the study.

Results

In our faculty, which has 108 students in the 3rd grade, 85 students in the 4th grade and 73 students in the 5th grade, students were asked to participate on a voluntary basis. One hundred forty-nine students, including 54 from 3rd grade, 60 from 4th grade and 35 from 5th grade students, answered the survey voluntarily. According to the answers, it was tried to determine students' perspectives on distance education.

When the answers to the first question (Table 1) "Do you think the distance education model is sufficient for theoretical courses" are examined, it is understood that the majority of the total answers given by the students are "Sufficient" with 40.9% (n=61), and then "I am not sure" with 30.9% (n=46). The answer "Absolutely Unsufficient" was preferred by 5 of the total participating students (3.4%).

None of the students in all classes answered "Absolutely Sufficient" to question 2 (Table 1) "Do you think the distance education model is sufficient for practical lessons?" 3rd and 4th-grade students did not prefer the answer "Sufficient" at all, but one of the 5th-grade students answered "Sufficient". 79.9% (n=119) of the students in all class categories and total think that the distance education model for practical lessons was definitely insufficient.

In Table 2-question 3 "Considering the theoretical courses, do you agree that faculty members are sufficient during distance education?", 50.3% (n=75) of the students participating in the survey agree that the faculty members are sufficient in distance education. In the second place, it is seen that the students are mostly undecided with 30.9% (n=46). Also, 4 students expressed their opinions with the answer "Other". Some of the student defined their views as "I agree for some teachers", "It depends on the teacher" and "Our teachers are doing their best, but according to the face-to-face training, the efficiency is definitely decreasing".

When question 4 (Table 2) "Considering the practical lessons, do you agree that the faculty members are sufficient during the distance education?" is examined, students largely disagree that the faculty members are sufficient in practical

1. Do you think the distance education model is sufficient for theoretical courses?

A) Absolutely sufficient B) Sufficient C) Not sure D) Insufficient E) Definitely insufficient

2. Do you think the distance education model is sufficient for practical lessons?

A) Absolutely sufficient B) Sufficient C) Not sure D) Insufficient E) Definitely insufficient

3. Considering the theoretical courses, do you agree that faculty members are sufficient during distance education?

A) I strongly agree B) I agree C) Not sure D) I disagree E) Definitely disagree F) Other

4. Considering the practical lessons, do you agree that the faculty members are sufficient during the distance education?

A) I strongly agree B) I agree C) Not sure D) Disagree E) Definitely disagree F) Other

5. Do you think you have technical difficulties in accessing lessons and exams during the distance education process?

A) Very frequently B) Usually C) Time to time D) Rarely E) Never

6. When you compare it with formal education, do you think you can achieve good and sufficient concentration in the distance education model?

A) Absolutely sufficient B) Sufficient C) Not sure D) Insufficient E) Definitely insufficient

7. Do you think you can participate in the lessons adequately in the distance education model process?

A) Absolutely sufficient B) Sufficient C) Not sure D) Insufficient E) Definitely insufficient F) Other

8. Do you think that the understanding of distance education is more advantageous than formal education?

A) Absolutely advantageous B) Advantageous C) Not sure D) Disadvantageous E) Definitely disadvantageous F) Other

9. Does the disruption of practical applications in the distance education model cause you to worry about professional competence in the future?

A) Absolutely concerned B) Usually worried C) Not sure D) Sometimes worried E) No concerns

10. Do you think the distance education model should be made continuous?

A) Must be for some theoretical courses B) Must be for practical courses C)Practical lessons face-to-face, theoretical lessons should be distance

D) Must be fully face-to-face education E) Must be totally distance education F) Other

11. Do you think remote exams contribute to learning and evaluation?

A) Absolutely contributed B) Contributed usually C) Not sure D) No contribution E) Definitely no contribution F) Other

12. Do you think online lessons are more efficient than face-to-face lessons?

A) Absolutely more efficient B) I can get efficiency C) Not sure D) I can't take efficiency

E) I can't take any efficiency F) Other

Figure 1. Survey questions and design

lessons (32.9%, n=49). Some students who chose other option answered "I cannot answer because there is no internship." and "It may not be the right approach to decide whether the lecturers will be sufficient or not, as practical lessons cannot be done."

When authors examine Table 3-5th question “Do you think you have technical difficulties in accessing lessons and exams during the distance education process?”, we see that the majority of students (51.0%, n=76) occasionally experience technical problems in accessing distance education. On the other hand, it is seen that only 9 (6.0%) students did not experience any technical problems.

In the analysis of the 6th question “When you compare it with formal education, do you think you can achieve good and sufficient concentration in the distance education model? ” (Table 4), the majority of the students stated that they could provide better and sufficient concentration in traditional education than distance education. Against this, 40 (26.8%) participants were undecided.

When question 7 (Table 4) “Do you think you can participate in the lessons adequately in the distance education model process?” is examined, it is seen that 65 of the students (43.6%) can provide sufficient participation in distance education. It is observed that 24 students (16.1%) were indecisive. One student expressed his opinion as "Since I cannot provide the same disciplinary environment, I follow the courses mostly from the recordings instead of online.”

When question 8 “Do you think that the understanding of distance education is more advantageous than formal education?” is examined (Table 5), the great majority (34.9%, n=52) think that distance education is unfavorable compared to traditional education. The number of students who find it advantageous and definitely advantageous is 14 in total and the number of undecideds is 43 (28.9%). The opinion of the student who chose the "other" option was " It can be advantageous in theoretical lessons."

As can be seen in the 9th question (Table 6) “Does the disruption of practical applications in the distance education model cause you to worry about professional competence in the future?” , most of the students participating in the survey (72.5%, n=108) are definitely worried about the interruption of practical applications. On the other hand, none of the respondents chose the "I have no worries" option. One student from each class was undecided.

When question 10 “Do you think the distance education model should be made continuous?” (Table 7) is analyzed, it is seen that the number of participants who want practical lessons face-to-face and theoretical lessons with distance education is more (39.6%, n=59). None of the participants wanted the practical lessons to be in distance learning. Distance learning option for some theoretical courses ranks first in 4th grade compared to 3rd and 5th class. The opinion of one of the 5th class students was "Both the practice and theory of our clinical courses must be through face-to-face training. Some courses such as anatomy should be face-to-face, but organic chemistry, elective courses, physics courses should be with distance education."

When authors look at question 11 “Do you think remote exams contribute to learning and evaluation?” (Table 8), 47 (31.5%) students in total were undecided about the contribution of remote exams to learning and evaluation. A total of 50 students think that it usually and definitely contributes. The student who chose the other option answered "It is not related to the moment of the exam, but the decrease in the severity of the exams, unfortunately, causes a decrease in the study concentration." as stated.

When the answers to the 12th question “Do you think online lessons are more efficient than face-to-face lessons?” are examined, it is seen that the participating students can get efficiency with a total of 34.2% (n=51). This is followed by the undecided option with a proportion of 29.5% (n=44). The number of students who think they cannot get any efficiency is 14 (9.4%) in total. 2 (1.3%) students conveyed their opinions as "It changes according to the way the instructor handles the lesson and the material (slide, video)." and "Some classes are more efficient online."

Discussion

In a study conducted by Genç et al., 23.1% of the students being educated at the Faculty of Theology stated that they were satisfied with distance education, while the majority of them were not satisfied with distance education. [9] Also, some studies conducted on Faculty of Nursing, students did not report a significant difference in student satisfaction between web-based education and face-to-face education. [10] In authors study, it can be said that there is a positive opinion of dentistry students for distance theoretical education.

When looking at the adequacy of distance education in terms of practical lessons, it was concluded that distance education is "Definitely Insufficient" with a proportion of 79.9% compared to theoretical lessons. No student has chosen the "Absolutely Sufficient" option, which highlights the importance and necessity of face-to-face education in dentistry for practical lessons. Although it has been shown in some studies that distance education is sufficient and useful in terms of theoretical courses, it has been determined that there are inadequacies and practical failures in distance education in clinical departments, some of which are applied for courses. [11] Nevertheless, in another study, the contribution of the distance education model to theoretical lessons was found to be relatively higher than that of professional practices. [12] From this point of view, these two studies support the present survey study. When it comes to applied courses, dissatisfaction and inadequacy results have been observed for students in the current distance education model.

In the present study, students stated that faculty members were sufficient in theoretical lessons in the distance education model, but not sufficient in practical lessons. Özyürek et al. stated that the lessons given by the faculty members through distance education were found to be inefficient by the students, but they stated that it was an important opportunity for individuals who could not access face-to-face education. [13] According to another study, it was found that the contribution of faculty members to students’ theoretical knowledge levels in distance education is higher than their contribution to practice. [12] When the results are examined, it was concluded that students need face-to-face training more, especially in practical training.

As a result of the sudden and rapid transition to distance education, the importance of technology has come to the fore again. Only 9% of the students participating in the survey stated that there were no technical problems in their access to the courses and exams in distance education. Birişçi et al. emphasized that the distance education process was negatively affected due to internet connection and various technical problems. [14] In another similar study, in-service training was provided by video conferencing method and teachers’ opinions were taken afterward. It has been determined that teachers’ opinions about in-service training through distance education are negative due to reasons such as lack of infrastructure and interaction. [15]

When compared with traditional education, 36.2% of the students said "Insufficient" and 24.2% preferred the expression "Definitely Insufficient" when asked if you can provide

Table 1. Distribution of the answers to question 1 and 2 in total and based on the students' grade

	Question 1				Question 2			
	3rd Grade	4th Grade	5th Grade	Total	3rd Grade	4thGrade	5thGrade	Total
Answer	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Absolutely sufficient	5	0	4	9(6.0)	0	0	0	0(0.0)
Sufficient	19	29	13	61(40.9)	0	0	1	1(0.7)
Not sure	21	17	8	46(30.9)	1	3	1	5(3.4)
Insufficient	7	12	9	28(18.8)	13	4	7	24(16.1)
Definitely insufficient	2	2	1	5(3.4)	40	53	26	119(79.9)
Total	54(100.0)	60(100.0)	35(100.0)	149(100.0)	54	60	35	149(100.0)

Table 2. Distribution of the answers to question 3 and 4 in total and based on the students' grade

	Question 3				Question 4			
	3rd Grade	4th Grade	5th Grade	Total	3rd Grade	4thGrade	5thGrade	Total
Answer	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
I strongly agree	5	3	5	13(8,7)	2	0	1	3(2.0)
I agree	22	34	19	75(50,3)	7	6	2	15(10.1)
Not sure	19	18	9	46(30,9)	16	15	11	42(28.2)
I disagree	3	3	1	7(4,7)	17	21	11	49(32.9)
Definitely disagree	3	0	1	4(2,7)	12	17	9	38(25.5)
Other	2	2	0	4(2,7)	0	1	1	2(1.3)
Total	54(100.0)	60(100.0)	35(100.0)	149(100.0)	54	60	35	149(100.0)

Table 3. Distribution of the answers to question 5 in total and based on the students' grade

	3rd Grade	4th Grade	5th Grade	Total
Answer	n	n	n	n (%)
Very frequently	4	0	0	4(2.7)
Usually	3	1	1	5(3.4)
Time to time	28	26	22	76(51.0)
Rarely	14	29	12	55(36.9)
Never	5	4	0	9(6.0)
Total	54	60	35	149(100.0)

Table 4. Distribution of the answers to question 6 and 7 in total and based on the students' grade

	Question 3				Question 4			
	3rd Grade	4th Grade	5th Grade	Total	3rd Grade	4thGrade	5thGrade	Total
Answer	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Absolutely sufficient	2	0	3	5(3.4)	4	7	2	13(8.7)
Sufficient	4	8	2	14(9.4)	21	28	16	65(43.6)
Not sure	12	17	11	40(26.8)	7	10	7	24(16.1)
Insufficient	16	26	12	54(36.2)	13	11	9	33(22.1)
Definitely insufficient	20	9	7	36(24.2)	8	4	1	13(8.7)
Other	0	0	0	0	1	0	0	1(0.8)
Total	54(100.0)	60(100.0)	35(100.0)	149(100.0)	54	60	35	149(100.0)

Table 5. Distribution of the answers to question 8 in total and based on the students' grade

	3rd Grade	4th Grade	5th Grade	Total
Answer	n	n	n	n (%)
Absolutely advantageous	1	0	2	3(2.0)
Advantageous	3	4	4	11(7.4)
Not sure	18	12	13	43(28.9)
Disadvantageous	13	31	8	52(34.9)
Definitely disadvantageous	19	12	8	39(26.2)
Other	0	1	0	1(1.7)
Total	54	60	35	149(100.0)

good and sufficient concentration in the distance education model. In another study, 36.2% of the students said "I cannot concentrate at all" to a similar survey question, while 34.9% chose the option "I cannot concentrate". [9] This situation shows us that for some students, concentration is provided in school-faculty environments where traditional education is provided, not at home or in different settings.

In the present study, it was found that the participation of most of the students in distance education classes was sufficient. In another study, the number of students who could not participate in distance education due to computer and technical problems were found to be in the majority. [16] In another

Table 6. Distribution of the answers to question 9 in total and based on the students' grade

Answer	3rd Grade n	4th Grade n	5th Grade n	Total n (%)
Absolutely concerned	41	45	22	108(72.5)
Usually worried	10	6	9	25(16.8)
Not sure	1	1	1	3(2.0)
Sometimes worried	2	8	3	13(8.7)
No concerns	0	0	0	0(0.0)
Total	54	60	35	149(100.0)

Table 7. Distribution of the answers to question 10 in total and based on the students' grade

Answer	3rd Grade n	4th Grade n	5th Grade n	Total n (%)
Must be for some theoretical courses	13	25	10	48(32.2)
Must be for practical courses	0	0	0	0(0.0)
Practical lessons face-to-face, theoretical lessons should be distance	25	17	17	59(39.6)
Must be fully face-to-face education	16	16	6	38(25.5)
Must be totally distance education	0	2	1	3(2.0)
Other	0	0	1	1(0.7)
Total	54	60	35	149(100.0)

Table 8. Distribution of the answers to question 11 in total and based on the students' grade

Answer	3rd Grade n	4th Grade n	5th Grade n	Total n (%)
Absolutely contributed	3	0	2	5(3.4)
Contributed usually	12	20	13	45(30.2)
Not sure	15	23	9	47(31.5)
No contribution	14	7	7	28(18.8)
Definitely no contribution	10	9	4	23(15.4)
Other	0	1	0	1(0.7)
Total	54	60	35	149(100.0)

study, it was stated that the most important reason that prevented half of the students from following the online course in distance education was the disconnection of the internet connection, and the other reasons were generally due to situations connected to the home environment.[13] This type of non-participation due to technical problems is a sad problem in today's technology. The fact that there are still such technical problems in the age we call the 'age of technology' shows us that the necessary importance is still not given to some issues related to education. While 34.9% of the students participating in the survey think that the distance education model is "Disadvantageous" compared to face-to-face education, 26.2% of them stated their opinions as "Defınıtely disadvantageous". In a study they conducted by Keskin et al, they found that distance education was advantageous in terms of allowing students to learn information at their own pace and to receive information at the specified time, but the students' not getting enough feedback, thinking that they could not express themselves sufficiently and forgetting the subjects they listened quickly show that this education model has its disadvantages. They concluded that taking only the information and grasping the information without practicing the students could cause them to forget the subjects quickly.[12] In the study of Özyürek et al., students found it advantageous in terms of listening to lessons as much as they wanted in distance education, but they found it disadvantageous in terms of not expressing themselves adequately.[13]

After two semesters of distance education, it was evaluated whether the students were sufficient and satisfied with a practical education. In addition to the feedback received from many students, 72.5% of the students participating in the survey in the present study stated "I am absolutely concerned" about professional competence in the future.

The answers given by the students regarding the continuity of the distance education model were found as "It should be for some theoretical lessons" with a proportion of 32.2% and "Theoretical Courses Should be for Distance Education and Practical Courses Face to Face" with a proportion of 39.6%. In a study, it was concluded that the distance education model will never replace face-to-face education, but it is seen as an education model that can be applied immediately after school holidays in cases such as earthquakes, floods, natural disasters, and epidemics.[16] Although it was found in another study that the distance education model could be sufficient for theoretical courses, it was stated that face-to-face training was needed for departments with practical and laboratory courses in their curriculum.[11] In another study, it was found that the teaching method was primarily mixed (37.93%) and then face-to-face (34.05%) education was preferred as the teaching method.[17] In the study conducted by Özyürek et al., was determined that distance education did not need to become widespread, and more than half of the participants (54.5%) stated that the dissemination of distance education would not be beneficial for society.[13]

While 30.2% of the students participating in the survey evaluated that the distance education model contributed to learning and evaluation as "Usually Contributed", 31.5% were undecided. Besides, 34.2% of the students preferred "I can get efficiency" from online courses, and 29.5% preferred the option "I am undecided". In a study, 11.1% of the students said "I can work efficiently" with distance education, while 11.9% said I am undecided.[9] In another study, it was observed that most of the students (84.4%) did not find distance education as effective as face-to-face education, but more than half of the students (59.5%) stated that distance education was an al-

ternative solution.[12]

As a result of the distance education model, which lasted for a year and two semesters under pandemic conditions, the opinions taken from the students showed that; Although distance education is a method that can be used in extraordinary situations and access difficulties, especially in faculties where practical education is very important, such as Dentistry education, it is likely to cause serious problems and dissatisfaction in its continuous use. If this method becomes permanent, the need for more serious trainings and the preparation of infrastructures was once again emphasized by the students. The authors hope that the negative effects on education of the pandemic process, which deeply affects the whole world, will be quickly compensated and more positive and qualified education methods will be integrated into our lives, especially in institutions that provide practical training.

Conclusion

While students find distance education sufficient for theoretical lessons, the majority of them find distance education insufficient in practical education. According to students, faculty members were found to be insufficient in the distance education model, especially in practical courses, and it is thought that faculty members who are accustomed to traditional education, like students, were introduced to the distance education model suddenly and without preparation. Considering the advantages of distance education, the majority of students find traditional education more advantageous.

Author Contributions

Gediz GEDUK; constructing the hypothesis or idea of research and/or article, taking responsibility in logical interpretation and conclusion of the results, reviewing the article. Çiğdem ŞEKER; reviewing the article, organizing and supervising the study design. Hatice BİLTEKİN and Emre HAYLAZ; taking responsibility in patient follow-up, collection of relevant biological materials, data management and reporting, execution of the experiments, taking responsibility in the writing the manuscript.

Conflict of Interest

There are no conflicts of interest in the text of the authors, including financial, advisory, institutional and other relations which may lead to prejudice or conflict of interest.

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ORIGINAL RESEARCH ARTICLE

The prevalance and radiographic evaluation of mandibular second premolar migration: A retrospective study

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Abstract

Purpose: To investigate the prevalence and radiographic characteristics of migrated mandibular second premolars by using panoramic radiography.
Materials & Methods: The previously taken 27758 panoramic radiographs were evaluated regarding the determining the prevalence of mandibular second premolar migration. Thirty-six radiographs were excluded from the study due to not providing the inclusion criteria. 27722 radiographs were evaluated retrospectively by the same operator. In the diagnosis of migrated teeth, radiographic features and demographic characteristics were recorded.
Results: Nine migrated second premolar teeth were detected in the evaluation of all the radiographs (%0.03). The mean age of the cases was 37 years. All the migrated teeth were impacted, unilateral and the average distance between normal and migrated location was 41 mm. In most of migration case (in 6 case) absence of first permanent molar tooth was observed.
Conclusion: It is concluded that, if the mandibular second premolar tooth are not located at physiologic position on the dental arch, a panoramic radiographic examination should be recommended to view all the jaws and related structures. Early detection of dental migration may be beneficial to prevent the possible further complications.

Key words: Impacted tooth; migrated teeth; panoramic radiograph

Introduction

Dental ectopia is a rare clinical finding characterized by an alteration in the physiological eruption pathway in the jaws.[1-4] Dental migration, a type of ectopia, is the movement of unerupted teeth to an area distant from its normal position in the jaws.[1] Dental transmigration, also known as a rare anomaly, is the movement of impacted teeth to the contralateral side of the dental arch.[2,3] Dental transmigration mostly affects the permanent dentition especially the upper canines, the lower second premolars, canines and lateral incisors.[4] The prevalence of intraosseous migration of the mandibular second premolar teeth is 0.25% according the previous studies and males are less affected than females.[1,5-7] Dental migration is mostly seen in the second decades of the lide and unilateral migration of the mandibular premolars is more common.[5,7] The etiology of the second premolar migration is still unclear although the multifactorial conditions have been reported.

The buds of mandibular second premolar teeth germ develop under the roots of primary molars.[8] Once root resorption process of primary second molars is initiated and the permanent first molars are extracted before the physiological exfoliation cycle, mandibular second premolars may tend to migrate distally towards to the permanent second molar region.[6,8] The first angulation of the second premolars and the early loss of the primary second molars are crucial factors regarding the distal migration. The process of migration continues until encountering with the another impacted or unerupted teeth.[4] Migrated teeth are also associated the abnormal eruption and masticatory forces.[9,10] On the other hand, other etiological factors are neoplasms, cysts, early loss of primary teeth, tooth retention, arch crowding, and supernumerary teeth.[11] The ob-

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jective of this research is to determine the prevalence and probable etiological factors of the migration of the second premolar teeth by using radiographic assessments.

Materials and Methods

This retrospective research was performed on panoramic radiographs taken from the patients who referred Oral and Maxillofacial Radiology Department. Ethical approval was obtained for this study (Uşak University Faculty of Medicine Ethics Committee Decision No: 202-06 Date: 19.06.2019). 27758 panoramic radiographs were evaluated regarding the determining the prevalence of mandibular second premolar migration. The following inclusion criteria were used to select the panoramic radiographs in this study:

1. No symptoms of multiple supernumerary teeth
2. No symptoms or evidence of syndromic features
3. No symptoms of skeletal problems
4. The age of the participants would be 13 or older.

Thirty-six radiographs were excluded from the study due to not providing the inclusion criteria. 27722 radiographs were evaluated retrospectively by the same oral radiologist. The radiological findings of migrated premolar teeth were recorded according to the following evaluation methods:

- Age and gender
- Medical history
- Migration pathway
- Right/left side of jaw
- Unilateral/bilateral
- Diagonal radiographic distance to normal position
- Eruption/impaction status
- Presence of primary second molar
- Absence of permanent first molar
- Absence of additional pathology
- Treatment history.

Results

In all the radiographs evaluated in the study, 9 migrated mandibular second premolar teeth were found (6 female, 3 male) (0.03%). All of the migrated teeth were unilateral, unerupted and the range of the age was between 18 to 67 (mean 37). Six of migrated teeth were located at left side of mandible and three were at right (Table 1).

In all affected cases, in six case, persistent primary second molar was observed without successors. All the migrated teeth had moved towards to distal direction. The distance among normal and migrated position were measured between 25.4-60.5 mm (mean 41 mm). While three migrated teeth had no pathologies, cystic lesion was observed in one case. Additionally, five of the cases had pre-eruptive intracoronal resorption (PIR). The case having cystic lesion was treated with enucleation and tooth extraction (Figure 1-6).

Discussion

Impaction is termed partially or totally uncomplete tooth eruption and impacted teeth have not erupted in dental arch beyond the physiological exfoliation time.[12] Inadequate dental arch length, supernumerary teeth, early loss of primary teeth, retention, dento-alveolar trauma, long-term chronic inflammation, developmental anomalies, crown/root malformation, genetic disturbances, neoplasms and cysts may be the etiological factors of impaction.[13,14] The most common impacted teeth are

Table 1. Clinical and radiographical features of migrated mandibular second premolar

Patient Number	Age	Sex	Medical History	Dm	Side	Uni / Bi	Distance	Er / Im	Primary Second Molar	Extracted of per. 1.m	Associated Pathology	Treatment Protocol
1	67	F	N.A	D	L	Uni	52,4 mm	I	CE	Yes	None	Observation
2	24	F	N.A	D	R	Uni	29,6 mm	I	CE	Yes	PIR	Observation
3	30	M	N.A	D	L	Uni	25,4 mm	I	CE	No	Cyst	Extraction
4	18	F	N.A	D	L	Uni	27,4 mm	I	CE	No	None	Observation
5	32	F	N.A	D	L	Uni	39,5 mm	I	CE	Yes	PIR	Observation
6	35	M	N.A	D	L	Uni	28,5 mm	I	CE	No	PIR	Observation
7	66	M	Cholesterol	D	L	Uni	53,5 mm	I	CE	Yes	PIR	Observation
8	36	F	N.A	D	R	Uni	60,5 mm	I	CE	Yes	PIR	Observation
9	27	F	N.A	D	L	Uni	52,1 mm	I	CE	Yes	None	Observation

F; Female, M; Male, N.A; Not Available, Dm; Direction of Migration, D; Distal, R; Right, L; Left, Uni / Bi; Unilateral / Bilateral, mm; millimeter, Er / Im; Eruption / Impaction, I; Impact, CE; Exfoliated Primary Second Molar, CR; Retained Primary Second Molar, Per; Permanent, m; molar;,PIR; Pre-eruptive Intracoronal Resorption

Figure 1. The impacted premolar has observed at angulus mandible in Patient number(PN 9)

Figure 2. An impacted right mandibular second premolar with the exfoliated primary second molar, located in right ramus mandible (PN 8)

Figure 3. An impacted left mandibular second premolar has observed next to impacted mandibular third molar crown (PN 4)

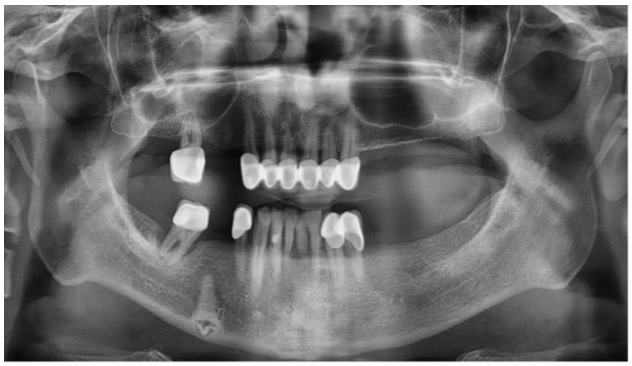

Figure 4. An impacted right mandibular second premolar at the mandibular lower edge (PN 6)

Figure 5. An impacted left mandibular second premolar associated with PIR (PN 7)

mandibular third molars followed by maxillary third molars, maxillary canines, mandibular canines, mandibular premolars, maxillary premolars, maxillary central incisors and maxillary lateral incisors.[14] Intraosseous tooth migration is a rare condition that occurs mostly in the lower jaw, especially in canines and second premolars.[15] According the results of the present retrospective study, we found 6 migrated premolars with the absence of permanent first molar. However, there is no additional information about timing of the extraction of permanent first molars. Thus, it is not certain that early loss of permanent firs molars could be the reason for the second premolar migration. In the present study, the mean distance between the normal position and migrated position of the mandibular second premolars was 40 mm. However, Okada et al. reported that approximately 10 mm movement of migrated mandibular premolars.[16] The over-distance of migration of impacted premolars showed that migrated tooth had continued until encounter any intrabony obstruction. Five of the 9 migrated mandibular premolars were associated with PIR. PIR is the radiolucent lesion that often appears in the coronal dentin, adjacent to the dentoenamel junction of unerupted teeth.[17,18] The authors have decided to follow-up all the migrated teeth with PIR. One of the 9 migrated mandibular premolars had cystic lesion and this case was treated by tooth extraction and enucleation of the cystic cavity. In this dental anomaly, clinical and radiological findings should be carefully investigated. Treatment options of the migrated teeth are surgical treatment, transplantation, orthodontic traction or periodic observation. If the migrated tooth is asymptomatic, it should be monitored by radiographic examination.[11] In case of dental follicle expansion or other pathologies such as infection, cyst, neurological symptoms, periodontal damage/root resorption in adjacent teeth extraction should be considered. In case of absence of mandibular second premolar on dental arch, panoramic radiograph should be advised, due to the potential distant migration. Migrated mandibular second premolars are often horizontally positioned

Figure 6. An impacted left mandibular second premolar associated with a cystic lesion (PN 3)

below the apices of the permanent teeth and near the border of the mandible. Therefore, periapical radiographs are not beneficial in the diagnosis of migration. According to the findings, radiographic examination of this entity should include panoramic radiographs, occlusal radiographs and cone beam or multidedector computerized tomography.[16,19]

Conclusion

The migration of mandibular second premolars is a rare asymptomatic condition. If mandibular second premolars are not seen on dental arch, panoramic radiographical examination should be performed due to potential distant migration. Migration-related complications may occur later stages of the life and early diagnosis of migration helps preventing the further complications.

Author Contributions

Study Idea / Hypothesis: H.T.Y., I.K. Study Design: A.T. Data Collection: H.T.Y., I.K. Biological material handling / collection: I.K., A.T. Literature Review: H.T.Y., I.K. Analysis and / or Interpretation of Results: I.K., H.T.Y. Article Writing: A.T. Critical Review: I.K., H.T.Y., A.T.

Conflict of Interest

Authors declare that have no conflict of interests.

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CASE REPORT

Loose intra-articular body in the temporomandibular joint: case report of a successful conservative management

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Abstract

Loose intra-articular bodies are a rare finding in the temporomandibular joint. Surgical removal of the loose bodies is often described as the only treatment option; however, it presents possible postoperative complications. The aim of this paper is to report the successful conservative management of a temporomandibular disorder associated with a single loose intra-articular body. A 62-year-old woman presented with pain in the right temporomandibular joint and pre-auricular region, limited mouth opening and open-lock episodes. Panoramic radiography and cone-beam computed tomography exams revealed the presence of a single loose body located anterior to the right condyle. Magnetic resonance images showed bilateral anterior disc displacement without reduction. A non-invasive approach consisting of an occlusal splint and low-level laser therapy associated with home-based physical therapy was performed for management of clinical signs and symptoms. The patient was followed up for 2 years and presented significant pain reduction and improvement in the range of mandibular movements. The combination of conservative therapies may be an alternative for surgical intervention to control pain and improve mandibular function in patients with temporomandibular dysfunction associated with a loose body in the temporomandibular joint.

Key words: conservative management; loose body; low-level laser therapy; temporomandibular dysfunction

Introduction

Loose intra-articular bodies (LB) are free-floating calcified masses in a joint. While commonly found in knee joint spaces, LBs affecting the temporomandibular joint (TMJ) are a rare finding.1 Common clinical symptoms are pain and swelling in the preauricular region, functional limitation, facial asymmetry, joint sounds and unilateral deviation of the mandible during mouth opening.[1,2] LBs in the TMJ may originate from Inflammatory processes, e.g. osteoarthritis and rheumatoid arthritis. In these conditions, the periphery of the mandibular condyle undergo changes that lead to the formation of bony projections, the so-called osteophytes. Portions of osteophytes may subsequently become detached and lie free in the TMJ as LBs.[3,4] Trauma and benign proliferative disorders, such as synovial chondromatosis, are other possible causes of LB formation inside the TMJ.[2,4]

The presence of LBs is often accompanied by multiple other alterations in the TMJ. Imaging exams can reveal the existence of internal joint derangement, bone erosion, sclerosis, flattening and osteophytes; nonetheless, these findings are non-specific.[2,3] The final diagnosis can only be established based on clinical, histopathological and imaging aspects.[1] Invasive procedures, such as arthroscopy and open surgery (arthrotomy),

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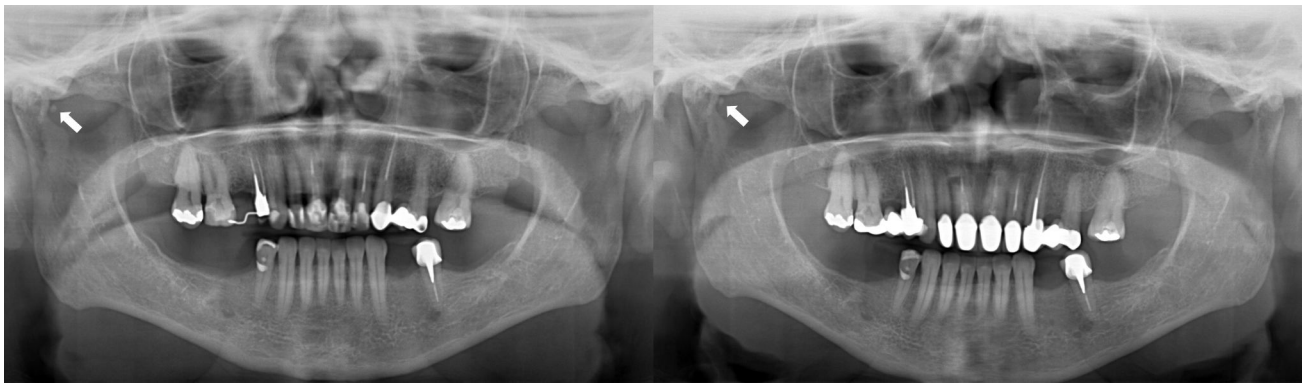

Figure 1. Panoramic radiograph shows loose solitary intra-articular body in the right temporomandibular joint space (arrow) at initial consultation (left) and 2-year follow up (right).

are the usual approaches for treatment and diagnosis, since LBs do not resolve spontaneously.[5,6] These procedures consist on surgical exploration of the joint and removal of the LBs, which leads to reduction of pain and improvement of joint mobility.[1] Nevertheless, surgical comorbidity should be taken in consideration, such as infection, bleeding, otologic injuries and neurovascular damages.[7]

The purpose of this article is to present a successful non-invasive management of signs and symptoms associated with the presence of a single LB in the TMJ. Panoramic radiography (PR), cone-beam computed tomography (CBCT) and magnetic resonance imaging (MRI) findings, the differential diagnosis and the conservative therapies performed are discussed.

Case Report

A 62-year-old female patient presented at the Temporomandibular Dysfunction Clinic of the School of Dentistry of Ribeirão Preto with pain in the right TMJ and pre-auricular region, mouth opening limitation and open-lock episodes. Clinical examination revealed limited mouth opening (29 mm) with corrected left deviation of mandible (2 mm). A limitation in the range of mandibular protrusion, left laterality and right laterality was also detected (Table 1). Crepitus sounds were found in right and left TMJs. Pain on muscular and articular palpation was measured using a visual analog scale and was present in six of the seven areas evaluated (Table 2). Analgesics and non-steroidal anti-inflammatory drugs were previously prescribed by other dental services but did not alleviate the symptoms. Medical history was negative for osteoarthritis, rheumatoid arthritis or other joint problems. The patient had not experienced head or neck trauma.

To aid the diagnosis, a panoramic radiograph was also performed at the first consultation. The exam revealed the presence of a round radiopacity in the right condyle region (Figure 1). A CBCT scan of the right TMJ was requested and confirmed the existence of a solitary intra-articular free body (2.9×2×2 mm) anterior to the right condyle, along with the presence of an osteophyte and discrete condylar cortical erosion (Figure 2). MRI of the left and right TMJs showed bilateral anterior disc displacement without reduction and the presence of osteophytes on both TMJs (Figure 3).

Based on clinical and radiological findings, osteoarthritis and synovial chondromatosis were considered as possible diagnoses. Final diagnosis could not be established due to the absence of histopathological analysis. The treatment plan comprised a combination of occlusal splint therapy, low-level laser application and home-based physical therapy. This case report was approved by the Research Ethics Committee of the School of Dentistry of Ribeirão Preto (University of São Paulo, Ribeirão Preto, Brazil) under the registration number CAAE 28125320.3.0000.5419. Written informed consent was obtained from the patient for the description and publication of this case report.

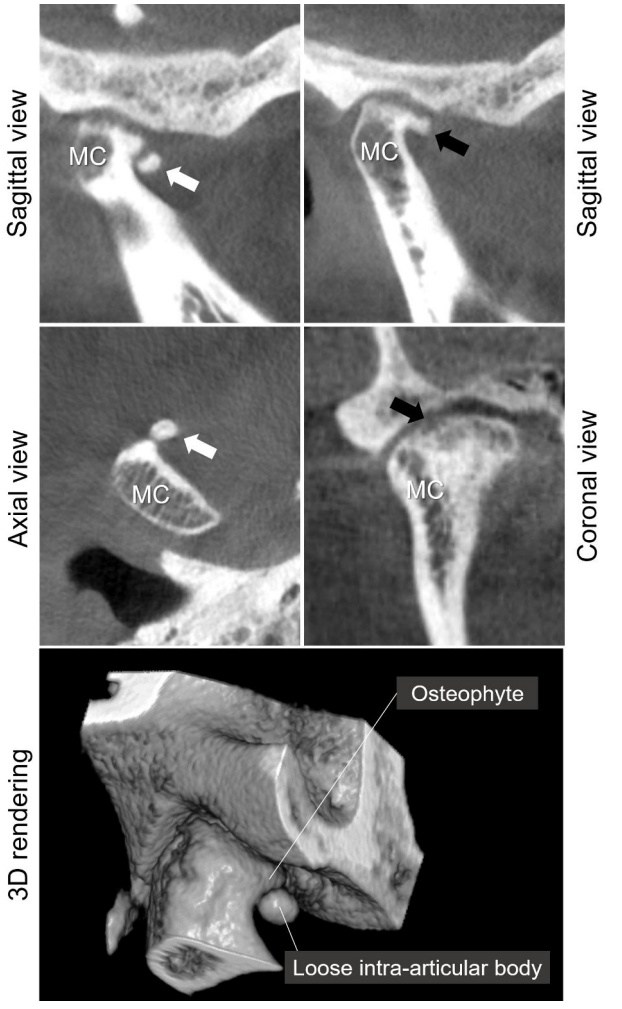

Figure 2. Cone-beam computed tomography scan of the right temporomandibular joint. The sagittal and axial views show the loose intra-articular body (yellow arrow) and osteophyte (white arrow). The coronal view shows discrete erosion of the mandibular condyle cortical (black arrow). MC: mandibular condyle.

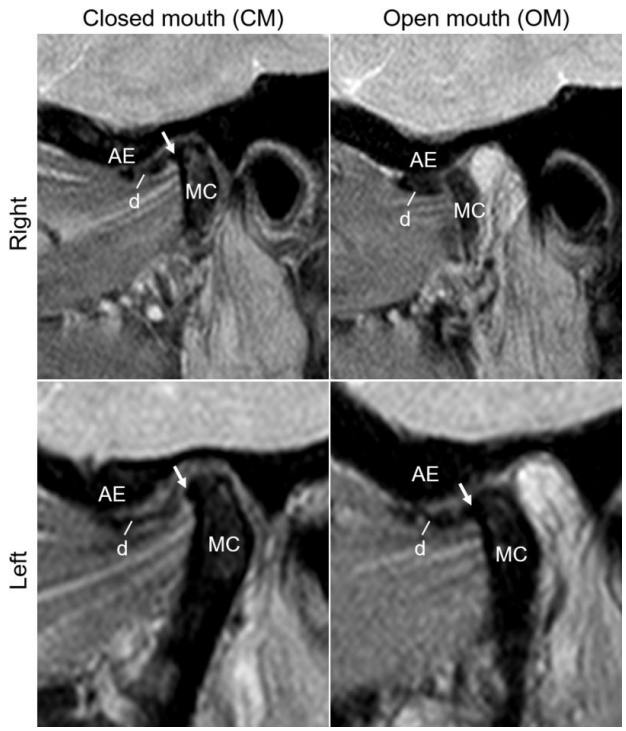

Figure 3. Sagittal proton density weighted magnetic resonance images in open and closed mouth positions of the temporomandibular joint (TMJ). On the closed mouth (CM) view of the right TMJ, the disc is located anteriorly to the mandibular condyle; the open mouth (OM) image shows there is no reduction of the disc displacement. The CM and OM views of the left TMJ also shows anterior disc displacement without reduction. The white arrows point to osteophytes. AE: articular eminence; D: articular disc; MC: mandibular condyle.

Occlusal splint therapy

An upper stabilization occlusal splint (OS) was made of transparent thermopolymerizing acrylic resin. The occlusion was adjusted until obtaining uniform and simultaneous bilateral contacts of all teeth in centric relation and lateral and anterior disocclusions by canine guidance. The patient was instructed to use the OS at night and to clean the device daily. One week after installment, the occlusal contacts were reassessed and the required adjustments were performed.

Low-level laser therapy

The low-level laser therapy (LLT) consisted of GaAlAs laser (TF Premier Plus device; MMOptics, São Carlos, Brazil) application once a week for six consecutive weeks at the following areas: masseter muscle (two points: upper and lower), anterior temporal muscle (three points: upper, middle and lower) and TMJ region (a central point and four points around the TMJ), with a distance of 1 cm between the application points. The laser head was positioned perpendicular to the tissues, in contact with the patient's skin. Continuous emission mode was used and the parameters were as follows: wavelength = 808 nm ±10 nm (infrared); spot area = 0.03 cm^2; time per point = 20 s; energy density = 35 J/cm^2; laser optical power = 150 mW.

Home-based physical therapy and patient education

The home-based physical therapy (PT) program comprised self-massage of masticatory muscles and application of moist heat pads on the painful areas. The self-massage was performed daily by the patient for 10 min with a moderate pressure using the index, middle and ring fingers in circular movements at the masseter and temporal areas, bilaterally. She was instructed to use 10 mg/g topical diclofenac potassium as an adjunct when experiencing high pain. Moist heat pads (40 to 50°C) were used bilaterally once a day for 20 min for 7 days. The patient was oriented to avoid deleterious oral habits (e.g. biting objects, teeth clenching, provoking articular sounds) and excessive mandibular movements, to cut solid food in small pieces to avoid muscular overload and to keep the muscles relaxed and the teeth apart during rest position. The patient was also informed about the relationship between chronic pain and psychological distress. All information and instructions were written down for the patient and she was told to continue the PT even if pain-free.

Table 1. Measurements (mm) of mandibular movements

Mandibular movement	Baseline	2-year follow-up	Difference
Protrusion	9	11	+2
Left laterality	8.5	11	+2.5
Right laterality	7.5	8	+0.5
Maximum mouth opening	29	34	+5

Table 2. Visual analog scale scores of pain on palpation (0 to 10)

Palpation area	Baseline		2-year follow-up	
	Right	Left	Right	Left
Anterior temporal muscle	6	2	1	0
Posterior temporal muscle	0	0	0	0
Superficial masseter	8	4	2	0
Deep masseter	3	6	2	1
Trapezoid	6	4	0	0
Medial pterygoid	5	8	1	1
Pre-auricular area	8	6	1	0

Treatment outcomes

The patient was followed up weekly for the first 6 weeks for the LLLT application, after which the intervals became broader (i.e. at 1 month, 6 months, 1 year and 2 years). The OS was adjusted when necessary and home PT and patient education were reinforced at every appointment. The patient noticed a decrease in pain and headache episodes over time. After 2 years, she was asymptomatic and no open-lock episodes happened during the follow up period. Measurements of mandibular movements and reassessment of pain on palpation were performed at the 2-year follow up ((Table 1 and Table 2). A notable decrease in pain in all areas was found compared to baseline (Table 2). Moreover, the range of mandibular movements increased significantly (Table 1).

A PR was also requested to evaluate the disease progression at the 2-year follow up. No additional findings or differences in the loose intra-articular body apparent size and position were found between baseline and 2-year follow up PR (Figure 1). Since the patient was pain-free and did not present any other clinical complaint, no additional exams were performed.

Discussion

The presence of LBs in the TMJ are often related to osteoarthritis (OA), synovial chondromatosis (SC), osteochondral fractures, rheumatoid arthritis (RA) or osteochondritis dissecans (OCD).[2–4] In the present case report, osteochondral fracture

was excluded from differential diagnosis due to absence of history of trauma. LB in OCD are believed to be the result of avascular necrosis and detachment of subchondral bone, which has also been related to previous trauma.[4,8] RA can affect the TMJ, more commonly at a late phase of the disease,[5,9] but the medical history for RA was negative. Based on clinical and radiological findings, OA or SC were considered as possible diagnoses.

OA and SC share many similar signs and symptoms e.g. pain and swelling in the preauricular region, functional limitation, facial asymmetry, joint sounds and unilateral deviation of the mandible during mouth opening.[2,3] OA is a degenerative joint disease characterized by cartilage degradation and abnormal remodeling of subchondral bone. Hyperplasia of the cartilage may also occur forming ossified projections (osteophytes) that may break off and lie free in the joint as LBs.[3,10] TMJs affected by OA show signs of degeneration such as cortical erosion, osteophytes, flattening or sclerosis of articular surfaces and narrowing of joint space.[11] The condition is believed to develop as a consequence of joint overload and/or internal derangements.[3,11] It has been reported that patients presenting non-reducing disc displacements have a higher risk of developing OA.[11]

SC is characterized by metaplastic changes of the synovial membrane, leading to cartilaginous nodule formation. When detached, those nodules can migrate to the articular space and undergo calcification, forming LBs of varying sizes. Joint effusion, an abnormal accumulation of intra-articular fluid, is also a common finding.[1,2] The mandibular condyle can present a normal morphology or degenerative changes similar to OA.[12] SC etiology remains uncertain and possible associated factors are inflammation, trauma, infection and joint overload.[2,8]

In the present case report, final differential diagnosis could not be established due to the absence of histopathological analysis. Clinical and radiological findings are consistent with OA, yet SC could not be ruled out. In SC, metaplastic activity takes place leading to the formation of cartilaginous nodules, which grow nourished by the joint fluid, and later originate calcified bodies. Therefore, multiple LBs that slowly grow over time are typical findings of SC.[2,12] There are few reports of single LBs in TMJ related to SC and, in contrast to the present case, they were large masses (6×4 mm and 16×9 mm).[6,13] The 2-year follow-up PR also showed no apparent progression of the condition or enlargement of the LB. Moreover, evident signs of joint degenerative changes consistent with OA (e.g. osteophyte formation and cortical erosion) were found in the CBCT exam. MRI showed bilateral anterior non-reducing disc displacement, which has been associated to a higher risk of developing OA,[11] and no joint effusion was detected.

The literature shows that TMJ OA responds positively to non-invasive treatments e.g. anti-inflammatory drugs, hyaluronic acid injections, oral splint therapy, pulsed electrical stimulation, LLLT and acupuncture.[10] Nevertheless, when LBs secondary to OA or SC were present, surgery was the treatment of choice.[1] LBs mechanically block joint motion, resulting in pain, mandibular deviation during mouth opening and restricted range of movements.[2] In this sense, the authors hypothesized that OS therapy could be beneficial to reduce signs and symptoms, since it increases TMJ space and reduces intra-articular pressure.[14] Massage therapy and heat pads were employed to lower muscle tension and increase local blood flow, therefore contributing to reduce pain.[15,16] LLLT was performed due to its analgesic and anti-inflammatory effects, which can lead to pain reduction and improvement in the mandibular function.[17]

Only one reported case in the literature of TMD with LBs was not treated surgically.[8] Soon after the diagnosis of the presence of multiple LBs, the patient presented significant reduction of signs and symptoms. The authors claimed that the spontaneous remission was probably due a change in the LBs position within the joint, and no invasive nor conservative interventions were performed. In the present case report, no apparent modification in the LB position was found at the 2-year follow up; therefore, the improvement in joint motion and pain reduction are believed to be due to the therapies performed. To the best of the authors' knowledge, this is the first report of a successful conservative management of signs and symptoms related to a LB in the TMJ.

Conclusion

In this case report, a conservative approach was able to control pain and improve mandibular function in a patient presenting a loose body in the TMJ. The results suggest that the combination of non-invasive therapies can successfully manage pain and functional limitations related to the presence of loose bodies in the TMJ, therefore avoiding the need for surgical intervention and patient exposure to possible postoperative complications.

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Author Contributions

Del Rey YC and Parize N carried out clinical treatment; collected the data; wrote the manuscript and revised the final version of the manuscript. Oliveira-Santos C analyzed the data; wrote the manuscript and revised final version of the manuscript. Almeida MG conceived the treatment plan; analyzed the data; wrote the manuscript and revised the final version of the manuscript.

Conflict of Interest

The authors declare no conflict of interest.

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CASE REPORT

Brown tumor of the mandible as an initial presentation of hyperparathyroidism

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Abstract

The paper presents a brown tumor case related to secondary hyperparathyroidism in an end stage kidney disease patient undergoing dialysis treatment. The interesting feature of the case is that the primary clinical presentation of the condition was a mild swelling in the attached gingiva of a mandibular molar tooth. Medical practitioners should be alert to the fact that some pathological conditions may have an initial presentation in the oral cavity. Thus, a thorough and careful examination of the oral mucosa with the accompanying dental radiographs of patients, should be noted and studied in all cases, where available.

Key words: brown tumor; hyperparathyroidism; mandible

Introduction

Parathyroid hormone is produced by the parathyroid glands and has a key role in bone metabolism. These glands, located behind the thyroid at the bottom of the neck, are about the size of a grain of rice. Hyperparathyroidism occur when they create too much parathyroid hormone in the bloodstream.1 Hyperparathyroidism (HPT) may be primary, secondary, and tertiary and all types are featured with the presence of overproduction of PTH. [1-3]

Brown tumor (BT) or osteitis fibrosa cystica is a benign osseous lesion, present in settings of excess osteoclastic activity, which may result in any form of uncontrolled PTH hypersecretion. [4,5]

Brown tumours are of fibrous tissue, and woven bone origin, but no bone matrix. The osteoclasts consume the bone formed by osteoblasts and this repetition of reparative bone deposition followed by additional resorption can expand beyond the usual shape of the bone, involving the periosteum in which case there is the present of pain in the osseous area involved.

Brown tumors may be rarely associated with ectopic parathyroid adenomas or end stage kidney condition, as is the case presented in this paper. [4,5]

In developed countries with the evolution of medicine and the early diagnosis of the condition, as well as the successful treatment of HPT, they are rarely seen and only in final untreated disease stages. [5]

We describe a patient who presented with a manifestation of the Brown tumor to the mandible manifested by orofacial alteration as the presenting symptom of Hyperthyroidisma.

Case Report

The patient was a 58 years old female Caucasian, who came to complain about a mild swelling in the attached gingivae of a mandibular molar (Figure 1). The patient's medical history only included end-stage renal disease (ESRD). She was on hemodialysis and had no other medical conditions. Upon clinical examination, a mild, painless swelling was noted in the attached gingivae of a mandibular molar. The swelling extended to the non-attached gingivae and was not movable upon palpation. No other clinical findings were noted.

The patient was sent for a panoramic radiography (Figure 2), and the presence of a radiolucent multilocular lesion in the area was detected. The lesion was located in the posterior mandible in close relation with mandibular canal but without any interference with third molar. Trabecular structure of the mandible

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Figure 1. Clinical presentation of the patients gingival swelling

Figure 2. A: Non-specific bacterial colonies inter-mixed with inflammatory infiltrate, and aggregates of necrotic debris (10X). **B:** Cystic cavity lined by a non-keratinized, hyperplasic stratified squamous epithelium (10X). **C:** Higher power showing foci of dystrophic calcification with a basophilic appearance in variable mineralization pattern (See arrows) (20X). **D:** An area showing numerous curvilinear dystrophic calcification (see arrows) and aggregates of red blood cells (20X).

Figure 3. a: Axial **b:** Coronal Computer tomography of the patient showing the extend of the lesion and its limitation to bone

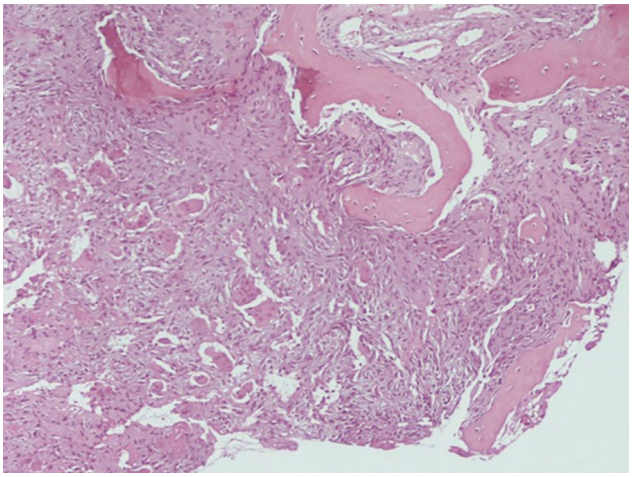

Figure 4. Histopathological section of the lesion with an increased osteoclastic activity

was altered due to do lesion there was thinning of the cortex without expansion of the mandible.

After examination with a medical CT (Figure 3), the extent of the lesion was noted. Since the patient did not have any other medical problems, a biopsy of the lesion was performed to set the diagnosis.

The histopathology of the lesion (Figure 4) showed multiple giant cells present and increased osteoclastic activity. The diagnosis of osteitis fibrosa cystica was given by the histopathology of the lesion. After the histopathology had set the diagnosis, the patient was asked to take a PTH exam and the PTH was 385 pg/mL with normal values ranging up to 55pg/mL. After the clinical, radiographic, histologic exams and the blood PTH levels, treatment of the patient was set according to the blood levels of PTH, and surgical excision of the lesion was performed.

Discussion

The parathyroid glands, situated behind the thyroid, respond to changes in serum ionized calcium concentrations and produde PTH. The hormone interacts with vitamin D and plays a key role with its metabolites in regulating calcium absorption and excretion.[6,7] The increase in levels of PTH is associated with the increased osteoclastic activity, extensive bone remodeling, and osteoblastic repair.

Hyperparathyroidism is a condition that can lead to a series of complications that decrease the life quality of the patient. In patients with chronic kidney disease (CKD), the impaired renal function leads to decreased vitamin D levels, causing an increase in parathyroid hormone (PTH) production and contributing to the development of secondary hyperparathyroidism. Lack of vitamin D leads to reduced calcium absorption by the intestine leading to hypocalcemia and increased parathyroid hormone secretion.[8] The bone disease in secondary hyperparathyroidism caused by kidney failure is termed renal osteodystrophy. Tertiary hyperparathyroidism is seen in those with long-term secondary hyperparathyroidism, which eventually leads to hyperplasia of the parathyroid glands and a loss of response to serum calcium levels. This disorder is most often seen in patients with end-stage kidney disease and is an autonomous activity.[8–10]

Figure 5. Histopathological section of the lesion with an increased osteoclastic activity

Diagnosis of brown tumors is merely presumptive. Histology sets the final diagnosis. Laboratory data and radiographs may be additionally used for definitive clinical diagnosis.

In radiographical examination, there are findings from the bones that can even aid the diagnosis of the condition in a large number of patients. Brown tumor may show no changes or a generalized osteoporosis image, making it difficult to diagnose. The lesions present as sharply defined, round or oval radiolucent areas which may appear multilocular.[11]

It is useful to know the serum levels of calcium and parathyroid hormone to set the differential diagnosis from giant cell lesions. In hyperparathyroidism as in the presented case, serum PTH level was 385pg/ml, which was indicative of the diagnosis of the brown tumor, when compared to other giant cell tumors.[3]

In the presented case, the patient's panoramic radiography that was taken two years ago (Figure 5), showed a very early lesion with no well-defined radiolucent osteolytic lesions near the middle section of the teeth' roots. In the present panoramic radiography of the same patient, the lesion had progressed to a well-defined lucency adjacent to the tooth's roots and extending to the surrounding bone. The lesion was removed regionally, and the systemic management revolved primarily in reducing circulating endocrine hormone (PTH). What should be noted here is that in the first panoramic radiograph though here was some indication, the diagnosis could not have been set from the radiographic image.

Similar cases have been dealt with accordingly with no need for further medical management.[6–10] In late diagnoses and those that do not respond to medical treatment, parathyroidectomy is the treatment of choice.12 In our case, an open curettage biopsy was performed and sent for histopathologic evaluation. The histopathology reported it as CGCG with sections showing microcellular connective tissue stroma with fibroblasts in abundance, and multinucleated giant cells, few osteoblasts, and numerous blood vessels (Figure 5) In the present case the brown tumor of the mandible was the first sign of the condition (hyperparathyroidism) due to the inbalance of osteoblastic, osteoclastic activity, formed by increased PTH levels and calcium phosphorous serum levels regulation.[1,9,11,12]

Upon reexamining the patient there was no recurrence of the lesion or presence of other similar lesions. The limitation of this paper can be lack of more comprehensive imaging of the current lesion since 3D imaging with additional/surface bone reconstruction can be necessary for surgical interventions.

Conclusion

The presented case had the unusual primary detection of the condition in the mandible. This should alert radiologists, and one should be careful of the medical history of a patient even upon taking a plain radiography. The differential diagnosis should be set, only after a thorough study of the patients both medical and dental history. Dentists should be aware of the medical conditions that may cause dental problems and should be more alert to certain patients.

Author Contributions

Delantoni A examined the case, photographed and prepared. Orhan K investigated the case and made the necessary corrections. Onder M made literature scanning and final edits.

Conflict of Interest

Authors declare that they have no conflict of interest.

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CASE REPORT

Treatment Management With Long Term Follow-Up In Late-Admitted Traumatized Permanent Incisors: Case Series

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Abstract

Traumatic dental injuries are particularly common in school-age children and often occur in the anterior region. Process management of cases is possible with alternative treatments according to the root development levels. This case series is aimed to present the treatment and 2-year follow-up of permanent anterior teeth with traumatic dental injuries.
Case 1: An 8-year-old patient, who had a bicycle accident 20 days earlier, was diagnosed with extrusion of #31. Due to late admission to the clinic, no repositioning procedure was applied to the tooth. Regenerative endodontic treatment was performed. During the radiological follow-up, the apex was closed in the 12th month; however, it was observed that obliteration started in the root canal at the 24th month. The case is still being followed up at regular intervals.
Case 2: A 13-year-old patient, who had a traffic accident 3 days prior, was diagnosed with subluxation in #11, and a root fracture was detected in the apical third of #21. In #21, root canal treatment was applied to the coronal part of the fragments. After the diagnosis of pulp necrosis in #11 in the 2nd month of the follow-up period, root canal filling was applied. During the follow-up period, no pathology was detected and no granulation tissue was formed between the fragments in #21.
In traumatic dental injuries, long-term follow-up, well-timed endodontic treatments, and material selection play an important role in success. With regenerative endodontic treatment, successful results can be obtained even in treatments applied in late-admitted patients.

Key words: delayed treatment; dental trauma; extrusion; regenerative endodontic treatment; root fracture; subluxation

Introduction

Traumatic dental injuries (TDI) are one of the public health problems that affect primary and permanent teeth, especially in children and adolescents. Although the prevalence of TDI varies depending on gender, socioeconomic level and environmental factors,[1] they tend to occur more often between the ages of 7-12[2] and approximately 25% of school-age children in permanent dentition experience TDI.[3,4] The most frequently affected teeth are the upper central incisors, followed by the lateral incisors and lower incisors.[1,5]

Traumatic dental injuries are classified as types of traumas on

(i) hard tissue and pulp,
(ii) periodontal tissues,
(iii) supportive bone,
(iv) gingiva and oral mucosa.[6]

Subluxation has been defined as the loosening of the tooth due to damage of periodontal ligament (PDL); but displacement is not observed clinically and radiographically.[7] Due to the damage of the neuro-vascular supportive tissue of the pulp, various undesirable consequences may occur after subluxation.[1] The studies revealed that symptoms such as discoloration, canal obliteration or root resorption may be observed over time.[8,9] Pedrini et al.[10] reported that 69% of 68 teeth with pulp necrosis were diagnosed within the first 3 months after subluxation injury. Extrusion is characterized by the partial axial displacement of the tooth from the socket. The mobility of the tooth increases with partial severance of PDL attachment

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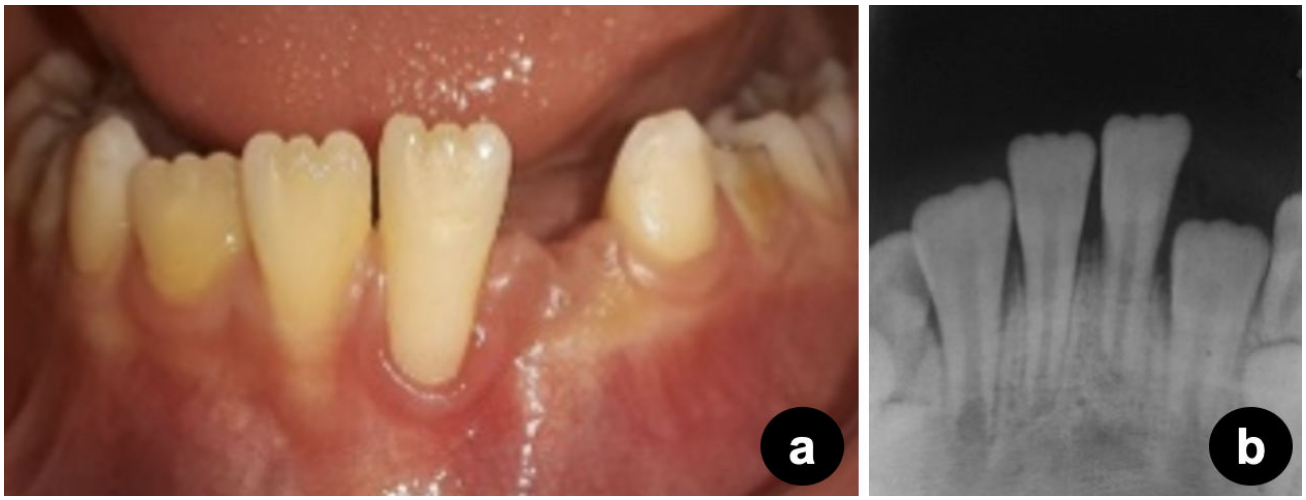

Figure 1. a: Preoperative view of Case 1 **b:** Preoperative radiograph showing extruded tooth.

and the damage of the apical neurovascular bundle. The healing process is stimulated through the reorganization of PDL and the regeneration of the vascular and nerve connections of the pulp.[7,11] Lee et al.[12] reported that pulp necrosis was experienced in 43% of extruded teeth. Endodontic treatments may be required in cases where pulpal pathologies are observed.

Root fractures, which constitute 0.5-7% of injuries in permanent dentition, are defined as those that involve cementum, dentine, and pulp.[7] The location of the fracture line can be observed at coronal, middle or apical third.[13] It has been shown that three healing modalities are considered for root fractures: hard tissue healing, connective tissue healing, and non-healing with granulation tissue.[7]

The primary goal of the treatment of TDI is to provide stabilization by correct diagnosis in the early stage. Treatment approaches vary depending on the vitality of the pulp, the position of the tooth, the age of the patient, and the stage of root development.[14] When the root canal treatment is required, calcium silicate-based root canal filling materials promise successful results considering their advantages such as impermeability, biocompatibility, and dimensional stability.[15] This case series aimed to present treatment plans and 2-year follow-up of upper and lower anterior teeth with different late-admitted traumatic dental injuries.

Case Reports

Case 1

An 8-year-old male patient consulted with the Department of Pediatric Dentistry with a complaint of mobility in teeth. It was learned that the patient had a bicycle accident 20 days prior and no treatment was applied in the meantime. Intraoral examination revealed mobility in tooth #31, gingival recession, and negative response to cold sensitivity test (Chloraethyl, Wehr, Germany) and a displacement of 2 mm along the axis (Figure 1a). Radiographic examination showed altered periodontal ligament space and immature root with open apex. The tooth #31 was diagnosed as extrusion (Figure 1b).

Due to late clinical admission, the tooth #31 could not be repositioned because the socket was not appropriate. A semi-rigid splint was applied between teeth #33 and #43 for 14 days and regenerative endodontic treatment was performed to #31. The protocol of the American Association of Endodontists was used as described below[16], the tooth was isolated with a rubber dam and the access cavity was prepared. The root canal was irrigated with 20 mL 1.5% sodium hypochlorite (NaOCl) solution followed by 20 mL sterile saline and dried with paper points. Equal proportions of ciprofloxacin (Cipro Biofarma, Istanbul, Turkey) and metronidazole (Flagyl Eczacibasi, Istanbul, Turkey) were ground and mixed with sterile saline. This antibiotic paste was placed in the root canal below the cemento-enamel junction using dental syringe. The access cavity was temporarily sealed with a sterile cotton pellet and restorative glass ionomer cement (Ionofil, Voco, Cuxhaven, Germany). After 3 weeks, the patient was asymptomatic. After applying a rubber dam, the access cavity was reopened, the antibiotic mixture was removed by irrigation with 20 mL sterile saline, 20 mL 17% EDTA and the root canal was dried with paper points. Bleeding into root canal was created by over-instrumentation at 2 mm past the apical foramen. Coronal third of the root canal was sealed with Biodentine (Septodont, Saint Maur des Faussés, France) over the blood clot, the tooth was permanently restored with reinforced glass ionomer cement (Ketac ™ Molar Easymix, 3M ESPE, Seefeld, Germany) and composite resin (Clearfil Majesty, Kuraray, Osaka, Japan).

In order to correct the anterior crossbite and to eliminate the occlusal trauma that may occur, vertical dimension of occlusion was increased by using inclined composite resin. When the upper anterior teeth reached a sufficient crown length, a removable appliance with the bite plane and labiolingual springs were used. The patient was recalled at 3-week intervals and the spring was activated. At the end of three months of treatment, the anterior crossbite was successfully corrected and gingival recession in tooth #31 was eliminated (Figure 2).

In the clinical and radiological follow-ups, no symptoms were observed, the periodontium was radiographically normal (Figure 3a-b), and apical closure was observed at the 12th month (Figure 3c). However, at the periapical radiograph taken at the 24th month, there was evidence of pulp canal obliteration at tooth #31 (Figure 3d). The patient is scheduled for further follow-up.

Case 2

A 13-year-old male patient was referred to the Department of Pediatric Dentistry with the complaint of loosening of tooth #21. It was learned that the patient had a traffic accident 3 days earlier. Clinical examination revealed damage to the nose, lips and mouth mucosa and mobility in teeth #11 and #21 (Figure 4a). In periapical radiography, presence of slight radiolucency was observed in the periapical region of tooth #11 and

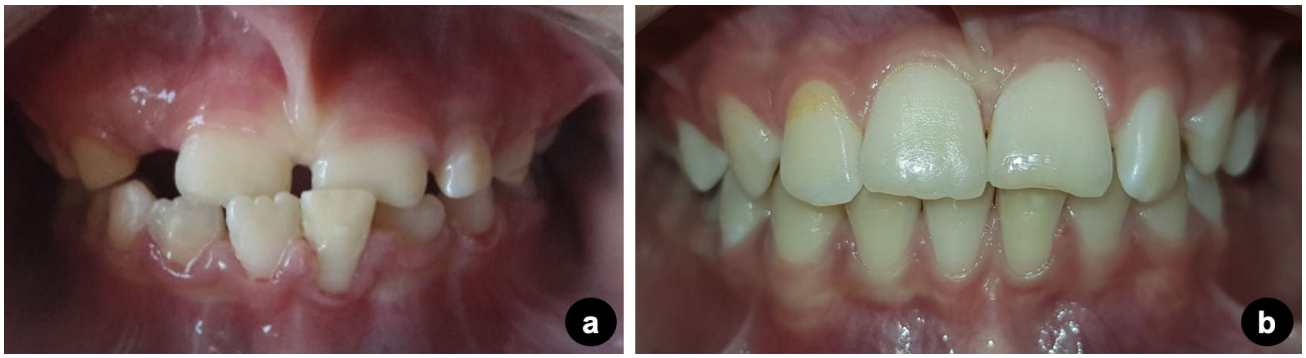

Figure 2. a: Pretreatment view of anterior crossbite. **b:** Intraoral photograph at the 24th month.

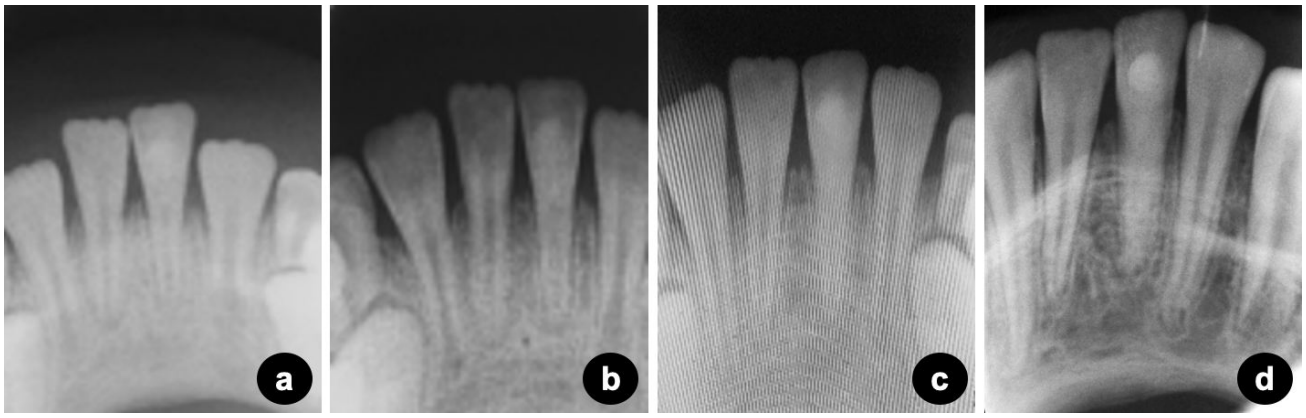

Figure 3. a:3-month follow-up radiograph. **b:** 6-months follow-up radiograph. **c:** At the 12-months follow-up, apical closure was evident. **d:** At the 24th month, pulp canal obliteration at #31 was observed.

diagnosed as subluxation; meanwhile horizontal root fracture was detected in the apical third of tooth #21 (Figure 4b).

A semi-rigid splint was applied between teeth #13 and #23 for 4 weeks. Following a negative response to the cold sensitivity test on tooth #21 in the second week, coronal part of the fracture line was considered as an immature tooth and root canal treatment was performed. The access cavity was prepared and the coronal pulp was removed. Root canal was instrumented and irrigated with 2.5% NaOCl, sterile salin. CaOH based root canal sealer (Kalsin, Aktu Tic, İzmir, Turkey) were placed into canals. After 3 weeks, permanent root filling was applied using Biodentine and the tooth was permanently restored with reinforced glass ionomer cement (Ketac ™ Molar Easymix, 3M ESPE, Seefeld, Germany) and composite resin (Clearfil Majesty, Kuraray, Osaka, Japan). At the 2th month of the follow-up, after the diagnosis of pulp necrosis in tooth #11, root canal treatment was initiated. Neo-MTA (Avalon Biomed Inc., Bradenton, FL, USA), which is a calcium silicate-based material, was used as permanent root filling material. In the clinical and radiographic controls at the 3rd, 6th, 12th, 18th, and 24th month, no symptoms were observed in the teeth, the fragments were healthy and no granulation tissue was formed in the tooth #21 (Figure 5, Figure 6). The patient is scheduled for further follow-up.

Discussion

Parameters such as correct diagnosis, appropriate treatment timing and long-term follow-up in traumatized teeth are all known factors affecting the success of the treatment.[17] Traumatic dental injuries are defined as an emergency that requires early intervention.[18] Therefore, it is important that patients apply to the clinic at the appropriate time in order to increase the chances of success of the treatment.

In severe extrusion cases, early repositioning is a very important stage in the course of the treatment, whereas in Case 1, the late admission of the patient prevented the extruded tooth #31 from being repositioned. It is thought that regeneration capacity will decrease as the probability of starting the process leading to pulp necrosis increases the possibility of damage to living tissues as a result of the severity of the trauma.[19–21] However, successful results can be achieved by applying regenerative endodontic treatment in cases with traumatized teeth with open apex in late-admitted patients.[22] For this reason, in the present case, regenerative endodontic treatment was preferred to the extruded tooth and it was observed that the apical closure was completed in the 12th month.

In cases of root fractures, the success of the treatment depends on factors such as the severity of the trauma, the location of the fracture, the placement of the coronal part and the degree of root formation. Calcified tissue healing, which is the most ideal result, is possible by splinting the teeth as soon as possible and in a way that the broken parts match each other.[23] However, if the fractured parts are separated from each other and the integrity of the pulp is disrupted as a result of the pre-intervention delay, the periodontal ligament cells initiate the healing process and hence, the fracture line joins with the connective tissue.[11,16,24] Accordingly, in Case 2, who applied to the clinic 3 days after the trauma, it is thought that healing occurred with fibrous connective tissue in the fracture line in tooth #21. It is reported that the apical fragment maintains vitality due to revascularization capability.[25] In the present case, root canal treatment was applied only to the coronal part of tooth #21, and no pathology was found in the apical part at the end of the 24-months follow-up period.

In addition to the correct diagnosis, appropriate treatment

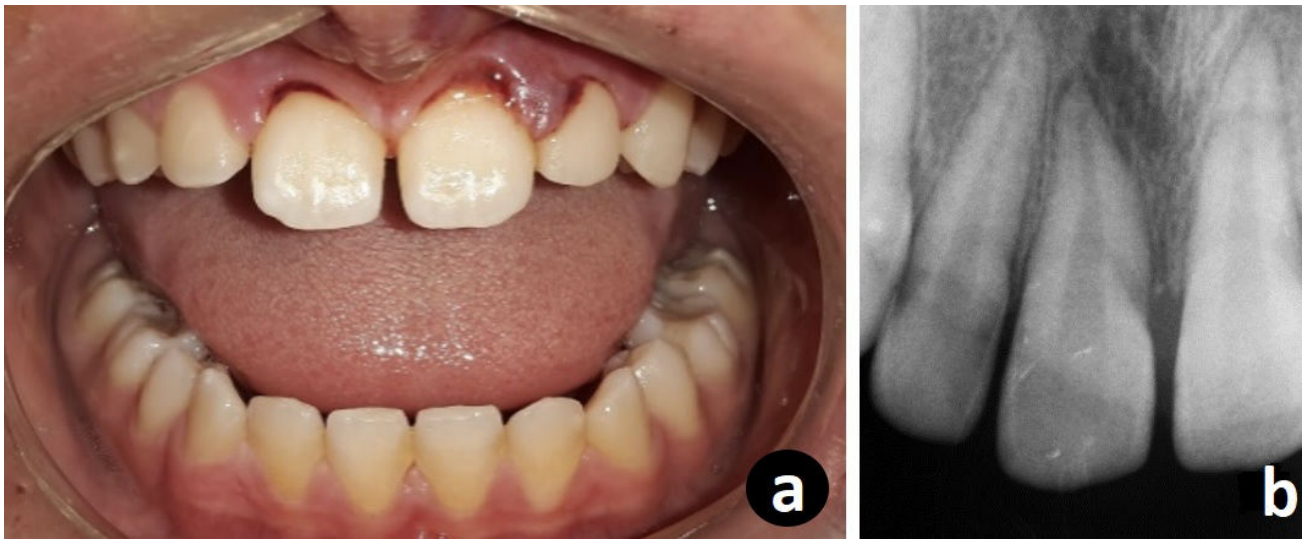

Figure 4. a: Preoperative view of Case 2. **b:** Preoperative radiograph showing horizontal fracture in the apical-third of the root of the tooth #21.

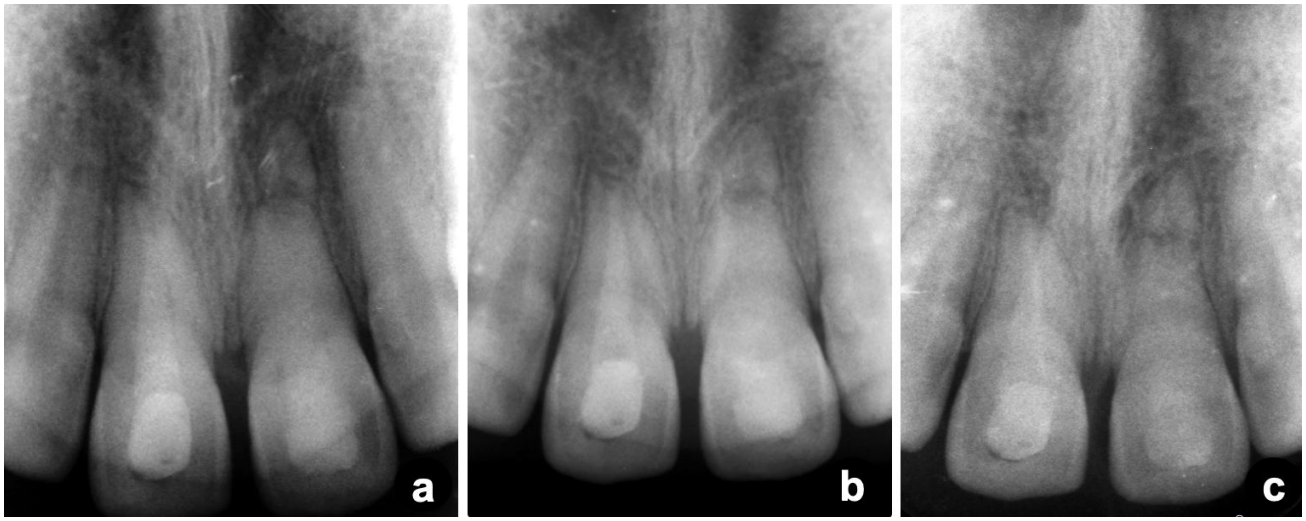

Figure 5. a:3-months follow-up radiograph after endodontic treatment. **b:**6-months follow-up radiograph. **c:**12-months follow-up radiograph.

Figure 6. a: Intraoral photograph at the 24th month. **b:** 24-months follow-up radiograph.

timing, clinical and radiological follow-up of the teeth is also necessary for early detection and treatment of complications that may occur after traumatic injuries. In the guideline published by the International Dental Traumatology Association, follow-up for at least 5 years is recommended for extrusion, intrusion and lateral luxation injuries in permanent teeth, also for crown/root fracture, root fracture, and alveolar fracture. The main complications that can be observed after trauma are defined as pulp necrosis and infection, pulp cavity obliteration and root resorption.[17] Even if the symptoms are resolved in the short term, it is important that follow-ups take a long time, as complications may occur in the long term. As a matter of fact, it was found that root canal obliteration started in the 24th month follow-up in Case 1, which was followed up despite apical closure observation at 12th month. Andreasen[23] reported that root canal obliteration is more common in teeth with incomplete root development than in teeth with complete root development, and in extrusion, lateral luxation, and intrusion injuries. In addition, it is thought that the stimulation of osteogenic cell formation[24] as a result of Ca ion release from Biodentine, a calcium silicate-containing material, may be one of the reasons for root canal obliteration. The primary goal of regenerative endodontic treatments has been identified as symptom relief and bone healing, while the secondary goal is the thickening of the dentin walls, lengthening of the root length and apex closure.[16] In addition to achieving these goals, it was decided that clinical and radiographic follow-up should continue due to the tooth being clinically asymptomatic and because of the absence of symptoms of a progressive infection in periapical tissues and. Aesthetic concerns should also be considered in anterior teeth. Since the components of MTA have been reported to cause discoloration of dental tissue,[26] a number of clinical techniques are recommended prior to the use of this material.[27] In recent years, materials containing calcium silicate such as Neo-MTA containing tantalum oxide and Biodentine with zirconium oxide have been developed as an alternative to the aforementioned components and studies have shown that these materials do not lead to discoloration of tooth.[28] Biodentine and Neo-MTA, which have proven successful in this respect, were used in Case 1 and in both teeth in Case 2. In Case 2, the possible effects of the materials on success could thus be followed. Similarly, in both cases presented in this study, no clinical discoloration was observed at the end of the 24-months follow-up.

Conclusion

In this case series, treatment options of late-admitted traumatized permanent anterior teeth and prognosis in long term are presented. The prognosis of the tooth is affected by the type of the injury, treatment delay and the root development of tooth. In trauma cases, properly-timed endodontic treatments play a very important role in success. It should be kept in mind that satisfactory results can be obtained with regenerative endodontic treatment, which has many advantages over apexification or de-vital canal treatment options, even in late-admitted cases. Another factor that will affect the success is that the materials planned to be used in endodontic treatments can serve biological purposes, have appropriate clinical results due to their use in aesthetic areas and have easy-to-apply features. In order to provide the patient with satisfactory results in terms of aesthetics, phonation and function, correct treatment plan and regular follow-ups are of vital importance.

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Author Contributions

C.Ç and N.Ö conceived the ideas; C.Ç, B.N.Y and N.Ö collected and analyzed the data; C.Ç, B.N.Y and N.Ö led the writing.

Conflict of Interest

The authors declare no conflict of interest related to this study.

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REVIEW ARTICLE

Adenomatoid Hyperplasia of The Oral Cavity: A Diagnostic Dilemma

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Abstract

This review study presents literature review and discusses the clinical significance of Adenomatoid Hyperplasia, a commonly misdiagnosed lesion. This rare entity has been seldom presented and is not well enough described in the literature. Only 15 reports with 95 cases could be attained during the online literature search using the keywords: Adenomatoid, Tumor, Hyperplasia, Minor salivary Glands. Data revealed a tendency towards the male gender. Age distribution of patients did not reveal a tendency towards a specific age group but presented a peak incidence in the 4th and 5th decades. Location data revealed a tendency towards the palate, especially the hard palate. Most of the presented cases were asymptomatic and the most common initial diagnosis made was salivary gland tumor. It was concluded that, adenomatoid hyperplasia of the oral cavity may resemble a wide range of pathologies and in order to differentiate and to achieve a correct diagnosis, histological evaluation is fundamental.

Key words: Adenomatoid Hyperplasia; Adenomatoid Tumor; Hyperplasia; Minor salivary Glands

Introduction

Minor salivary glands, which is responsible %5 of daily saliva secretion, are found on the walls of the oral cavity and named as labial, buccal, palatal, lingual, minor sublingual, palatoglossal and Ebner glands. Labial glands are found between the oral mucosa and orbicularis oris muscle of lips. Their secretion is directly drained into the oral vestibule. Buccal glands are located between the mucosa lining of cheeks and buccinator muscle. Some of these glands are found around the opening of the parotid gland and sometimes visible are called molar glands. These glands are mixed mucous and serous glands. There has been a wide variety of pathology related to minor salivary glands in which Adenomatoid hyperplasia (AH) is one these pathologies. [1,2]

AH has been initially reported by Giansanti et al. in 1971. [3] Till today AH remain to be an uncommon hyperplastic lesion; comprising neoplasm-resembling lesions. [4] The etiology of AH is unknown; although it is thought that chronic local trauma may have a role. [5] It usually presents as bluish or reddish, asymptomatic masses or elevated nodules. [6] It may occur in all salivary gland-bearing areas of the body; in addition, reported cases concerning the oral cavity present the palate as the preferred site of occurrence. [7] Histologically it presents no abnormality other than an apparent hyperplasia of the salivary gland tissue and after adequate surgical excision of this benign lesion recurrence is not expected. [5] Its resemblance to pleomorphic adenomas and salivary gland tumors makes the lesion clinically important. [4]

Literature Review

The local IRB granted exemption in writing, due to the study's retrospective nature. Data collection was made in PubMed, Science Direct and Google Scholar databases with the keywords

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Table 1. Clinical review data on reports of patients with adenomatoid hyperplasia

No:	Authors	Article Type	Year	Cases	Age/ Gender	Location	Clinical Impression	Country
1	Giansanti et al.	CR	1971	2	44/F	P	Salivary Gland Tumour	USA
					24/M	PJ	Pleomorphic Adenoma	
2	Arafat A et al.	CR	*1981	10	55/M	RA	Fibroma	USA
					33/M	P	Glandular Hyperplasia, Adenoma	
					34/M	SP	Acinic cell tumour	
					35/M	P	-	
					24/M	HP	Pleomorphic Adenoma	
					43/M	P	-	
					45/M	PJ	Glandular Hyperplasia	
					UnA/UnA	SP	Fibroma	
					UnA /F	SP	Cylindroma	
					UnA /F	HP	-	
3	Brannon RB et al.	CR	1985	1	31/M	RA	Glandular Hyperplasia	USA
4	Brown FH et al.	CR	1986	2	22/M	SP	Salivary Gland Tumour, Neural Tumour	USA
					31/M	HP	-	
5*	Buchner A et al.	CR	1991	40	9-79, Mean 44,5/ 17F, 23M	HP=17, SP=10, PJ=6, RA=2, BM=2, ULM=1, LLM=1, T=1	-	USA
6	Barrett et al.	CR	1995	20	47/M	PJ	Pleomorphic Adenoma	UK
					26/F	HP	Glandular Hyperplasia	
					63/F	HP	Pleomorphic Adenoma	
					65/F	PJ	Fibroepithelial Polyp, Pleomorphic Adenoma	
					44/M	HP	Pleomorphic Adenoma	
					65/F	HP	Pleomorphic Adenoma	
					33/M	PJ	Pleomorphic Adenoma, Adenoid Cystic Carcinoma	
					41/M	HP	Lymphoma, Salivary Gland Tumour	
					39/F	SP	UnA	
					34/M	HP	Pleomorphic Adenoma	
					54/M	HP	Salivary Gland Tumour	
					36/M	HP	Lymphangioma	
					63/M	PJ	UnA	
					35/M	HP	UnA	
					67/M	PJ	UnA	
					67/F	HP	Pleomorphic Adenoma	
					49/F	PJ	Fibroepithelial Polyp, Pleomorphic Adenoma	
					62/M	PJ	Denture Hyperplasia	
					60/F	PJ	Denture Hyperplasia, Mucocele, Mucoepidermoid Carcinoma	
					54/M	RA	Neural Tumour	
7	Bryant C et al.	CR	1996	1	48/M	PJ	Salivary Gland Tumour	UK
8	Tagawa S et al.	CR	1996	1	65/M	SLG	-	Japan
9	Nozaki S et al.	CR	1996	1	13/F	PJ	Salivary Gland Tumour	Japan
10*	Campos LA	CR	1996	12	26-67, Mean 47/ 7F, 5M	SLG	-	Colombia
11	Chen YK et al.	CR	1999	1	49/M	RA	Fibroma, Neurofibroma	China
12	Shimoyama T et al.	CR	2001	1	31/M	HP	Pleomorphic Adenoma	Japan
13	Sharma GK et al.	CR	2011	1	20/M	LLM	Mucocele	India
14	Manor E et al.	SR	2013	1	52/F	HP	-	Israel
15	Dereci Ö, Çimen E	CR	2014	1	48/M	BM	Salivary Gland Tumour	Turkey

* Individual data for cases was not present.

Abbreviations: CR=Case Report, SC=Short Communication, M=Male, F=Female, RA=Retromolar Area, P=Palate, SP=Soft Palate, HP=Hard Palate, PJ=Hard-Soft Palate Junction, BM= Buccal Mucosa, ULM=Upper Labial Mucosa, LLM=Lower Labial Mucosa, T=Ventral Aspect of the Tongue, SLG=Sublingual Gland, UnA=Unavailable.

'adenomatoid', 'adenomatoid hyperplasia', 'Salivary gland', 'Minor salivary gland' keywords. Articles only in English language and reports on humans have been selected for the study. Since 1971, to the best of our knowledge, only 15 case reports, presenting 95 individual cases have been published in the English-language literature (Table 1).[3–17] A new case has also been added to previously existing data. The review revealed 24 papers, of these papers, 8 could not be fully accessed[18–24], one was related to the subject 'Adenomatoid Ductal Proliferation'[25] and one involved macaque monkeys.[26]

Adenomatoid hyperplasia of the minor salivary glands is an uncommonly reported entity in literature. The majority of cases were presented from the USA (55 cases), followed by the UK (21 cases), Colombia (12 cases), Japan (3 cases), Turkey, China, India, Israel (1 case). Nevertheless, a great number of literature in Japanese was also present in literature.

Gender distribution revealed patients to be 39.58% female (38 patients) and 59.37% male (57 patients); for 1 patient (1.04%) gender data was not available. This data revealed a tendency towards the male gender concerning AH.

Features of the Lesion

Age distribution revealed patients to be 1% between the age range of 0–9, 4.3% between the age range of 10–19, 8.3% between the age range of 20–29, 19.8% between the age range of 30–39, 18.7% between the age range of 40–49, 13.5% between the age range of 50–59, 16.7% between the age range of 60–69 and 2% between the age range of 70–79. For three patients (3.1%) age data was not present. For the remaining 12 patients (12.5%) presented by Campos et al. (13), age data was not present for each individual case but the age range for cases was explained as 26–67 years with a mean of 47 years. This data revealed a higher frequency in the in the 4th, 5th, 6th and 7th decades of life compared to other age groups. Although this data did not reveal a tendency towards a specific age group it presented a peak incidence in the 4th and 5th decades.

Data concerning locations of the AHs revealed the lesion as 6.3% in the retromolar area, 71.9% on the palate (presented as 4.2% palate, 15.6% soft palate, 33.3% hard palate, 18.8% hard-soft palate junction), 4.2% on the buccal mucosa, 1% on the upper labial mucosa, 2% on the lower labial mucosa and 13.5% in the sublingual gland. This data revealed that AH had a tendency towards locating itself on the palate, especially the hard palate.

Differential Diagnosis

Among the presented cases, the most common initial diagnosis made was salivary gland tumor involving benign pleomorphic adenoma and adenoma, and malignant mucoepidermoid carcinoma and adenoid cystic carcinoma (21 cases). Salivary gland tumors occur much more commonly in the major glands (80–85%) and the majority is of benign nature (75–80% for major glands, 50–55% for minor glands).[27] Pleomorphic adenoma (PA) is a benign, mixed and most commonly encountered salivary gland tumor. It is a slow-growing, painless mass, commonly occurring in the 5th decade of life with a predilection to the female gender. Although the most common localization of PA is the major salivary glands, especially the parotid gland (>80%), it may also appear in the minor salivary glands with the palate being the most common intraoral site.[27] With its clinical features very much resembling to AH, it was the most common initial diagnosis made among salivary gland tumors (11 cases).

When clinical impressions were evaluated, it was observed that other differential diagnosis of AHs involved fibroma, acinic cell tumor, cylindroma, fibroepithelial polyp, lymphoma and lymphangioma, denture hyperplasia, mucocele, and neurofibroma and neural tumor.

Although some cases referred with pain and tenderness, most of the presented cases were asymptomatic. Data of smoking habits and present dentures were not present for most cases.

As result of the present literature review it was concluded that AH of the oral cavity is a rare entity mostly occurring in male gender at the 4th and 5th decades of life, commonly presenting as asymptomatic masses and have a predilection to be localized at the palate. With these features, they may resemble a wide range of benign and malign pathologies. In order to differentiate the lesion from these wide ranges of pathologies and to achieve a correct diagnosis, histological evaluation is fundamental.

Author Contributions

All authors have contributed to; conception and design of the study, data collection and analysis, writing the manuscript, approval of the final version to be submitted.

Conflict of Interest

Authors declare no Conflict of Interests for this article.

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