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Quarterly

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Fluoride releasing dental materials used in orthodontics: Literature review

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Review Article

Abstract

BACKGROUND AND AIM: In this manuscript, fluoride releasing dental materials controlling demineralization in fixed orthodontic patients, and the current strategies to prevent white spots were evaluated.

METHODS: General literature review was carried out in SciVerse ScienceDirect databases. The search strategy included the terms from Medical Subject Headings (MeSH) created by National Library of Medicine.

RESULTS: 44 relevant studies were included and the respective data were extracted. Many studies showed new alternatives for the treatment of white spot lesions by the use of orthodontic appliances.

CONCLUSION: Patients receiving fixed orthodontic treatment should be instructed in a proper brushing technique using a fluoride containing toothpaste, and high risk patients should be bonded with fluoride releasing agent. Additionally, it is recommended to apply fluoride varnish periodically during orthodontic treatment.

KEYWORDS: Orthodontics; Dental Materials; Fluorides; Tooth Demineralization

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Orthodontic treatment is one of the elective procedures to improve the patient's dentofacial appearance. The placement of orthodontic appliances is a standard procedure to align teeth with.^{1,2}

Patients taking orthodontic treatment have variations in oral environment, sometimes increasing bacterial counts, increasing salivary pH acidity, retention of food particles on the fixed appliances. Problems occur principally when fixed appliances are placed because the permanent retentive areas makes the oral hygiene difficult.³⁻⁵ This may cause decalcification in certain patients after

active treatment.^{4,6} The effects of demineralization differ from no perceptible alteration to white spots lesions on the teeth, or cavitation. They may require further therapy after orthodontic treatment to mask or remove them. Decalcification is a substantial problem during treatment, with 2% to 96% frequency.^{1,2}

Commonly applied material for treatment of lesions is topical fluoride.⁷ Fluoride-releasing products have been developed to be selected as restorative materials, liners, sealants, and orthodontic adhesives. All these mechanisms may therefore reduce

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demineralization and promote prevention of dental hard tissues. Nowadays, fluoride-containing dental materials are available for the professional use, including glass-ionomers, resin modified glass-ionomer (RMGI) cements, compomers, giomer, composites, varnishes, bracket adhesives, and inclusive fluoride-releasing elastomeric ligatures. However, it is assumed that the antibacterial and cariostatic properties are often associated with the amount of fluoride released.^{1,8-11}

Clinicians and researchers are concerned about enamel demineralization related with orthodontic treatment. Topical presentation of fluoride is known to reduce caries, plaque activity is blocking bacterial enzyme systems.⁴ Patients under orthodontic treatment have sources of topical fluoride that can use at home, including dentifrices and mouth rinses.^{12,13}

This manuscript evaluated literature for fluoride releasing dental materials controlling demineralization in fixed orthodontic patients; moreover, it discusses about the current strategies for preventing white spots, and makes respective recommendations.

Methods

General literature review was carried out, rather than systematic review. For this review we used some methodological steps followed in other studies.¹⁴

In December 2016, two reviewers (X. A. M-H. and E.N.S-V.) searched in SciVerse ScienceDirect databases for articles published from 2000 through 2016. The search strategy included the terms from Medical Subject Headings (MeSH) of National Library of Medicine (fluoride release, tooth remineralization, and orthodontics). They limited the search to studies involving fluoride releasing in orthodontics treatment which published in English. This review was a planned strategy to guarantee high compassion originally, rather than specificity.

Two researchers (R.J.S-V. and E. L-C.) reviewed articles and abstracts produced by

the search engine to classify those that appeared to be investigations addressing the structured review. They eliminated meeting reports and summaries, editorials, opinion pieces and unpublished papers.

Another researcher (C.E. M-S) abstracted the articles, evaluated the quality of the measures used in the studies and reviewed the studies' designs and analytic methods. He noted member enrolment, procedures of remineralization, and analysis methods. Differences in interpretation was discussed and resolved.

Results

By using this search strategy, we found 44 citations published between 2000 and 2016. Although we can see that various attempts have been made to modify materials and minimize white-spot lesion formation during fixed appliance treatment, demineralization is still a problem.

A lot of studies that show new alternatives for the treatment of white spot lesions by the use of orthodontic appliances (mainly fixed) were detected. However, we focused on those that investigated regarding fluoride release.

Effect of fluoride-containing toothpastes and mouth rinses: Toothpastes have been extensively recommended for cleaning teeth. However, in the last century the real therapeutics, mostly fluoride, were combined into their formulation, resulting in important developments to the oral health of people all over the world.¹⁵

Mouth rinsing is a simple method of self-application of fluoride; there was evidence that the combined regimen (fluoride toothpaste plus fluoride mouth rinse) increases the prevention factor, and the rate of the consumption of the fluoride mouth rinse as well as the consistent promotion of fluoride in the oral fluids to preserve an ideal fluoride absorption were important for caries control.^{13,16,17}

Given high concentration of fluoride in toothpastes (F = 1000-1500 ppm), it is credible that they respond with enamel surface

forming a reservoir of ions that are released after brushing. It has been reported that fluoridated toothpaste augmented discharge of fluoride. Several studies suggested that the enamel crown is an important reservoir for topically applied fluoride.^{9,10,18,19}

Moreover, It has been reported that dental brushing at least twice a day using a toothpaste (5000ppm fluoride), was superior in recovering enamel health after demineralization to lower concentration toothpaste (1000ppm fluoride). Concentration and doses of fluoride for dental application are discussed. Fluoride materials that release a larger quantity of fluoride are more bioactive to prevent decalcification and caries. Lesser concentrations of fluoride can be more convenient in enamel recovering. Higher quantity of fluoride might be inconvenient for remineralization. In brief, higher dose of fluoride is better for prevention formation and lower dose of fluoride is better for the remineralization.⁷

Fluoride varnishes: Fluoride varnishes were developed over 30 years ago to increase the connection period with enamel, allowing greater acceptance of fluoride ions into the tooth. In a recent study, certain fluoride varnishes were shown to release fluoride for as long as 28 weeks. Fluoride ions inspire the formation of calcium fluoride and fluoroapatite. This reaction improves remineralization of the etched enamel, making it more unaffected to demineralization.^{20,21}

The effectiveness of combined fluoride varnish and antimicrobial agents in preventing white spot lesions has been investigated. There was no difference in the development of white-spot lesions in teeth treated only with fluoride varnish versus teeth treated with an antimicrobial agent combined with fluoride varnish. Other studies have reported the physical properties and effectiveness of varnishes in reducing dental caries.^{5,17,21,22}

Tooth decalcifications can be developed quickly around brackets. Some scientists described that the submission of fluoride

before or at time of orthodontic fixed appliances placement did not alter the adhesion of the attachments.²⁰

Resins: Direct placement of brackets with a light-cured composite resin began in 1975 and it has become the standard method in clinical practice as well as the most common technique.²³⁻²⁵

Composites may have fluoride in diverse forms, such as mineral salts or leachable glasses. Thus, not only the quantity of fluoride, but also the type and particle size of the fluoridated filler, kind of resin, silane treatment, and porosity might be important issues to fluoride release. Integration of inorganic fluoride enlarged releasement. Most of the fluoride is already released during the setting reaction, followed by a lesser quantity of long-term fluoride release.^{8,26,27}

The amount of fluoride released from composite resins is significantly lower than that from glass-ionomer cements and compomers. Therefore, it is uncertain that fluoride-releasing composites can inhibit caries. Recently, numerous composite resins filled with fluoridated glass particles, which can give a similar level of fluoride release to compomers, have been developed. It is reported that these materials were effective in caries inhibition in vitro. However, it is questionable whether the composite resins filled with fluoridated glass particles can have a significant caries preventive effect over a longer period, because the quantity of fluoride ions released from these materials declines with the aging of the material and finally reaches a low level.^{23,28}

Ionomers: To be clinically successful, composites require a dry field after acid etching of the enamel surface. Because of these problems, glass ionomer cements (GICs), which have the distinct advantage of fluoride release, have been studied as another material for orthodontic bonding.²⁹⁻³¹

Diversity of ions are released from the glass including fluoride during reaction phase.^{8,26,29} Initial high release from glass-ionomers (first 24h) is possible due to the burst

of fluoride released from the glass particles when responding with the polyalkenoate acid through the setting response. It is known that the amount of released fluoride ions decreases subsequently to dental brushing. Studies have demonstrated that the increasing amount of fluoride ions released from GICs, after short time, is distribution measured and follows a decreasing gradient. In this manner, the initial high quantities of fluoride quickly decrease after 24h.⁸

The advantages of glass ionomers are the physiochemical bond of tooth through the absorption of calcium in teeth to carboxylate groups in the reacted GIC, and fluoride released or recharged. GIC also bonds to nonprecious metals and plastics and does not require a completely dry bonding field, as do resin-based composite materials. Despite the advantages of GIC, it has some inadequacies with orthodontic procedures for bonding. Research has demonstrated poor bond strength with GICs, about 2.4 to 5.5 MPa, by using either phosphoric or polyacrylic acids. GICs also have a greater rate of bonding failure than composite resin systems.³⁰

Resin-modified glass ionomer: GICs are sensitive to moisture as well as dehydration conditions while placing, and they have demonstrated poor physical and mechanical properties at setting. It was reported that, with the addition of a small amount of light-cured composite resin, poor early physical and mechanical properties of GICs could be improved. These improvements were combined in the material known as RMGI cement, introduced to the dental profession almost 20 years ago.³⁰

RMGIs were innovated by including methacrylate to the polyacrylic acid, which are light-cured.^{8,30} These materials have a true acid-base reaction on mixing, similar fluoride release and rechargeability as do GICs, but they will set on demand and are not nearly as sensitive to moisture or dehydration on setting as GICs. RMGIs also demonstrate better physical properties. Varied differences

of force in adhesion of RMGIs to dental structure range from 5.4 to 18.9 MPa.³⁰

Polyacid revised resins: To improve some properties such as tensile strength, manufacturers incorporated more amount of resin into GICs. These materials require enamel etching for adhesion. The name of these materials is polyacid modified composite resins (PMCRs), or compomers.⁸

Compomers contain macromonomers, such as bisphenol glycidyl dimethacrylate or urethane dimethacrylate, with low concentration of acid-functional monomers. Filler glass is equal to conventional GICs but in slighter dimensions as known from composites.⁸ These groups of materials do not release same amounts as GICs or RMGIs; however, some studies demonstrated fluoride release. Bond strengths for PMCRs have been reported to be 7.3 to 12.0 MPa.³⁰

Giomer: This is a new group of fluoride-containing esthetic materials for restoration. Giomer uses surface pre-reacted glass (S-PRG) technology. Manufacturers of giomers claim fluoride release, biocompatibility, and smooth surface. Their purported fluoride release and flexural strength, higher than RMGIs already prescribed in orthodontics, make these materials very attractive for research.³⁰

Adhesives: Advances in adhesive dentistry have led orthodontists to include new adhesives, composite resins, and bonding techniques into their clinical practices.³²⁻³⁵

The potential ability of fluoride release and absorption of orthodontic adhesives has attracted considerable interest for preventing enamel demineralization or white spot lesion formation.^{36,37} The fluoride in these materials induces an anticariogenic activity by increasing dentine resistance to acids present in the oral cavity. Adhesives with fluoride, have been shown to release ions with an initial burst at the time of curing, followed by a rapid decrease during subsequent days.^{10,38} Bioactive and antibacterial adhesives are considered useful to eliminate caries.^{35,39}

The use of adhesive systems in combination with fluoride releasing resins may reduce the caries inhibition effect. However, fluoride-releasing resin composites cannot be used without the application of the adhesive system because the bonding to dentine fails without such a system. Therefore, it becomes necessary to choose an adhesive system that reduces fluoride release as little as possible.^{2,35,40-42}

Self-etching primer (SEP) combines acid and primer in the same step, simplifies bonding procedures, reduces chair time, and avoids contamination.^{35,42,43}

Elastomeric ligatures: Fluoride-releasing elastomeric ligature ties containing tin fluoride (SnF_2) are currently available to orthodontists. An *in vitro* study has confirmed that the quantity of fluoride released initially by elastomeric ligature is high; however, levels dramatically decreased after seven days.⁴⁴ These materials may reduce salivary concentration of *Streptococcus mutans* (*S. mutans*), increase tooth resistance at 20 μm depth after a month in oral environment, and reduce decalcification during treatment.^{10,20} The use of 20 elastic modules releases 46.22 $\mu\text{gF/ml}$ during the first five days, 1.42 $\mu\text{gF/ml}$ after the second week, and 0.84 $\mu\text{gF/ml}$ after the fourth week; recommending should be replaced monthly.⁴⁵

This does not seem to be an option with prolonged effects, but can be a preventive tool that may help to avoid problems of demineralization and dental caries during orthodontic treatment.

Discussion

Patients develop considerably more white spots lesions when they are under orthodontic treatment, which might compromise the good health and esthetic appearance of the subjects at the end of the active treatment. Furthermore, the evolution of caries occurs sooner in patients with brackets. White spots lesions can convert visible around the brackets within 30 days after bonding bracket (formation of caries

generally takes 6 months).^{5,17} Thus, prompt diagnosis allows clinicians to perform minimally invasive therapy by using diverse agents for remineralizing to prevent progression of white spot lesions. In this context; patients undergoing orthodontic treatment should be instructed perfectly for brushing with fluoride containing toothpaste and mouth rinse, and topical applications with varnish are highly recommended because several studies suggest that the enamel crown is an important reservoir for topically applied fluoride.^{9,10,18,19} It has been described that fluoride varnish applied before or at the moment of bracket bonding did not inhibit the bond strength.²⁰

On the other hand, before placing brackets, enamel has to be conditioned with conventional acid etching technique or SEPs;^{42,43} selective etch or self-etch are both good alternatives specially if the bonding systems contain fluoride to prevent undesirable formation of white spot lesions. Moreover, composite resins or glass ionomers can be used for bonding orthodontic brackets. Both materials are fabricated with different presentation of fluoride (inorganic salts, leachable glasses, fillers, or organic fluoride). Most of the fluoride is already released during the setting reaction, followed by a smaller amount of long-term fluoride release.^{8,26,27} However, GICs are more effective to release fluoride ions.²⁹⁻³¹

For these reasons, in effort to obtain the best bonding properties of composite resins and more fluoride released as GICs, RMGI cements have been developed that are suitable materials for placing brackets. Bonding brackets with PMCRs are possible; although these modified composites are non-fluoride releasing materials. Moreover, giomers are another option for bonding orthodontics brackets, because this kind of composite modified resin, fabricated with S-PRG technology, increases fluoride ions released from the particles while keeping bond strengths.³⁰

In any case, fluoride releasing materials might perform as a reservoir for ions of

fluoride from topical source. Elastomeric ligatures for tying arch wires are another orthodontic material that can release fluoride and improve the concentration of ions in the mouth and prevent decalcification.⁴⁴

After all, it is not clear whether initial burst or long-term release may be clinically more important to prevent caries, as certain remineralizing mechanisms need rather low but constantly provided quantities of fluoride. Further studies are necessary to understand the release mechanism and improve white spot lesions prevention during orthodontic active treatment.

Conclusion

According to this literature review, it can be

concluded that patients receiving fixed orthodontic treatment should be instructed in a proper brushing technique using a fluoride containing toothpaste; and high risk patients should be bonded with fluoride releasing agent. Additionally, it is recommended to apply fluoride varnish periodically during orthodontic treatment. These groups of dental materials are prescribed to prevent undesirable white spot lesions during orthodontic active treatment.

Conflict of Interests

Authors have no conflict of interest.

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None.

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Incidence, location, and type of isthmus in mandibular second molars among individuals of an Iranian population

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Original Article

Abstract

BACKGROUND AND AIM: Isthmuses are narrow and strip shaped connections between two canals containing pulpal tissue that may encompass bacteria as well. They are hardly accessible for cleaning; therefore, success and failure of root canal treatments could be affected by their presence. The present study was carried out aiming to evaluate the incidence, location, and type of isthmus in mandibular second molars (MSMs) among individuals of an Iranian population.

METHODS: 80 MSMs with inclusion criteria, belonging to individuals of an Iranian population were collected and disinfected. After embedding the samples' roots in the acrylic resin, teeth were sectioned horizontally at 2, 4, and 6 mm distances from the apices. Then they were viewed and recorded by a stereomicroscope under $\times 30$ magnification. According to Kim classification, two endodontists recorded the number of canals, incidence, and type of the isthmuses. In cases of disagreement, a third endodontist was involved to judge on the right opinion between the two. The acquired data were analysed using chi-square test.

RESULTS: The results showed that 96.3% and 3.75% of MSMs had two and three roots, respectively. Type V (described in the following) was the most frequent type of isthmus at mesial and distal roots. C-shaped canals composed 3.7% of the samples and showed isthmus at all the three sections. There was a significant difference in the distribution of isthmuses ($P < 0.001$).

CONCLUSION: According to this study, different types of isthmuses prevail in high rate of mesial and about half of the distal roots of MSMs, which are important for root canal cleaning and shaping.

KEYWORDS: Anatomy; Molar; Tooth; Root Canal

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Detection and debridement of the isthmuses are one of the most important factors affect the success of endodontic treatments of posterior teeth.¹ Isthmuses are narrow and strip shaped connections between two canals containing pulpal tissue, which are hardly accessible by routine root canal instruments.² Left remnants of untouched pulpal tissue are

of utmost significance while encountering the necrotic teeth accumulated by bacteria.³

Isthmuses could be found in C-shaped and two-canal roots.⁴ The incidence of isthmus in mesial roots of mandibular molars has been reported to be 54%-89%, most of which occurring at 4-6 mm distances from the apex.⁴⁻⁸ In a study conducted on mandibular second molars (MSMs) among Chinese population,

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85% of isthmuses were detected at 5 mm distance from the apex.⁵ In a similar study carried out in Brazil, it was revealed that the most common location for isthmus was at 5.5 mm from the apex with complete type being the most incident.⁹ Evaluation of the location and type of isthmuses present in mesial roots of mandibular first molars has been documented among the individuals of an Iranian population.¹⁰ To the best of our knowledge, there was no study regarding the investigation of the characteristics of this anatomical feature in MSMs of Iranian population. Therefore, in order to improve our knowledge with respect to the internal anatomy of teeth and to decrease the failure rate in root canal treatments, this study was conducted with the aim to assess the incidence, location, and type of the isthmuses existing in MSMs among individuals of an Iranian population according to Kim classification.⁶

Methods

This cross-sectional descriptive study was approved and registered by the ethics committee of Tehran Dental School, Islamic Azad University, Tehran, Iran, under the number 24617. In this study, 80 MSM belonging to Iranian population, which have been extracted due to periodontal problems, were collected randomly from different clinics and dental offices in Tehran. Initially the total of 150 samples were kept in 5.25% sodium hypochlorite solution for an hour to be disinfected. After taking a radiography image, exposed bucco-lingually, teeth samples having internal or external resorption, open apex, crack or fracture, calcification, or previous root treatments were excluded from the study. Root surfaces were debrided from any calculus or remaining organic tissue by a scaler. Afterwards, the teeth were placed in an acrylic resin from their cervical to apical parts and horizontal sections were prepared at 2, 4, and 6 mm distances from the apex perpendicular to the long axis of the root, using a low-speed handpiece with a thin

metallic disk (0.17 mm long, 2.0 mm wide, D and Z, Germany).¹⁰ The sections were fixed onto a lam, viewed and recorded by a stereomicroscope (Nikon UFX-DX, Tokyo, Japan) connected to a camera, under $\times 30$ magnification. Two endodontists who calibrated the teeth samples regarding the types of isthmuses according to Kim classification prior to the study, marked the number of canals, incidence, and type of the isthmuses. In cases of disagreement, a third endodontist was involved to judge on the right opinion between the two.

The Kim classification consisted of 5 types [Figure 1]:

Type I: Presence of two canals without a noticeable communication

Type II: Presence of two canals without a definite communication

Type III: Similar to type II but with three canals instead of two canals

Type IV: Extension of the main canal into the isthmus

Type V: Presence of a complete communication or corridor between the two canals

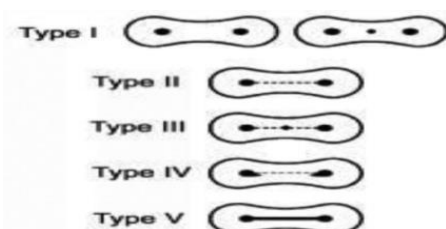


Figure 1. Isthmus classification⁶

When the root had one canal, it was called type 0. The acquired data regarding the relationship between the incidence and types of isthmuses with canal location were analysed using chi-square test after determining the incidence and confidence intervals. The statistical significance level was set at 0.05.

Results

Of all the 80 evaluated MSMs, 96.3% and 3.7% were two and three rooted, respectively. 95.0% of mesial and 36.3% of distal roots were reported to have two canals.

Table 1. Incidence and types of isthmuses at mesial and distal roots of mandibular second molars (MSMs) along with C-shaped canals at different levels from the apex

Type	2 mm			4 mm			6 mm		
	Mesial	Distal	C-shape	Mesial	Distal	C-shape	Mesial	Distal	C-shape
I [n (%)]	21 (26.25)	2 (2.50)	-	15 (18.75)	1 (1.25)	-	12 (15.00)	-	-
II [n (%)]	14 (17.50)	1 (1.25)	-	25 (31.25)	1 (1.25)	-	26 (32.50)	1 (1.25)	-
III [n (%)]	-	-	-	-	-	-	1 (1.25)	1 (1.25)	-
IV [n (%)]	6 (7.50)	1 (1.25)	-	10 (12.50)	1 (1.25)	-	10 (12.50)	2 (2.50)	-
V [n (%)]	29 (36.25)	3 (3.75)	3 (100)	25 (31.25)	15 (18.75)	3 (100)	27 (33.75)	25 (31.25)	3 (100)
0* [n (%)]	10 (12.50)	73 (91.25)	-	5 (6.25)	62 (77.50)	-	4 (5.00)	51 (63.75)	-
%	100	100		100	100		100	100	
P	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

*One-canal root

C-shaped canals composed 3.7% of the samples and showed isthmus at all the 3 sections. Table 1 lists the comparison of the incidence and type of isthmuses at mesial and distal roots and C-shaped canals at different levels of tooth sectioning. In addition, figure 2 shows various types of isthmuses at different sections. The incidence of isthmus at mesial roots' sections from the apex was as 61.3%, 75.1%, and 80.1% at 2, 4, and 6 mm, respectively. Similarly, the incidence of isthmus at two canal distal roots was, 6.4%, 21.2%, and 36.4% at 2, 4, and 6 mm, respectively from the apex; with complete connections being the most common type (type V). Moreover, there was a significant difference in the distribution of isthmuses ($P < 0.001$).

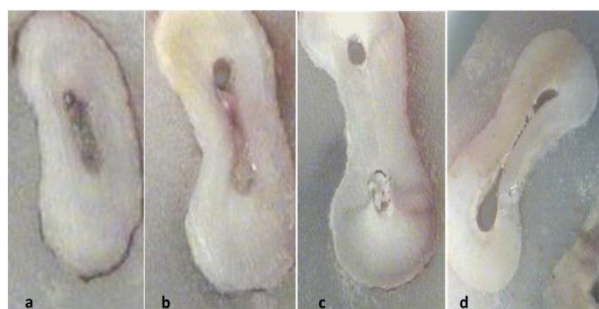


Figure 2. Types of isthmus, sections, and distances from the apex respectively in mesial root of mandibular second molars (MSMs): (a) Type V, first section, 2 mm; (b) Type V, second section, 4 mm; (c) Type II, third section, 6 mm; (d) Type IV, third section, 6 mm

Discussion

A methodology to study the internal anatomy of a tooth is a primary tool when

searching for isthmuses. In this study, 80 MSMs were used to evaluate incidence, location, and type of isthmus among individuals of an Iranian population using stereomicroscope at levels of 2, 4, and 6 mm from the apex according to Kim classification.

The results obtained in the present study indicated that 96.3% and 3.7% of MSMs were two and three-rooted, respectively. 95.0% of mesial and 36.3% of distal roots were reported to have two canals. C-shaped canals comprised 3.7% of the samples, with an isthmus being present at all three levels.

Different evaluation methods have been used in various investigations studying isthmuses, including, sectioning, staining, and clearing, sectioning and viewing under stereomicroscope, using micro-computed tomography, and cone beam computed tomography (CBCT).^{4,5,9,11}

In the present study, MSMs were evaluated; in contrast to other studies that assessed mandibular first and second molars as a whole,^{5,12} or used a smaller sample size when studying one type of tooth.^{2,6}

In this study, the incidence of an isthmus being present at 6 mm from the apex in mesial roots was found to be 80.1%, which about half of them had complete connections. This finding was in accordance with a study by Fan et al. in China, who utilized CBCT to evaluate the incidence of an isthmus being present in MSMs at 5 mm distance from the apex.⁵ In addition, they reported that the samples, which had complete connections, accounted for 76%, which was much higher

than the present study. In some studies, assessing mandibular molars as a whole, not distinguishing between first and second molars, the incidence of isthmuses in mesial roots was reported to be 54%-80% at 4-5 mm from the apex.^{10,13}

IN the present study, an isthmus was found at 4 mm from the apex of mesial roots in 75.1% of cases, 43.8% of which were of the complete type. Hsu and Kim, in a study conducted in North America using sectioning technique, reported the incidence of isthmuses in MSMs at the 4 mm level from the apex to be 80.0%.⁶ Some other studies announced this rate as 33%-83% at the 4 mm level in mesial roots of mandibular molars.^{3,7}

In the present study, the rate of an isthmus being present at 2 mm from the apex of mesial roots was 61.3%, 43.8% of which were of the complete type. In some studies on the evaluation of mandibular molars, the total incidence of an isthmus in mesial roots at 2 mm distance from the apex was reported as 30%-70%.^{6,10}

The dissimilarity noted in different studies could be due to variations in the number of samples, ethnicity, or the evaluation techniques.

Mehrvarzfar et al. used a sectioning technique and observed the samples under a stereomicroscope.¹⁰ In this study, the incidence of isthmuses in mesial roots of mandibular first molars, at 2, 4, and 6 mm from the apex, was 91.7%, 88.3%, and 70.0%, respectively. The rates reported in this study were higher at all three levels when compared to the findings of the present study. However, the incidence rate of a complete isthmus at 4 mm from the apex was similar in both studies. In conclusion, the presence of isthmuses among samples from an Iranian population was higher in more

coronal sections in comparison with more apical sections. Nevertheless, both mandibular first and second molars showed a high rate of isthmuses in all three sections.

In the present study, 36.00% of distal roots were found to contain two canals, which is in contrast to the findings of the study by Lima et al. who reported that 65.40% of the lower second molars contained two canals.⁹ C-shaped canals comprised 3.75% of the samples and always showed an isthmus of complete type at all the three sections. However, in a systematic review pertaining to the Iranian population, the total incidence of C-shaped canals was 6.96%, which is much less than Asian populations but closer to Middle Eastern countries.¹⁴

The mesial roots of human MSMs have a high incidence of isthmuses, which may be along with clinical implications, especially with regard to root canal debridement and surgical endodontics being performed on the mesial roots of these molars.

Conclusion

Within the limits and conditions of this study, a high rate of mesial roots were found, and almost half of the distal roots of Iranian MSMs present different types of isthmuses, which could be a reservoir for accumulating bacteria and therefore, endangering the success rate of surgical and non-surgical endodontic treatments.

Conflict of Interests

Authors have no conflict of interest.

Acknowledgments

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Incidence of dental developmental anomalies in permanent dentition among Ardabil population, Iran, in 2015-2016

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Original Article

Abstract

BACKGROUND AND AIM: Dental anomalies are typically detected in radiographic screening. The present study was conducted with the aim of investigating the dental anomalies found in panoramic radiographs taken from the study population in Ardabil, Iran, in 2015-2016.

METHODS: The present study was conducted on 1800 panoramic radiographs obtained from 799 men and 1001 women in the Radiology Department, Dental Faculty of Ardabil University of Medical Sciences, Ardabil. The radiographs were precisely evaluated in terms of various dental anomalies, including root dilaceration, missing teeth, impaction, retained deciduous, supernumerary teeth, peg lateral teeth, talon cusp, taurodontism, and lingual pit. The data were analyzed using the chi-square and Fisher's exact tests.

RESULTS: The results of this study revealed that 331 patients had at least one dental anomaly. Dilaceration with 42.0% was the most common anomaly. The other anomalies detected in the radiographs included missing teeth, impaction, lingual pit, peg lateral teeth, retained deciduous teeth, supernumerary teeth, talon cusp, and taurodontism with a rate of 20.2%, 18.4%, 10.8%, 10.2%, 7.8%, 6.6%, 1.5%, and 0.3%, respectively. No cases of microdontia, macrodontia, germination, and fusion were observed. Dental anomalies were more incident among women than men ($P = 0.010$). Furthermore, the detected anomalies had a higher rate in maxilla compared to mandible ($P = 0.010$).

CONCLUSION: As the findings of this study indicated, dilaceration was the most common dental anomaly, followed by missing teeth and impaction, respectively.

KEYWORDS: Incidence; Dentition; Anomalies; Panoramic; Radiography

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Developmental dental anomalies are a series of structural changes in human dentition that are diagnosed with alterations in size, shape, position, and number of the teeth.¹ Disturbances in tooth formation may occur in different stages of tooth development and can be congenital or developmental.²⁻⁴ In this regard, genetic factors, like mutation of certain genes, and environmental factors can cause these conditions.^{5,6}

Dental anomalies are less common in

comparison to dental caries and periodontal diseases, however, they greatly interfere in the dental treatment planning.^{7,8} Dental anomalies create problems in the function, occlusion, and esthetics of the patients; therefore, the early diagnosis of these deviations are of paramount importance.⁹⁻¹¹ Since most of these disorders are asymptomatic, the early detection of these anomalies requires the use of panoramic radiographs during the clinical dental examination.¹² The incidence of dental

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anomalies yields significant data for phylogenic and genetic investigations. Moreover, these anomalies considerably affect the orthodontic, endodontic, and prosthodontic treatment planning.

The incidence of dental anomalies has been investigated among different populations. Nonetheless, different results have been reported regarding the incidence and distribution by gender, age, and site of the occurrence. With this background in mind, the present study was conducted to determine the incidence of dental anomalies and the most involved teeth through the examination of patients' panoramic radiographs.

Methods

This study was based on the evaluation of the panoramic radiographs of 1800 patients (including 799 men and 1001 women) referring to the Oral Radiology Department, Dental Faculty of University of Medical Sciences, Ardabil, Iran during 2015-2016. The inclusion criteria included age of > 12 years, sufficient enamel formation, and no history of permanent tooth extraction, except for the third molar.

In addition, the exclusion criteria included history of systemic diseases or syndromes (e.g., Down's syndrome, cleidocranial dysostosis (CCD), and ectodermal dysplasia), cleft lip and cleft palate, trauma or fracture of jaws, orthodontic treatment, and low-quality radiographs.

The teeth were considered impacted when their eruption interfered with other teeth, bone, or soft tissues. Taurodontism was defined as an apical displacement of the pulp chamber, elongation of the tooth trunk, and shortened roots. Dilaceration was defined as the abrupt deviation of the long axis of the crown or root portion of the tooth. In this study, roots with 20 degrees or more deviation from the normal axis of the tooth were considered to be dilacerations. Furthermore, the missing teeth were referred to congenital absence of teeth. Tooth supernumerary was defined by an increase in

the number of teeth.

The radiographs were studied by two expert dentists based on direct observational method using a view box. In order to reduce the radiographic misinterpretation, two oral radiologists carefully studied the findings and verified them. The patients' panoramic radiographs showed at least one dental anomaly. For all of the patients, the radiographs were ordered by other dentists for routine dental treatments during 2015-2016.

The radiographs were evaluated to recognize dental anomalies, including dilacerations, impacted teeth, supernumerary teeth, missing teeth, taurodontism, microdontia, macrodontia, gemination, fusion, dens in dent, talon cusp, and peg lateral. The collected data were analyzed using descriptive and inferential statistics including chi-square and Fisher's exact tests in SPSS (version 16, SPSS Inc., Chicago, IL, USA).

Results

This study comprised of 799 men and 1001 women including 44.4% and 55.6% of the subjects, respectively with the age range of 12-60 years. Out of the 1800 selected records, 331 (18.4%) cases had at least one dental anomaly. The incidence rates of anomalies were 11.4% and 7.0% among the women and men, respectively. The comparison of men and women in terms of the incidence of dental anomalies revealed a significant difference between them in this regard ($P = 0.001$). Maxilla was found to be more involved than mandible ($P = 0.001$). The distribution and incidence of developmental dental anomalies are presented in tables 1 and 2.

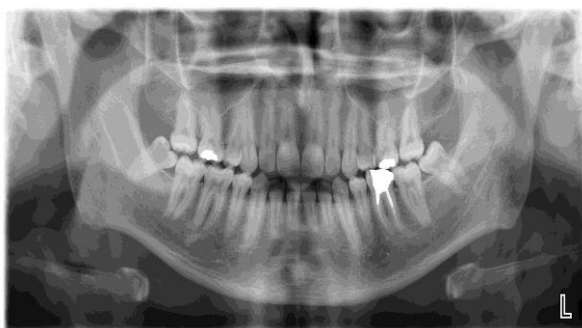
Dilaceration was found to be the most incident dental anomaly with 42.0% (Figure 1), followed by missing teeth and impaction with rates of 20.2% and 18.4% shown in figures 2 and 3, respectively. Additionally, taurodontism and dens invaginatus were observed in one and two patients, respectively. However, no case of macrodontia, germination, or fusion was detected.

Table 1. Incidence of anomalies among the population under study based on gender

Type of anomaly	Man	Woman	Total rate [n (%)]	P
Dilaceration	47	92	139 (42.0)	< 0.001
Missing teeth	37	30	67 (20.2)	0.392
Impacted teeth	19	42	61 (18.4)	0.009
Lingual pit	13	23	36 (10.8)	0.090
Peg lateral	13	21	34 (10.2)	0.170
Retained deciduous teeth	7	19	26 (7.8)	0.190
Supernumerary teeth	12	10	22 (6.6)	0.670
Talon cusp	3	2	5 (1.5)	0.650
Taurodontism	1	-	1 (0.3)	-
Total numbers of anomalies	152	248	400 (100)	-

**Figure 1.** Dilaceration of left maxillary and mandibular premolars

The most common involved teeth in dilaceration were mandibular first premolars, followed by mandibular second premolars.

**Figure 2.** Missing of right and left maxillary and mandibular second premolars

Furthermore, mandibular second premolar

was the most frequent missing teeth, followed by maxillary permanent lateral incisor. Maxillary canines and mandibular second premolars were the most incident impacted teeth. Supernumerary tooth was the next common anomaly with the incidence rate of 6.6%. Out of the 22 supernumerary teeth, mesiodens was the most common supernumerary tooth detected among 8 men and 3 women with the ratio of 2:1.

**Figure 3.** Impaction of left maxillary canine

The results of this study revealed a significant difference between maxilla and mandible with regard to impaction, missing, and retained dental anomalies ($P = 0.001$, $P = 0.038$, and $P = 0.050$, respectively). However, no such difference was observed in terms of other anomalies.

Table 2. Incidence of anomalies among population under study based on the site

Type of anomaly	Maxilla	Mandible	Total number [n (%)]	P
Dilaceration	59	80	139 (42.0)	0.075
Missing teeth	42	25	67 (20.2)	0.038
Impacted teeth	44	17	61 (18.4)	0.001
Lingual pit	34	2	36 (10.8)	< 0.001
Peg lateral	34	0	34 (10.2)	< 0.001
Retained deciduous teeth	18	8	26 (7.8)	0.050
Supernumerary teeth	14	8	22 (6.6)	0.200
Talon cusp	4	1	5 (1.5)	0.180
Taurodontism	1	-	1 (0.3)	-

Discussion

Developmental dental anomalies include changes in the number, morphology, size, and eruption of the teeth. Systemic or local factors may account for these anomalies.¹³ The incidence and degree of these anomalies are inconsistent for different population groups. The anomalies of the teeth are usually identified in routine clinical and radiographic examinations.

In the present study, the incidence of dental anomalies diagnosed by panoramic radiographs was approximately 18.4%, however, some other studies have reported different rates. In this regard, Kathariya et al. reported the incidence rate of 39.2% for dental anomalies among the school-age children in India in 2012.⁸

Furthermore, in the studies carried out by Ezoddini et al. in Yazd, Iran,¹⁴ Shokri et al. in Hamadan, Iran,¹⁵ and Yassin in Saudi Arabia,¹⁶ the incidence rates of dental anomalies were reported as 40.80%, 27.00%, and 25.39%, respectively. This discrepancy in the reports may be due to differences in evaluation criteria and also genetic and regional factors among the studies. In line with the other studies, in the current study, the women had a higher incidence rate of dental anomalies.^{2,7,10,17}

Dilaceration was the most common recorded anomaly in the present study as 42%. The most incident teeth with dilacerations were the mandibular first premolars, followed by mandibular second premolars. However, Ezoddini et al reported an incidence rate of 15% dilacerations in Yazd.¹⁴ This difference between the results of the present study and those of the aforementioned study may be due to the use of periapical radiographs instead of panoramic radiographs for the detection of the developmental disturbances in Yazd. Consistent with the present study, Saberi and Ebrahimipour reported that dilacerated teeth were the most common anomaly in Zahedan, Iran.²

According to the results of the present study, the incidence of missing teeth was

20.2%, which was generally higher than those obtained in other populations.^{7,14,17} The absence of teeth was bilateral in 52.2% of the cases. In the current study, men and women were comparable in terms of the incidence of missing teeth, which is in congruence with the findings of other studies. There are some differences in the literature concerning the description of the most frequently missing tooth, excluding third molars.

In this study, the most common congenital missing teeth were the mandibular second premolars and maxillary lateral incisors, respectively; this finding is consistent with the results obtained by Kim.¹⁸ In the studies performed by Gomes et al.¹⁹ and Gupta et al.,¹ the incidence of missing maxillary lateral incisors was higher than that of the mandibular second premolars.

The impaction of maxillary permanent canines is a dental anomaly often encountered in orthodontic practice. Tooth impaction accounted for 18.4% incidence in the present study, and the maxillary canine was the most impacted tooth. Kathariya et al. showed that impactions as 39.2% were the most incident anomaly among the Indian population, and most of the impacted teeth were related to maxilla.⁸ The Incidence rates of 44.76%, 8.30%, and 2.95% for impaction have been reported by Shokri et al.,¹⁵ Ezoddini et al.,¹⁴ and Ghabanchi et al.,⁷ respectively, in different regions of Iran. This inconsistency between the results might be ascribed to the consideration of third molars.

In the present study, the incidence rates of the supernumerary teeth and taurodontism were 6.6% and 0.3%, respectively. In a study conducted by Ezoddini et al., taurodontism with a rate of 7.5%, was reported to be more incident in Yazd compared to the present study.¹⁴ In addition, Saberi and Ebrahimipour reported an incidence rate of 5.38% for taurodontism in Zahedan.²

Conclusion

As the findings of the present study

indicated, the rate and types of dental anomalies vary among different populations. According to the results, dilaceration was the most common dental anomaly, followed by missing and impaction, respectively. Various dental anomalies with different frequencies occur in many countries, and even within the same country among different ethnic or regional groups. The early recognition and careful management of dental anomalies can prevent prosthodontic or orthodontic

treatment complications.

Conflict of Interests

Authors have no conflict of interest.

Acknowledgments

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Dentists' attitude and perceived educational barriers to oral health promotion among patients with disabilities

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Original Article

Abstract

BACKGROUND AND AIM: Individuals with disability usually suffer from complex oral problems and marked physical limitations, and therefore need special dental care. The dentists' attitude and perceived educational barriers for oral health promotion among the individuals with disabilities were evaluated in the present study.

METHODS: In this cross-sectional study, 193 dentists participating in the 54th International Congress and Exhibition of Iranian Dental Association in 2014 were invited to complete a valid and reliable questionnaire. The questionnaire included questions on attitude, satisfaction with training courses, perceived barriers to learn about oral health of patients with disabilities, age, gender, office location (city), and experience of treating patients with disabilities. The results were analyzed in SPSS software using linear regression analysis.

RESULTS: A total of 177 questionnaires were collected. The mean age of the participants was 35.5 (10.1) years, and 53.8% of the participants were men. The mean score of attitude and perceived barriers was 27 out of 52, and 13.6 out of 24, respectively. Dentists were not satisfied with education they had received. The most important barrier was the shortage of experts for training (52.1%). The linear regression model controlling the confounders revealed a better attitude among dentists with higher satisfaction with their academic education and among those perceiving less barriers in receiving the related academic educations.

CONCLUSION: The dentists' attitude towards the oral health promotion of patients with disabilities was not in a desirable level. The dentists satisfied with their training during academic education had a better attitude towards treating these patients, indicating the need for more extensive interactive training programs.

KEYWORDS: Dentistry for Disabled; Attitude; Barrier; Dentist; Oral Health

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Individuals with physical and mental disabilities usually suffer from complex oral and dental problems and marked physical limitations, and therefore need special dental care.¹⁻³ Like other individuals, the individuals with disabilities have a right to benefit from the standards of health care. However, evidence suggests that they experience lower levels of public health in their lifetime, have unmet

health needs, and receive less attention in screening programs.⁴ Therefore, it is important to design and implement plans to improve provision of health services to these patients and eliminate its barriers.

Lack of specialized knowledge on individuals with disabilities, difficulty of working with these patients, and attitudes and misunderstandings about disability are the main challenges of health care providers

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in this regard.⁵ The attitude towards oral health among these patients and the level of knowledge on this issue can deeply affect their attendance in health centers to receive treatments, the level of their physical and mental disability, and the tension the patients and their caregivers suffer from every day.⁴ Moreover, oral health may be overshadowed by the potentially life-threatening medical problems and disabilities among these patients and be regarded as a lower priority.⁶

The dentists' negative attitude may affect the services provided to the patients with disabilities. Although negative attitudes are not usually obvious, they can hamper the provision of appropriate and preventive services.⁷ In other words, the negative attitude of experts and health care providers towards individuals with disabilities is an invisible barrier to medical services.⁸ Moreover, the patients with disabilities reported the negative attitude of the health service providers and their behavior as the main barriers to their access to health services.⁹ Acquiring the necessary skills in this regard may provide conditions to remove these barriers,¹⁰ so that the factors like "necessity of allocating more time for treatment of disabled patients" will no longer be a reason for lack of access to dental services.

Since the culture and geographical location along with the type and duration of dental education are different in each country, the present study was carried out with the aim to evaluate the attitude of general dentists towards health promotion among patients with mental and physical disabilities. In addition, the level of satisfaction with different educational fields and barriers of training on oral health promotion among the individuals with disabilities were assessed in this study.

Methods

The dentists participating in the 54th International Congress and Exhibition of Iranian Dental Association in 2014 were invited

to take part in this cross-sectional study.

The dentists with a comprehensive understanding of Persian and willing to join the study were included and non-Iranian dentists were excluded from the study. A valid questionnaire¹¹ with some researcher-made questions was used to evaluate the dentists' attitude. First, the questionnaire was evaluated by 5 faculty members in Community Oral Health Department, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran, who confirmed its validity after some modifications. To assess its reliability, the questionnaire was completed by 10 general dentists twice with an interval of 2 weeks, which showed an actual agreement of 85% [Intraclass Correlation Coefficient (ICC) = 0.85] and Cronbach's alpha of 75%.

The attitude section of the questionnaire contained 13 questions on a Likert scale with answers ranging from "strongly agree" to "strongly disagree", including "I don't know" (Table 1). The total attitude scores ranged from 0 to 52.

Satisfaction with training on different stages of oral health promotion among patients with disabilities (Prevention and treatment, table 2) was assessed by 6 questions with answers on a Likert scale as "completely satisfied" to "completely unsatisfied", and "no idea". The total satisfaction scores ranged from 0 to 24. There were also 6 questions on barriers to receiving training on health promotion among individuals with disabilities with answers on a Likert scale as "to a very large extent", "to some extent", "to a little extent", "to a very little extent", and "no idea". There were also some questions about age, gender, experience of working with patients with disabilities with yes/no answers, and office location (city).

The study objective was explained to dentists who met the inclusion/exclusion criteria. Qualitative data were presented as mean $\pm$ standard deviation (SD). Data were analyzed using linear regression analysis in

Table 1. Dentists' responses to questions regarding attitude towards oral health among patients with disabilities

Item	Completely agree [n (%)]	Agree [n (%)]	Disagree [n (%)]	Completely disagree [n (%)]	No idea [n (%)]
I feel comfortable with treating patients with disabilities	77 (40.5)	30 (15.8)	33 (17.4)	7 (3.7)	14 (7.4)
Providing health services to patients with disabilities makes me nervous.	14 (7.4)	54 (28.4)	58 (30.5)	7 (3.7)	22 (11.6)
I enjoy providing health care for individuals with disabilities.	33 (17.4)	47 (24.7)	37 (19.5)	17 (8.9)	19 (10.0)
Working with individuals with disabilities is stressful for me.	17 (8.9)	56 (29.5)	39 (20.5)	18 (9.5)	25 (13.2)
I am capable of assessing the special needs of patients with physical disabilities including the visual and auditory disorders.	22 (11.6)	38 (20.0)	44 (23.2)	14 (7.4)	31 (16.3)
I am capable of how to assess the unique needs of mentally disabled individuals	25 (13.2)	43 (22.6)	33 (17.4)	25 (13.2)	26 (13.7)
I prefer not to treat patients with mental disabilities.	18 (9.5)	39 (20.5)	49 (25.8)	17 (8.9)	25 (13.2)
I prefer not to treat patients with physical disabilities.	18 (9.5)	41 (21.6)	41 (21.6)	28 (14.7)	21 (11.1)
I believe my academic dental education has prepared me to treat patients with disabilities.	16 (8.4)	30 (15.8)	50 (26.3)	33 (17.4)	29 (15.3)
I think I am aware of the dental needs of patients with disabilities.	18 (9.5)	39 (20.5)	52 (27.4)	16 (8.4)	25 (13.2)
I have self-confidence for treating patients with disabilities.	16 (8.4)	51 (26.8)	33 (17.4)	22 (11.6)	31 (16.3)
I believe I can treat patients with disabilities.	24 (12.6)	43 (22.6)	37 (19.5)	16 (8.4)	34 (17.9)
Dentists may refuse to treat patients with disabilities as it may upset other patients.	21 (11.1)	35 (18.4)	42 (22.1)	32 (16.8)	29 (15.3)

SPSS software (version 18.0, SPSS Inc., Chicago, IL, USA). P values less than 0.05 were considered to be significant. The study was approved by the research ethics committee of Tehran University of Medical

Sciences. All participants were assured about confidentiality of the information and the right to withdraw at any stage of the study. In addition, the questionnaires were anonymous.

Table 2. Dentists' satisfaction with academic education

Level of satisfaction Educational issue	Completely satisfied [n (%)]	Satisfied [n (%)]	Unsatisfied [n (%)]	Completely unsatisfied [n (%)]	No idea [n (%)]
Communication with the patient	34 (17.9)	54 (28.4)	44 (23.2)	13 (6.8)	17 (8.9)
Treatment environment (without barriers and easy transfer)	11 (5.8)	40 (21.1)	49 (25.8)	30 (15.8)	21 (11.1)
Oral manifestations related to disability and prevention of dental diseases	11 (5.8)	45 (23.7)	50 (26.3)	27 (14.2)	24 (12.6)
Advising parents and caregivers of patients with disabilities to observe oral health, diet, and fluoride use	11 (5.8)	48 (25.3)	38 (20.0)	40 (21.1)	19 (10.0)
Performing dental procedures and behavioral control	8 (4.2)	48 (25.3)	53 (27.9)	31 (16.3)	21 (11.1)
Related ethical and legal issues	13 (6.8)	46 (24.2)	50 (26.3)	25 (13.2)	23 (12.1)

Table 3. Barriers to receiving training on dental and oral health among individuals with disabilities

Item	To a very large extent [n (%)]	To some extent [n (%)]	To a little extent [n (%)]	To a very little extent [n (%)]	No idea [n (%)]
Low number of faculty members expert in this field	31 (16.3)	68 (35.8)	32 (16.8)	20 (10.5)	8 (4.2)
Lack of practical courses	24 (12.6)	49 (25.8)	52 (27.4)	21 (11.1)	13 (6.8)
Low number of patients	36 (18.9)	57 (30.0)	36 (18.9)	17 (8.9)	11 (5.8)
Scarcity of educational materials	23 (12.1)	40 (21.1)	40 (21.1)	23 (12.1)	29 (15.3)
Density of dental curriculum	34 (17.9)	39 (20.5)	43 (22.6)	20 (10.5)	22 (11.6)

The dentists' responses to questions in the sections of attitude, barriers, and satisfaction were reported as rate (%). The total and mean score of the attitude, satisfaction, and barriers was calculated separately. A linear regression model was used for the multivariate assessment of factors related to the differences in mean scores.

Results

Totally, 193 dentists were included in the study. 16 (8.3%) of the questionnaires were excluded due to errors in completion, and the final analysis was performed on 177 questionnaires. The mean age of the dentists was 35.5 ± 10.1 years. Of 173 participants, 93 (53.8%) and 80 (46.2%) were men and women, respectively. 94 dentists answered the question about their current office location. The results showed that one third (32.7%) of the dentists worked in Tehran.

Of 160 participants, 90 (24.5%) had no experience of working with patients with disabilities however, 75 (45.5%) had the experience of treating the disabled.

Table 1 represents the dentists' responses to questions regarding their attitude towards the oral and dental health of patients with disabilities. Among the participants, (24.2%) believed that their academic dental education

has prepared them to treat patients with disabilities and 35.8% asserted that providing services to individuals with disabilities makes them nervous.

Table 2 represents the dentists' responses to questions on satisfaction with academic training. Dentists were not satisfied with education they had received regarding the oral health promotion for the disabled as the highest and the lowest satisfaction rate was reported for the communication with the patient and performing dental procedures and behavioral control with 17.9% and 4.2%, respectively.

As shows in table 3, the most important barriers to receiving training about oral health promotion among individuals with disabilities were the shortage of experts to present the required training courses in the school (52.1%), lack of practical courses, and density of the curriculum (38.4%).

The scores of the domains of attitude, satisfaction with training, and barriers to receiving training about oral health promotion of individuals with disabilities are shown in table 4. The mean score of attitude, satisfaction, and barriers was 27 out of 52, 11.1 out of 24, and 13.6 out of 24, respectively.

The results of linear regression controlling for backgrounds revealed that the dentists

Table 4. Scores obtained in different domains related to oral health among individuals with disabilities (n = 177)

Domain	Maximum Possible	Lowest score	Highest score	Mean $\pm$ SD
Attitude	52	11	43	27 $\pm$ 5.7
Satisfaction with academic educations	24	0	24	11.1 $\pm$ 5.2
Barriers to learning on oral health of individuals with disabilities	24	0	24	13.6 $\pm$ 5.4

SD: Standard deviation

with higher satisfaction with their academic educations ($B = 0.465$, $P < 0.001$) and among those who reported less barriers in receiving the related academic educations ($B = 0.302$, $P = 0.003$), had better attitude. Age, gender, office location (city), and work experience were not associated with the dentists' attitude towards oral health promotion of patients with disabilities.

Discussion

Treatment of the dental problems is one of the major health challenges of patients with disabilities as the oral health among these individuals may affect their general health and quality of life (QOL). The findings of the present study showed the unfavorable attitude among 27 (52%) out of 52 of the dentists towards the oral health of the patients with disabilities which is in accordance with studies reporting the poor oral health of the individuals as a result of different problems including the dentists' negative attitude.^{6-9,11-13}

Previous studies have reported statistics regarding the dentists' awareness, attitude, and willingness to treat the dental problems and promote the oral health of patients with disabilities. A study by Oredugba and Sanu in Nigeria showed that although 80% of dentists treated these patients, their mean awareness of oral health promotion among such patients was 18%.¹⁴ In Australia, only 18% of the dentists had an appropriate level of knowledge about dental and oral diseases among the individuals with disabilities.¹⁵ Two studies showed that 74% and 94% of the dentists in the United States of America (USA) and Saudi Arabia treated these patients, respectively.^{16,17}

The negative attitude of the dentists towards these patients plays an important role in their undertreatment,^{18,19} which could result from academic educations, as it has been reported that these educations significantly affect the dentists' inclination to treat patients with disabilities.^{3,20} Vainio et al.²¹ conducted a study among dental students in the USA and found

that they had a moderate inclination to treat these patients. The findings of this study revealed that the students were not satisfied with their education about providing care for these patients and felt the need for more training. Moreover, the lack of providing the necessary education for dentists is itself a barrier to treatment among these patients as it can lower their self-confidence in addition to creating a negative attitude. Educational programs have an important role in training experienced medical staff and will therefore affect the oral health among individuals with disabilities.²²

The results of the present study indicated that the dentists were not satisfied with their education regarding the individuals with disabilities and only 48% of them had the experience of working with these individuals. Lack of specialized educators for training was a major barrier to providing care for patients with disabilities in the present study. Continuous medical education (CME) programs have an important role in training skilled and experienced dentists and positively affect the oral health of the individuals with disabilities.²³ The findings of the present study suggested the low level of the educational courses for dental students regarding individuals with disabilities, indicating the need for revising the dental education curriculum.

Treatment complexities and difficulties of treating patients with disabilities in terms of communication and anatomical problems, associated diseases, and lack of cooperation with the dentist may impede service delivery to this target group. Therefore, the availability of special facilities for patients with disabilities along with appropriate dental educations are important steps since providing dental treatment for these patients may require a team effort and the intervention of a medical team depending on the degree of disability, anatomical problems, and underlying diseases.^{24,25} In addition, there is an inverse relationship between the economic status and oral and dental

health.^{26,27} In fact, economic factors are an important issue as an inverse relationship has been confirmed between the level of oral health and the economic level.^{28,29} Therefore, it seems that the State Welfare Organization, as the steward of health and medical care for special patients, should take steps to increase the dental insurance coverage of these patients in the country.

As other studies using self-administered questionnaires, the present study had some limitations. Participants could have dishonesty with their answers due to the social desirability. The researchers in the present study tried to decrease dishonesty by assuring respondents that their personal information would not be revealed and the data would be analyzed anonymously.

The supplementary interventional studies are suggested to be performed to assess the effectiveness of different educational courses on dental care for patients with disabilities,

targeting undergraduate dental students.

Conclusion

The present study showed that the dentists' attitude towards promotion of the oral and dental health status of patients with disabilities was not in a desirable level. The dentists with higher satisfaction with their training and less perceived barriers during academic education had a better attitude towards treating the patients with disabilities. This indicates the need for more extensive training programs.

Conflict of Interests

Authors have no conflict of interest.

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Rate and comparison of periapical inflammatory lesions using clinical diagnosis and histopathological findings during the 18-year study period

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Original Article

Abstract

BACKGROUND AND AIM: Inflammatory Periapical lesions are the most common periapical lesions. These lesions are often diagnosed based on clinical and radiological examination, which may be different from the histological finding. The present study was carried out with aim to assess the rate and to compare clinical and radiographic features with histological diagnosis of periapical pathology.

METHODS: This retrospective study was conducted on dental school pathology records in Kerman, Iran, from 1996-2014. Cases with incomplete records and without net histology diagnosis were excluded. Age, gender, site of lesion, clinical diagnosis, and histopathological diagnosis were extracted from the records. The data were analyzed using chi-square test in SPSS software. A P value of 5% was considered as the significance level.

RESULTS: 1854 cases met the inclusion criteria. 129 of the cases were periapical inflammatory lesions. The mean age of individuals was 29.39 ± 15.14 years. Periapical cysts were the most incident lesions in clinical and histopathologic diagnosis. An overall of 98.9% of histopatologic diagnoses were compatible with clinical diagnosis. Inflammatory periapical lesions in maxilla were greater and this difference was significant ($P = 0.001$). Inflammatory periapical lesions were higher among men compared to women, with significant difference ($P = 0.001$).

CONCLUSION: This study showed that periapical cysts were the most incident inflammatory lesions followed by periapical granuloma.

KEYWORDS: Periapical Lesions; Cyst; Granuloma; Incidence; Inflammatory; Odontogenic

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Formation of apical inflammatory lesions is a defensive reaction secondary to the presence of microbial infection in the root canal and their toxic products in the apical zone.¹ Periapical lesions are of the most incident pathological conditions within the alveolar bone.²

Periapical granuloma is defined as a mass of chronically or sub-acute inflamed granulation tissue at the apex of a non-vital

tooth. Periapical cyst is formed when the epithelium at the apex of a nonvital tooth is stimulated by inflammation.¹ Histopathological evaluation of periapical lesions is necessary to establish definitive and differential diagnosis.³

Petersson et al. indicated that there is no accurate and correct radiographic method for evaluation of bone changes in periapical area.⁴ Histologic evaluation is the best method for diagnosis and differential diagnosis in periapical lesions.¹ Rate of

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periapical cyst and granuloma is different in different studies. In a study by Koivisto et al., periapical cyst and granuloma were 73.00% of all biopsies.⁵ In a study by Becconsall-Ryan et al. on radiolucent inflammatory jaw lesions, the rate of periapical granuloma and periapical cyst were 59.70% and 29.20% respectively.⁶ Radics et al. showed that 65.20% of surgical periapical lesions were periapical granuloma.⁷ Ali argued that 24.70% of all biopsies in a 6-year period evaluation included radicular cysts.⁸ Berar et al. showed that 63.30% and 18.30% of cases were histologically diagnosed as periapical granuloma and radicular cyst, respectively.³ In a clinicopathologic evaluation of 322 cases by Manor et al., 48.00% of lesions were radicular cyst.⁹ Love and Firth showed that periapical granulomas and cysts were the most common periapical lesions of endodontic origin.¹⁰ Carrillo et al. showed that 65.70% of surgical periapical lesions were periapical granuloma.¹¹ The rate of inflammatory periapical lesions varies in different studies and the final diagnosis of these lesions are based on histopathologic evaluation. Therefore, the present study was performed aiming to evaluate the inflammatory periapical lesions during an 18-year period.

Methods

In this retrospective study, 1872 biopsies were reviewed in pathology department of Kerman dental school in southeast of Iran from 1996-2014. Data including demographic variables (gender, age), site of biopsy, and clinical diagnosis, were collected from pathology archive. Lesions with inadequate material and without net histopathology diagnosis were excluded. Finally, 1854 cases remained for examination. Of 1854 recorded, lesions with periapical granuloma, periapical cysts, and fibrous scar diagnosis and lesions with radiolucent radiographic description were selected. Then slides of these lesions were reviewed by a pathologist according to histopathologic criteria for cyst definition and the data were recorded in a checklist. Then

the obtained data were analyzed by chi-square test in SPSS software (version 21, IBM Corporation, Armonk, NY, USA). A P value of 5% was considered as the significance level. This study was approved by the ethics committee of Kerman University of Medical Sciences with the code k/91/260.

Results

Of 1854 biopsies, 129 cases were periapical inflammatory lesions. The mean age of individuals was 29.39 ± 15.14 years and the age range of patients was between 6-67 years. Clinical diagnosis included 89, 5, 1, 6, 6, and 28 cases of radicular cysts, odontogenic keratocysts (OKC), adenomatoid odontogenic tumor (AOT), residual cyst, osteomyelitis (OM), and periapical granuloma, respectively.

Regarding histopathology examination, 24, 6, and 1 cases were periapical granuloma, residual cyst lesions, and scar tissue, respectively. Regarding residual cysts and OM and fibrous scar, all of clinical diagnoses were compatible with histopathologic diagnosis (Figure 1). In overall, 98.92% of histopatologic diagnoses were compatible with clinical diagnosis.

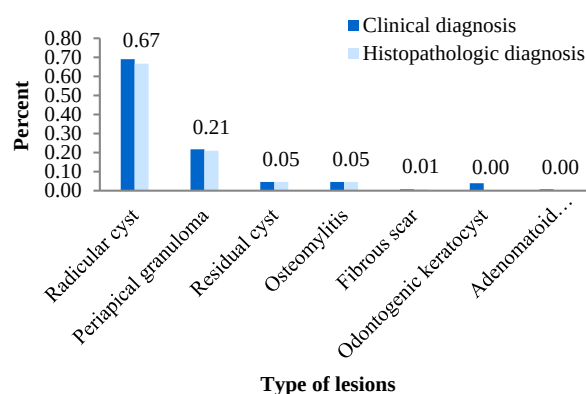


Figure 1. Clinical and histopathological diagnoses according to type of lesions

Inflammatory periapical lesion in maxilla and mandible were 63.50% and 26.50%, respectively and the difference between them was significant ($P = 0.0001$). 56.00% and 44.00% of periapical inflammatory lesions were among men and women, respectively with significant

difference ($P = 0.0001$) (Table 1).

Table 1. Correlation between periapical inflammatory lesions according to gender and location

Variable		n (%)	P
Gender	Men	72 (56.0)	0.0001
	Women	57 (44.0)	
Location	Maxilla	82 (63.5)	0.0001
	Mandible	47 (26.5)	

Discussion

Periapical lesions are of the most incident pathological conditions within the alveolar bone,² and the majority of these lesions include periapical cysts or granulomas.³

The results of the present study showed that the mean age of patients was 29.39 ± 15.14 years, which is similar to the study by Gbadebo et al.¹² In addition, in the present study, radicular cysts were the most incident inflammatory periapical lesions, followed by granuloma periapical. These findings are compatible with some studies like the one conducted by Beconsall-Ryan and Love.¹³ It was revealed that 66.66% of biopsies were radicular cysts, which is in agreement with the study by Selvamani et al.¹⁴ Koseoglu et al.¹⁵ showed that 59.00% of odontogenic cysts were periapical cysts. In the present study, periapical granuloma was the second most incident lesion. This finding is inconsistent with the studies by Koivisto et al.,⁵ Beconsall-Ryan et al.,⁶ and Spatafore et al.,¹⁷ which indicated that dental granuloma were had a higher rate of incidence compared to the periapical cysts. These differences may be due to criteria for cyst diagnosis, as in some cases, epithelial lining of the cyst wall may be destroyed by inflammatory cells. The present study illustrated that lesions were significantly higher among men in comparison with to women. This finding is compatible with the study by Gbadebo et al. indicating a 53.00% rate of periapical inflammatory lesions among men.¹²

It was found in the present study that 4.56% of inflammatory periapical lesions included residual cysts. When periapical cyst

remains after the extraction of the involved tooth, it is called a residual radicular cyst.¹⁸ Periapical cyst and residual cyst have similar histopathologic characteristics.¹⁹

In the present study, 0.07% of lesions were scar tissue. Love and Firth reported a 2% periapical lesions among 100 cases.¹⁰ Scar tissue in the studies by Lin et al.¹⁶ and Beconsall-Ryan et al.⁶ were 2.70% and 0.60%, respectively. In the present study, it was revealed that the majority of the lesions as 63.50% were in maxilla site. This difference was statistically significant. This finding is compatible with similar studies indicating that maxilla was the most common site of inflammatory periapical lesions.^{3,12,16,20,21} Infection of medullary cavity is called OM.¹ It was found in the present study that 4.56% of lesions were OM. This rate is higher than that of the study reported by Beconsall-Ryan et al.⁶ indicating that 0.02% of lesions were OM. This difference may be due to difference of the study method. The higher rate of the samples were clinically diagnosed to be periapical cysts; this was compatible with histopathologic diagnosis. This findings is not compatible with the study by Gbadebo et al.¹² reporting that the majority of the cases were clinically diagnosed to be periapical cyst, however being diagnosed as periapical granuloma in histological examination. Clinical and radiological diagnoses of periapical cyst is based on presence of a well-defined radiolucent lesion associated with a necrotic tooth.^{22,23} Final diagnosis of inflammatory periapical lesions is based on histopathological examinations, in addition, histopathology is more sensitive for diagnosis of periapical cysts and granulomas. However, despite the advantages of using cone-beam computed tomography (CBCT), differentiation of periapical granuloma against cysts are only possible through histological evaluation as CBCT is not sensitive enough.

Conclusion

Based on the findings of the present study, periapical cyst was more incident compared

with other inflammatory periapical lesions. Moreover, lesions in maxilla were more significant than mandible.

Conflict of Interests

Authors have no conflict of interest.

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Impact of verbal explanation on parental acceptance level of different behavior management techniques in dental office

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Original Article

Abstract

BACKGROUND AND AIM: Parents' attitudes towards different aspects of dentistry especially the use of behavior management techniques (BMTs) can greatly effect a child's cooperation in a dental office. The present quasi-experimental study was conducted with the aim to assess the effect of a verbal explanation on parents' acceptance level of the most common BMTs used in pediatric dentistry.

METHODS: A videotaped presentation showing the 6 most commonly used BMTs in Iran was presented to 60 parents recruited by a convenient sampling method. Using visual analogue scale (VAS), the acceptance level of each BMT was measured before and after an explanation on the reasons of each BMT. Paired t-test, repeated measures analysis of variance (ANOVA) and independent t-test were used for statistical analysis of data. Significance level was set as 0.050.

RESULTS: Giving a verbal explanation on BMTs had a statistically significant effect on the acceptance of BMTs. Tell-show-do (TSD) and hand-over-mouth (HOM) techniques achieved the highest and lowest mean scores of parental acceptance, respectively. The acceptance of physical restraint ($P = 0.013$) and parental presence/absence (PPA) ($P = 0.015$) of parents was obtained higher among men compared to women using t-test.

CONCLUSION: Giving an explanation to parents while performing a BMT is effective in raising parents' acceptance of the technique. Non-invasive methods such as TSD and PPA of parents are the more favorable methods to parents.

KEYWORDS: Pediatric Dentistry; Behavior Control; Parental Consent

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For a child, regular dental visits are necessary in order to maintain a good oral health.^{1,2} Even the simplest dental procedures are considered to be stressful among young children.³ Although the majority of children behave appropriately and can tolerate a dental treatment,⁴ fear of dental treatment

can sometimes cause uncooperative behavior making it impossible for dentists to carry out the required dental care.⁵ This is especially true for complex or long lasting dental procedures.⁶

In addition, children who do not experience a successfully complete dental procedure tend to have more stress for other

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dental treatments ahead.³

Child's behavior in dental office is greatly affected by parents' attitude and an effective communication of the child with parents is essential in providing optimum dental treatment by the dentist.⁷ Moreover, many parents do not know how difficult it can be for a dentist to provide dental care for the uncooperative children and expect dentist (specially a pedodontist) to carry out treatment regardless of child's inappropriate behavior.⁸

According to American Academy of Pediatric Dentistry (AAPD) guidelines on behavior management, consent must be obtained from parents before performing any behavior management technique (BMT) other than communicative managements.⁹

Evidence show that parents prefer less aggressive BMTs, hence more aggressive techniques like hand-over-mouth (HOM) and physical restraints are sometimes not accepted. Similarly, studies In Iran have shown that parental presence/absence (PPA) and tell-show-do (TSD) are easily accepted whereas HOM and physical restraint and general anesthesia (GA) are of techniques which are not always consented.^{10,11} Notably, less aggressive BMTs are not always efficient and many dentists are obliged to use more aggressive techniques for behavior control.

Fully informing parents about a BMT, specially more aggressive ones, could change parents' attitude towards the technique.¹² As a detailed verbal explanation on each required BMT could be time consuming, it is important to investigate whether a full verbal explanation regarding the aim and course of the required BMT could change parents' attitudes in a positive way, and if so, if it is true for all BMTs.

No study has been conducted in Iran regarding the investigation of the effect of a verbal explanation on the acceptance of BMTs. Iran is a country with a wide variety of cultural backgrounds. Culture is an important factor regarding parents' attitude towards BMTs,¹¹ and dentists should be aware of the most accepted BMTs in the

culture of the society and ways in which they could change parents' attitude towards more aggressive techniques in case of necessity of use of these techniques.

Therefore, the present study was carried out with the aim to investigate the effect of a verbal explanation on parents' acceptance level of BMTs and to identify the most common BMTs accepted by parents in south east region of Iran (Kerman City).

Methods

This cross-sectional descriptive analytic study was conducted in pediatric dentistry clinic of Kerman University of Medical Sciences. This clinic is a public dental one. Due to lower dental costs in morning shifts (treatment is carried out by undergraduate and post graduate students), morning patients are usually from lower socioeconomic levels. Meanwhile, the dental treatments in the afternoon shift is carried out by pedodontists with a higher cost. Therefore, patients referring in the afternoon shift are in higher socioeconomic status compared to those referring in the morning shift. According to similar studies by Lowe⁸ and Eaton et al.¹² and considering type one error of 5% and test power of 80%, 60 subjects were selected from among parents who accompanied their children for dental treatment in the clinic. A sampling list was not available in order to carry out a random sampling method, thus, a convenience sampling method was used for the selection of subjects. In order to achieve a more acceptable sample size, a dental student who was familiar with BMTs, referred for the data collection in random days and random times. Moreover, subjects were selected from both morning and afternoon shifts in order to have a more acceptable sample. A brief explanation describing the aim and course of the study was given to parents who were waiting to receive a dental appointment for their child treatment. A written informed consent was obtained from parents who agreed to participate.

According to other similar studies,

exclusion criteria were set as below. Parents of children with a long lasting hospitalization experience, parents of the disabled or retarded children, parents of children under 2 and above 15 years of age, and single parents.^{5,10}

The present study was granted ethical approval by ethical committee of Kerman University of Medical with the code k/92/165.

Parents were asked to fill in a checklist that included 2 parts. The first part consisted of the following items: demographic data including gender, age, and family income, items regarding the dental fear among subjects, and child's previous dental experience and previous dental fear in their parents' point of view, which were asked and recorded as low, medium or high. It should also be noted that the subjects remained anonymous in the study.

The second part of the checklist was completed while a videotaped presentation was demonstrated. The presentation included 12 visual analogue scale (VAS) lines (6 and 6 related to the acceptance rate of 6 BMTs before and 6 BMTs after watching the explanatory film, respectively).

The videotaped presentation was made in 3 parts to demonstrate the 6 frequently used BMTs, namely TSD, Voice control, HOM, physical restraint, PPA, and GA.

Parents were sent to the dental school theatre room in groups of 10 to 15. The film was presented to them in a calm atmosphere using a 2*1.5 meter dimension Epson projector. In the first two minutes of the video, an explanation was given on the aim of the study and the instruction to fill in the checklist. In the second part of the film, a pedodontist performed 6 BMTs on a child during an assumed dental treatment. All 6 BMTs were performed on 1 child to avoid different child faces affecting the results. Each BMT lasted 1 minute. In the third part, the same BMTs were presented again, this time with a narrator's voice simultaneously giving an explanation on the aim, reasons and indication of each BMT (the explanatory film).

While carefully watching the second part

of the film, after each BMT was shown, the film was paused and subjects were asked to rate their acceptance of each of 6 the BMTs by marking on the VAS response line respective to that BMT. Then the third part of the film (the explanatory film) was demonstrated and subjects were asked to mark their acceptance rate after each BMT was explained. Hence, the first 6 VAS lines in the checklist indicated the acceptability of the 6 BMTs before the explanation and the next 6 VAS lines were marked after watching the explanatory film.

The VAS response line represented continuous scale ranging from 0 to 100 mm. The scores 0 and 100 on the left and right sides of the line represented completely acceptable and completely unacceptable responses, respectively. The distance between the mark and the left end of VAS line was measured using a calibrated ruler and recorded as the acceptability level.

Since the results of the intervention (the explanatory film) was recorded immediately after the intervention, the presence of a control group of parents did not seem necessary and was not considered in the study design.

Data were analyzed using repeated measures analysis of variance (ANOVA), paired t-test, and independent t-test in the SPSS software (version 18, SPSS Inc., Chicago, IL, USA). The significance level was set at 0.050.

Results

Of 65 parents invited, 60 parents participated in the study; of which, 40 (66.7%) and 20 (33.3%) were women and men, respectively. All 60 subjects completed the study procedure and no one left the study. Mean age of the parents was 36.7 ± 7.6 years.

The education level of majority of parents (62.0%) was under bachelor's degree and 38% of the participants had a bachelor's degree or higher.

53.3% and 46.7% of the subjects belonged to a low-income and high-income family, respectively.

Concerning dental fear, 53.4%, 38.3%, and 8.3% of the parents had moderate, low, and high levels of dental fear, respectively. Along with fear among parents, 48.0%, 27.0%, and 20.0% of children had moderate, low, and high levels of dental fear in their previous dental experience. However, 5.0% of the children had no experience of dental treatment.

Acceptance of different BMTs: Table 1 shows the mean parental acceptance rate related to each BMT before any explanation. TSD gained a mean VAS score of 81.98 ± 20.21 and hence was the BMT with the highest rate of acceptance. However, HOM achieved the least mean VAS score as 20.21 ± 27.49 .

Table 1. Mean acceptance rate of each behavior management technique (BMT) before explanation

BMT	VAS score (mm) (mean $\pm$ SD)	Ranking
TSD	81.98 ± 20.21	1
GA	29.06 ± 29.17	5
Voice control	29.40 ± 30.90	4
HOM	20.21 ± 27.49	6
Physical restraint	29.68 ± 29.95	3
PPA	55.01 ± 32.93	2

BMT: Behavior management technique; TSD: Tell-show-do; GA: General anesthesia; HOM: Hand-over-mouth; PPA: Parental presence/absence; VAS: visual analogue score; SD: Standard deviation

Figure 1 demonstrates the mean

acceptance level of different BMTs before and after the verbal explanation. The rate of acceptance of TSD by parents was significantly higher compared to all the other BMTs ($P < 0.001$). Following TSD, the PPA technique achieved the most acceptance level ($P < 0.001$). No statistical significance was found in terms of acceptance level among the remaining BMTs, i.e., GA, voice control, HOM, and physical restraint, thus it was not possible to judge on the ranking of the remaining BMTs (Table 2).

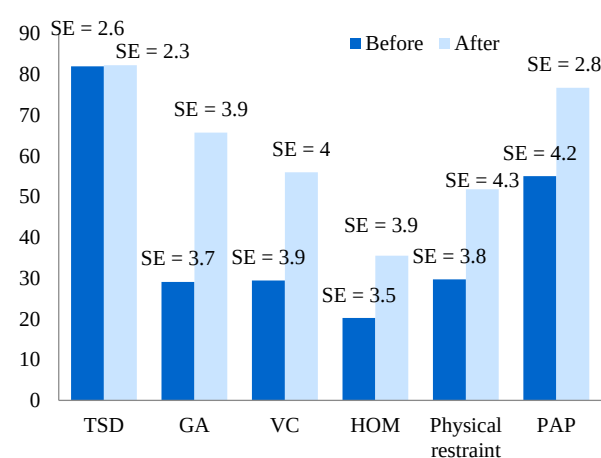


Figure 1. Mean percentage of behavior management technique (BMT) acceptance before and after the verbal explanation
SE: Standard Error; TSD, Tell Show Do ; VC, Voice Control ;HOM, Hands Over Mouth; PPA, Parental presence/absence

Table 2. Pairwise comparisons between different behavior management techniques (BMTs) regarding their parental acceptance before explanation

Pair wise comparison		Mean difference	SE	P
TSD	GA	52.917	5.104	< 0.001
	Voice control	52.583	4.663	< 0.001
	HOM	61.767	4.364	< 0.001
	Physical restraint	52.300	4.567	< 0.001
	PPA	26.967	5.217	< 0.001
GA	Voice control	-0.333	5.006	> 0.999
	HOM	8.850	4.272	0.640
	Physical restraint	-0.617	4.366	> 0.999
	PPA	-25.950	4.578	< 0.001
Voice control	HOM	9.183	3.088	0.064
	Physical restraint	-0.283	3.863	> 0.999
	PPA	-25.617	4.496	< 0.001
HOM	Physical restraint	-9.467	3.496	0.133
	PPA	-34.800	4.351	< 0.001
Physical restraint	PPA	-25.333	3.970	< 0.001

TSD: Tell-show-do; GA: General anesthesia; HOM: Hand-over-mouth; PPA: Parental presence/absence; SE: Standard error

Effect of verbal explanation: Furthermore, for all BMTs, the comparison of acceptance level before and after explanation showed a statistically significant difference ($P < 0.050$), therefore giving an explanation was very useful in raising parent's acceptance level in all BMTs. Nonparametric tests were also performed for all data analyses which yielded the similar results.

Effect of basic and demographic data: Regarding the physical restraints, an acceptability score of 42.80 ± 37.20 and 23.10 ± 23.40 was obtained for men and women, respectively [$P = 0.013$, confidence interval (CI) = 95%]. In addition, an acceptability score of 69.70 ± 32.00 and 47.60 ± 31.10 was obtained respectively for men and women in terms of the PPA technique ($P = 0.015$, CI = 95%). According to these results, there was a statistically significant difference in terms of the acceptance level between women and men, as men tended to show higher acceptance levels of the above techniques.

Participants' education level did not affect their acceptance level of any BMT after the explanation.

For statistical analysis, 3 dental fear levels mentioned above were recoded as two levels of low dental fear and moderate/high dental fear. Results did not show any statistically significant difference between the acceptance levels among parents with low fear compared to parents with moderate/high dental fear.

Regarding child's dental fear, an initial acceptance level of 89.40 ± 8.00 was obtained for parents of children with a low dental fear (according to statement of their parents) for TSD, which was higher than the acceptability level of 78.40 ± 23.00 achieved by parents of children with a moderate/high dental fear ($P = 0.010$). This difference was not statistically significant for other BMTs.

Moreover, family income did not affect the parents' acceptance of any BMT before the explanation, however after the verbal explanation, the acceptance of TSD was significantly higher among parents with high

income compared to low income parents ($P = 0.046$).

Discussion

In this study, the most accepted BMTs were TSD and PPA; this is in agreement with other studies reporting TSD as the most accepted BMT in terms of viewpoint of parents, as it is a safe and non-invasive technique. It seems that the acceptability of this technique has not changed over time,^{4,12-15} hence it can be applied to Iranian parents. Accordingly, providing detailed explanation regarding these techniques does not seem necessary.

In addition, the HOM and GA had the least acceptance rates; this finding is also consistent with other studies with very little difference in ranking.^{4,5,12,16,17} For example, Eaton et al. indicated that HOM and physical restraints were the BMTs with lowest rates of acceptance.¹²

In a study by Razavi and Purtaji,¹⁰ a lower acceptance rate was obtained for GA compared to HOM, which is in contrast to many other studies presenting HOM as the lowest rate of acceptance of BMT by parents. These studies violated the hypothesis that easier accessibility and lower costs of HOM could be the reason for this difference.

Although HOM is still considered acceptable to many dentists, concerning the low parental acceptance of HOM in recent studies, this technique has been removed from AADP guidelines.¹⁸

This study is also in agreement with previous studies regarding GA as a fairly unacceptable BMT.^{4,14} As, Paryab et al.¹⁹ declared that Iranian parents considered that GA may harm the intellectual and mental skills of their children.

An important and useful finding of this study was the effectiveness of explanation on the rationale and aim of the technique on raising parents' acceptance for all BMTs. For TSD and PPA which were acceptable BMTs even before explanation, detailed explanation does not seem to be necessary and could be time wasting due to the frequent use. BMTs

with higher aggression like HOM and GA require detailed explanation about the aim, course, and advantages of the techniques. Although this explanation might seem time-consuming, it can change parents' attitude and help achieve their consent. This was confirmed by other studies. In a case-control study by Scott and Garcia-Godoy, it was concluded that explanation could make HOM a more acceptable technique to parents.²⁰ In addition, in a study by Havelka et al.,²¹ the positive effects of explanation on parents' acceptance level was observed for all BMTs. This was not true among the low educated parents' regarding GA.

In the present study, the initial acceptance of men of physical restraint and PPA was higher compared to that of women. Moreover, Chen et al. indicated that passive restraint was more accepted among men, in addition, women tended to accept TSD more than men.²² If the use of these techniques are ever needed, spending enough time for convincing mothers is very important.

Similar to the study by Chen et al.,²² no relationship was found regarding parent's education level between parents' education and their acceptance of BMTs after the explanation. Therefore, it seems that for all BMTs, an explanation can be useful in acceptance of the technique even among the parents with low level of education.

In fact, the sample size in this study was not sufficient for analyzing the education level since parents were not evenly distributed in different educational levels. This sample size was mainly suggested for the comparison of different BMTs and also for the evaluation of the effect of explanation on the acceptance level; this was one of the main limitations of the study.

The results of the present study showed that parents' dental anxiety was not related to

the acceptance of BMTs. Boka et al. also concluded that parental dental experience and anxiety did not affect their acceptance of each of the BMTs.¹⁷

Finally, child's dental anxiety only affected their parents' initial acceptance of TSD and did not raise the acceptance of parents of other BMTs.

Conducting this study was along with some limitations. As mentioned previously, a completely random sampling was not possible to carry out due to the lack of a sampling frame. In addition, a larger sample of parents including parents in private dental offices would make a better distribution in different demographic variables.

Furthermore, it would be more desirable to evaluate the acceptance of other BMTs like sedation with nitrous oxide (N₂O), especially with the unstable trend of parental acceptance related to this technique over time.^{4,8,11} Unfortunately, this technique is not frequently used in Kerman dental offices.

Conclusion

Pediatric dentists in different societies should be aware of the parental acceptance of different BMTs in their society in order to increase the chance of choosing the best BMT.

Sometimes, the use of BMTs with higher aggression are needed, as achieving the ability to raise parental acceptance of BMTs is very helpful.

Conflict of Interests

Authors have no conflict of interest.

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Assessment of the quality of randomized controlled trials in orthodontics published in PubMed indexed journals by Iranian authors from 2007 to 2017

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Original Article

Abstract

BACKGROUND AND AIM: Randomized controlled trials (RCTs) are the gold standard for providing evidence in clinical research. The present study was performed with the objective to assess the quality of reports of RCTs in orthodontics in PubMed-indexed journals published by Iranian authors from 2007 to 2017.

METHODS: All the articles on orthodontics published from 2007 to 2017 and indexed in PubMed with Iran affiliations were reviewed and quality evaluation was performed on them using JADAD checklist.

RESULTS: A total of 23 RCTs were evaluated. The mean of total score was 3.09 out of 5 and only 39.1% of the articles had appropriate methods of blinding and randomization. The cause for withdrawal was given in 65.2% of the articles.

CONCLUSION: The results of this study indicated that the quality of RCTs published by Iranian authors in orthodontics was acceptable, however improvements were necessary.

KEYWORDS: Randomized Clinical Trials; Quality Assessment; Orthodontics; Iran

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Evidence-based medicine (EBM) applies the outcomes of the scientific research to daily and routine clinical practice. Currently, this concept is popular among dentists and is known as evidence-based dentistry (EBD).¹ Clinical trials consist of scientific experiments involving subjects and/or patients designed to determine the most effective therapy for a disease condition. Generally, the results elicited from clinical trials help establish a protocol for populations affected by the same condition of the study sample or to choose from among different therapies available.²

The results of high-quality randomized clinical trials (RCTs) are considered to be strong

evidence in EBD.^{3,4} In the field of dental science, like medicine, a new treatment procedure is rarely used in routine practice unless some randomized clinical trial(s) support it.⁵ RCTs are the gold standard for providing evidence in clinical research. Quality of RCTs has recently been defined as “the likelihood of the trial design to generate unbiased results”.⁶ However, even the RCT study design cannot eliminate all the bias, which can occur during designing, conducting, reporting, or application phase, hence causing incorrect results. In recent years, the need for predictable and effective dental treatments has prompted clinicians to look for therapeutic approaches validated by experimental trials; however,

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unfortunately, the quality of many published medical and dental RCTs is variable.⁷

It is important that RCTs, as the most valuable research method for assessing the efficacy of treatments, be reported with the highest possible level of quality.⁷

Although the number of RCTs by Iranian researchers has increased in recent years, the most important issue is the quality of these studies.

Badri et al. investigated orthodontic studies conducted in Iran and published in international and national journals, concluding that orthodontic research production has made significant progress in Iran in recent years up to 2012.⁸

Criteria and checklists have been prepared worldwide to assist readers in assessing the quality of studies regarding RCTs. The present study was investigated to assess the quality of RCT reports in the field of orthodontics published in PubMed-indexed journals conducted in Iran during 2007-2017 using the JADAD score.

Methods

This study is a cross-sectional analytical study. In order to retrieve studies on RCTs in orthodontics conducted in Iran, an electronic search was conducted in the PubMed. First, keywords including orthodont, malocclusion, functional orthopedic, crossbite, open bite, deep bite, overbite, prognath, orthognath, retrognath, mandibular deficiency, mandibular excess, maxillary deficiency, maxillary excess, growth modification, dentofacial orthopedics, maxillary growth, mandibular growth, molar relationship, occlusal problem, occlusal anomaly, occlusal discrepancy, tooth problem, tooth anomaly, tooth discrepancy, vertical excess, vertical deficiency, tooth movement, tooth correction, teeth correction, tooth alignment, teeth alignment, distal movement, mesial movement, distalization, mesialization, functional appliance, removable appliance, and fixed appliance,⁹ were entered in the "all fields" search box and clinical trials were

selected for article type and 3534 articles were found. Then, the word "Iran" was typed in the "affiliation" search box and 64 articles were found. In the next step, the "publication dates" was set to 2007 to 2017. Hence, 23 RCTs were identified.

Each article was read by two reviewers separately and the JADAD scale checklist was completed. Randomization, blinding, and accountability of all patients, including withdrawals, were 3 important factors of clinical trials based on which the results of the studies were scored. JADAD scale checklist consisted of 5 scores in total; 2, 2, and 1 of which in relation to randomization, blinding, and dropout rate, respectively.⁶

The scores were allocated as follows: 1, 1, -1, 1, 1, -1, and 1 for a/an randomized study, additional point for an appropriate method, inappropriate randomization method, subject blinded to intervention, evaluator blinded to therapy, inappropriate method of blinding, and description of withdrawals and dropouts, respectively.¹⁰ The maximum achievable score was 5. Low-quality trials resulted in a score of < 3.¹¹

Data were analyzed using descriptive statistics and Pearson correlation coefficient in SPSS software (version 18, SPSS Inc., Chicago, IL, USA).

Results

23 articles were conducted on orthodontics in Iran and cited in PubMed from 2007 to 2017, as presented in table 1. The maximum number of articles was reported for the year 2014 (7 articles) (Figure 1).

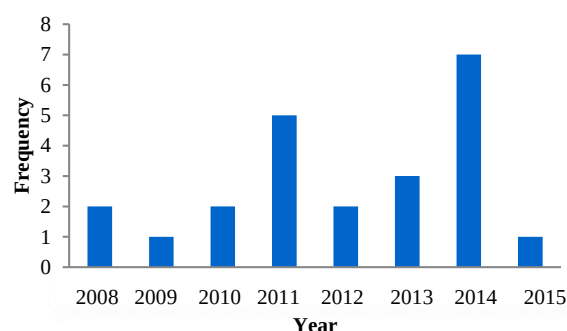


Figure 1. Number of articles published per year

Table 1. Studies on orthodontics conducted in Iran and cited in PubMed from 2007 to 2017

Affiliation	Author name	Title
Hamedan	Nasrin Farhadian	Streptococcus mutans counts among patients
Mazandaran University of Medical Sciences, Sari	Farhad Sobouti	Effects of laser-assisted cosmetic smile lift...
Shahid Beheshti University of Medical, Tehran	Ladan Eslamian	The effect of 810-nm low-level laser...
Tehran branch, Islamic Azad University	Haleh Hashemi	The effect of recommending a CPP-ACPF product on salivary...
Tehran branch, Islamic Azad University	Fariborz Amini	Effects of fixed orthodontic treatment using...
Shiraz University of Medical Sciences, Shiraz	Sepideh Torkan	Clinical and radiographic comparison of the...
Shiraz University of Medical Sciences, Shiraz	Hamidreza Eftekharian	Effect of Tranexamic Acid Irrigation on...
Hamedan	Amirfarhang Miresmaeili	Effect of carbon dioxide laser irradiation...
Mashhad University of Medical Sciences, Mashhad	Arezoo Jahanbin	Effectiveness of Er: YAG laser-aided fiberotomy...
Hamedan	Mohammad Zandi	Short-term skeletal and dental changes following...
Tehran branch, Islamic Azad University	Ladan Ansari	The effect of endotracheal tube cuff pressure co...
Shiraz University of Medical Sciences, Shiraz	Parisa Salehi	Comparison of survival time between two types of orthodontic...
Mashhad University of Medical Sciences, Mashhad	Fahimeh Farzanegan	Pain reduction after initial archwire placement in...
Shahid Beheshti University of Medical, Tehran	Rahman Showkatbakhsh	The effect of facemask and reverse chin cup...
Shahid Beheshti University of Medical Yazd	Rahman Showkatbakhsh	Treatment effects of R-appliance and Anterior...
Tabriz University of Medical Sciences, Tabriz	Soghra Yassaei	Comparison of the efficacy of calcium...
Tabriz University of Medical Sciences, Tabriz	Koroush Taheri Talesh	Prevention of relapse following intraoral vertical ramus...
Tehran branch, Islamic Azad University	Behnam Bohluli	Trigeminocardiac Reflex, Bilateral Sagittal Split Ramus...
Tehran branch, Islamic Azad University	Abdolreza Jamilian	Treatment effects of the R-appliance and twin block in Class II...
Shahid Beheshti University of Medical, Tehran	Rahman Showkatbakhsh	The effect of pulse electromagnetic...
Tabriz University of Medical Sciences, Tabriz	Javad Yazdani	Comparing the effect of 3 orthognathic surgical...
Mashhad University of Medical Sciences, Mashhad	Barat A. Ramezanzade	Histological changes in human dental pulp...
Hamedan	Nasrin Farhadian	Effect of fluoride varnish on enamel demineralization...

CPP-ACPF: Casein phosphopeptide-amorphous calcium phosphate fluoride

The articles were published in 16 scientific-research journals. The maximum number of articles was published in American Journal of Orthodontics and Dentofacial Orthopedics (AJODO) with 5 articles (Figure 2).

Of 23 articles, the maximum number was related to Shahid Beheshti University of Medical Sciences, Tehran, Iran, with 5 articles (Figure 3).

JADAD quality assessment: The results of JADAD quality assessment are presented in table 2.

Based on this assessment, the most frequent score in randomization was '1' in 52.2% of the articles. The mean randomization score was 1.30.

Assessment of blinding and its methods revealed that the most frequent blinding score (39.1%) was '2' with a mean of 1.13.

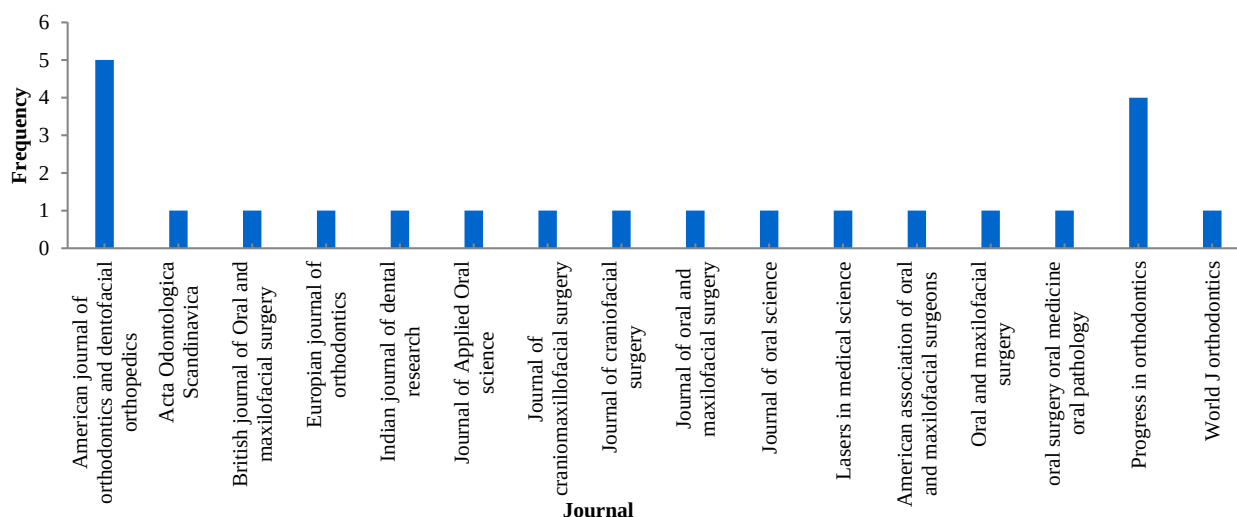


Figure 2. Rate of articles in terms of journals

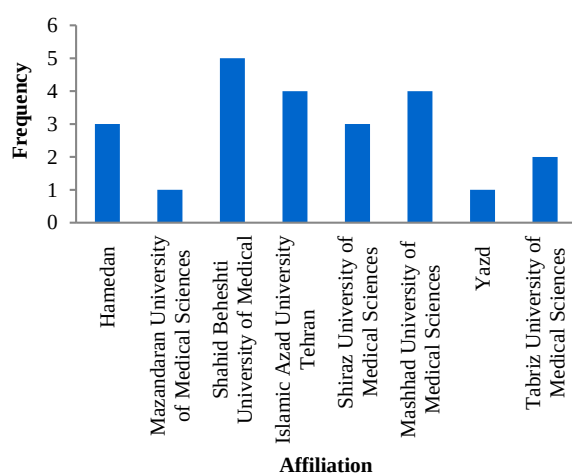


Figure 3. Rate of articles in terms of affiliation

In terms of dropout, the majority of the articles (65.2%) gained score 1 and the mean of dropout scores was 0.65.

Table 2. Rate of articles with score received in each item

Articles	0	1	2	3	4	5
Randomization	8.7	52.2	39.1			
Blindness	26.1	34.8	39.1			
Dropout	34.8	65.2				
Total score	4.3	8.7	21.7	26.2	21.7	17.4

The most frequent total score in JADAD quality assessment was '3' in 26.0% of articles and the mean of the total score for 23 articles was 3.09.

Correlation analysis showed no significant

correlation between the total score and year of publication ($P = 0.281$, $r = 0.235$).

Discussion

In the present study, quality assessment was performed on clinical trials in the orthodontics field indexed in PubMed on studies conducted in Iran in recent 10 years using the JADAD scale.

The investigation of the literature indicated that most of the articles published in recent 10 years were published in 2014. Regarding the inclusion of dental schools, the results showed that the Dental School of Shahid Beheshti University of Medical Sciences published the highest rate of RCTs in orthodontics indexed in PubMed. The type of journal is an important factor in the quality of articles

The majority of articles received a score of '1' in relation to randomization, which means that almost half of the studies did not use or describe suitable methods for randomization and more than half of the studies were poor in terms of randomization.

For blinding and its methods, more than half of the studies were poor and only 39.1% of the studies had employed adequate methods in blinding. Withdrawals/dropouts had been reported in most of the articles.

There are major concerns in relation to

blinding in certain disciplines like orthodontics. In fact, since orthodontic appliances usually have different shapes or configurations, clinicians usually realize which intervention the patients to receive. In some cases, for instance in trials involving functional removable appliances, a second blinded clinician should carry out the measurements after the patient has removed the appliance and the clinical chart has been hidden.¹²

4 articles, including the studies on "Comparison of survival time between two types of orthodontic fixed retainer", "The effect of recommending a Casein phosphopeptide-amorphous calcium phosphate fluoride (CPP-ACPF) product on salivary and plaque pH levels among orthodontic patients", "Clinical and radiographic comparison of the effects of two types of fixed retainers on periodontium" and "S. mutans counts among patients wearing removable retainers with silver nanoparticles compared to those wearing conventional retainers" gained maximum score of 5 and only one of the articles gained no score (0).

Maximum mean of total scores was contributed to 3 articles from Shiraz University of medical sciences that gained 4.6 points and articles that published on "Progress in Orthodontics" journal with mean score of 4.3.

Quality status of RCTs analyzed here did not significantly change over time.

In an investigation by Harrison, the quality of reporting of RCTs published in 3 orthodontic journals AJODO, British Journal of Orthodontics (BJO), and European Journal of Orthodontics (EJO), from 1989 to 1998 was assessed and the results revealed that the quality of reporting orthodontic clinical trials was insufficient to allow readers to assess the validity of the trials.¹⁴

In another study by Shimada et al., the quantity and quality of randomized controlled trials (RCTs) in orthodontic practice in PubMed from 2003 to 2007 was assessed and the results showed that the quality of RCTs was low and almost half of

the articles were found in AJODO.¹⁵ In the present study, the maximum number of articles were also published in AJO-DO, however, the mean total score in the present study was 3.09, indicating that these RCTs had relatively high quality in terms of JADAD scale.

There has been a significant increase in the number of Iranian dental articles in recent years and during the last 2 decades indexed in the PubMed database.¹³

It is clear that a larger quantity of scientific studies is related to increased scientific development, however, the quality of publications is also important.

In a study by Habib Agahi et al. on critical appraisal of reporting RCTs published in Iranian dental journals during 2003-2010, the Consolidated Standards for Reporting Trials (CONSORT) scale was used for assessments. The results of this study showed that the quality of reporting RCTs in Iranian dental journals generally did not have the proposed standards, requiring improvements.¹⁶

With the development of EBM, RCTs have achieved a high status in the hierarchy for evaluation of the efficacy and safety of all the trials with an important role in decision making for clinicians.

RCTs are now considered as the best research design for comparison of therapeutic alternatives. Proper reporting of RCTs allows for easy determination of the RCT quality, which is important as low-quality RCTs might exaggerate the effects of treatment, potentially causing erroneous conclusions.¹⁷ So far, only a few studies have been focused on the quality of RCTs and RCT was assessed in few dental disciplines.

Of all the RCT quality assessment tools, JADAD scale is the most commonly used one, providing an easy scoring procedure for quantitative evaluation of the quality of a trial and is often used for assessing the quality aspects of controlled trials method.¹⁸

To the best of our knowledge, no study is available on the assessment of the quality of RCTs published in orthodontics field in Iran

using JADAD criterion. The current study indicated that the quality of RCTs in studies regarding orthodontics conducted in Iran and published in 10 recent years, is a suitable level, however needing improvements, especially in terms of the randomization and blinding methods. The majority of studies conducted in Iran have not been indexed in PubMed, however, this source was used in the present study due to its open access and international visibility.

The limitation in the present study was review of few articles (23 articles), hence causing many statistical analyses not to be performed in order for inclusion of subgroups.

Since the number of studies conducted in Iran on orthodontics indexed in PubMed, was low and since no single resource can cover all the information, in addition, only relying on JADAD guidelines is not enough, further studies are suggested to be undertaken to evaluate the quality of RCTs indexed in other medical databases and with

other scales like the CONSORT.

Conclusion

The findings of this study showed that the quality of clinical trials in orthodontics indexed in PubMed conducted in Iran in recent 10 years was fairly good. However, more attention is necessary regarding the methodological quality for randomization and blinding. Efforts, like compliance with the JADAD guidelines, should be made to minimize potential sources of bias and an increasing trend for improving the quality of RCTs.

Conflict of Interests

Authors have no conflict of interest.

Acknowledgments

We would like to thank all members of Department of Orthodontics and Endodontology Research Center, Kerman University of Medical Sciences.

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Evaluation of the effect of Kandovan propolis against Streptococcus Mutans

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Short Communication

Abstract

BACKGROUND AND AIM: In recent years, propolis has been introduced as one of the most efficient agents against cariogenic bacteria. However, due to the lack of data on the propolis collected from Kandovan (Eastern Azarbaijan, Iran), this study was designed to investigate the effect of this type of propolis on Streptococcus mutans (S. mutans).

METHODS: In this experimental study, the ethanolic extraction of propolis (EEP) was prepared with different concentrations (1%, 3%, 5%, and 10%) while the distilled water was incorporated as control. The antibacterial efficacy was tested via two standard methods including the agar disk diffusion and minimum inhibitory concentration (MIC) tests. Finally, the resulting data were analyzed using one-way analysis of variance (ANOVA) and Bonferroni post-hoc tests ($\alpha = 0.05$).

RESULTS: The obtained MIC was 2.5 mg/ml. However, in disk diffusion test, the 1% and 3% EEP solutions did not exhibit any zone of inhibition, however the 5% EEP showed very strong antibacterial effect ($P < 0.001$).

CONCLUSION: The EEP extracted from Kandovan had significant antibacterial effect against S. mutans when prepared in 5% concentration. Therefore, this type of propolis could be considered as one of the most efficient propolis against S. mutans.

KEYWORDS: Propolis; Streptococcus Mutans; Antibacterial

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Various anti-microbial substances have been extensively utilized in dentistry for caries prevention due to microbiological etiology of tooth decay.¹⁻³ Accordingly, numerous chemical antibacterial agents have been marketed in the form of mouth rinses, varnishes, chewing gums, etc., which are recommended for caries prophylaxis.⁴⁻⁶

In recent years, numerous investigations had focused on the incorporation of natural products in preventive dentistry due to their cost effectiveness and also the lack of systemic adverse effects.^{3,7,8} Among these

natural gifts, propolis has been introduced as one of the most successful materials.⁹⁻¹⁴ Honeybees produce the propolis as a semisolid substance in the entrance of the hive and employ it to seal the hive and the defensive techniques.^{15,16} Beside these beneficial properties of propolis, it has been shown to have unique antibacterial capacity against a wide range of bacteria including the cariogenic microbes.⁹⁻¹⁴ Since Streptococcus mutans (S. mutans) has been introduced as the main bacterium responsible for dental caries, the majority of the studies have been accomplished regarding these bacteria. In this

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regard, it has been frequently documented that the propolis has effective suppressive effect against *S. mutans*.⁹⁻¹⁴ However, the chemical composition of propolis is directly related to its geographic origin due to the variation in honeybee's nutrition that is obviously dependent on the host plant.^{16,17} Moreover, some publications also confirm that even the year of collection would significantly influence the propolis properties.¹⁸ Hence, investigating the propolis collected from different geographical areas would be beneficial and necessary in dentistry field to validate the most effective propolis against the *S. mutans*.

Only very few studies have been carried out evaluating the antibacterial potency of Iranian propolis against *S. mutans*.^{19,20} Although all these studies confirm a significant effectiveness for Iranian propolis, the results presented in these studies are controversial regarding the required dose for controlling *S. mutans*.^{19,20} Furthermore, there is no available data about the Kandovan propolis.

Therefore, this study was conducted to evaluate the antibacterial effect of Kandovan propolis against *S. mutans*.

Methods

Propolis extraction: The propolis was harvested by hand in spring season (April-May 2015) from beehives situated in Kandovan area, a region in Eastern Azarbaijan Province roughly located in the north-west of Iran. The samples were desiccated and stored at 4 °C prior to the start of the study.

The ethanolic extraction of propolis (EEP) was prepared and adjusted to the Bosio et al. method.¹² Accordingly, the propolis was added to ethanol 95% (v/v) and shaken for 7 days at room temperature. Then, the whole mixture was centrifuged and filtered using a Whatman filter paper. In the next step, the solution was desiccated and a powder was obtained.

Finally, the powder was diluted by ethanol to produce 1.3% and 5.0% solutions for disk diffusion test while the 10% solution

was serially diluted for the minimum inhibitory concentration (MIC) tests.

Bacterial strain and growth condition:

S. mutans Persian Type Culture Collection, Iranian Research Organization for Science and Technology (IROST), (PTCC) 1683 was employed in this study and the bacteria were cultured overnight in 5 ml of Mueller-Hinton Broth (Liofilchem, Italy) at 37 °C. Ultimately, the bacterial suspension was adjusted to 0.5 McFarland standards incorporating the sterile normal saline.

Susceptibility test: The susceptibility test was accomplished via disk diffusion method. In this process, 200 µl of bacterial suspension was uniformly spread on the Mueller Hinton Agar by means of a sterile swab. In this way, the standard paper disk was wiped by 10 µl of 1%, 3%, or 5% solutions while the same amount of distilled water was used as negative control. Finally, the disks were immediately placed on the prepared agar medium, which were incubated at 37 °C, and the inhibition zone around each were measured in mm scale after 24 hours. This test was triplicate for every sample.

MIC: 1 ml of 10% EEP solution was inserted in a tube and it was serially two fold diluted into 6 other tubes using ethanol. Then, 1 ml of the prepared bacterial suspension ($\sim 1.5 \times 10^8$ bacteria/ml) plus 1 ml of Nutrient Broth (Merck, Germany) were added in each tube. After 24 hours of incubation at 37 °C, the minimum concentration, which inhibited bacterial growth (according to the liquid turbidity) was considered as MIC. Moreover, the distilled water and the pure bacterial suspension were incorporated as negative and positive controls, respectively.

After exploring the normal distribution using Kolmogorov-Smirnov test, the data were examined using one-way ANOVA and Bonferroni post-hoc tests. A P value of 0.050 was considered as the significance level.

Results

1 sample of the Mueller Hinton Agar

cultured media is shown in figure 1 representing the obtained inhibition zones. In addition, the mean $\pm$ standard deviation (SD) related to inhibition zone for groups 1%, 3% and 5% EEP were 0, 0 and 14.5, respectively. As can be seen, it was discovered that the 1% and 3% EEP solutions did not have any significant difference with distilled water. Therefore, 1% and 3% EEP could not be considered as antibacterial agents against *S. mutans*.

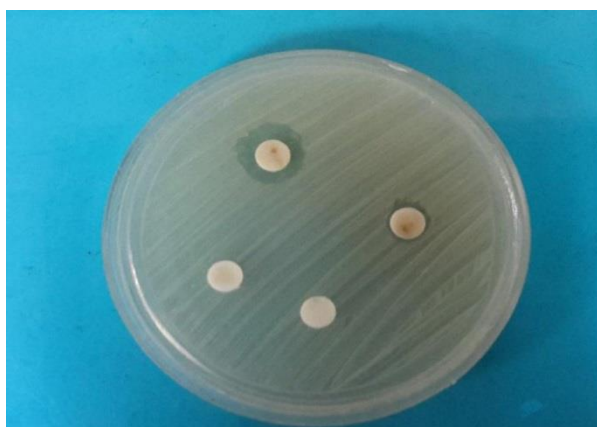


Figure 1. The observe bacterial growth inhibition zone around each sample in agar medium
The upper most, right, bottom and left disks contain 5%, 3%, 1% and 0% of EEP solution respectively.

In contrast, the 5% EEP showed noticeably higher inhibition zone that had a statistically significant difference with other groups ($P < 0.001$).

Moreover, the MIC of propolis samples in the present study was obtained as 2.5 mg/ml.

Furthermore, figure 2 displays micro-tubes incorporated in MIC test. As can be seen, the MIC was obtained as 2.5 mg/ml according to the liquid turbidity.

Discussion

The results of the current study revealed significant antibacterial effect of Kandovan propolis against *S. mutans* in 5% concentration.

Although the antibacterial potency of propolis has been frequently documented in previous studies, this study was the first one examining the Kandovan propolis against *S. mutans*.



Figure 2. The minimum inhibitory concentration (MIC) test, which were accomplished by seven, serially diluted concentrations of propolis solution
Three different rows represents triplicate of the test for confirmation, while the distilled water (the most left column) and the pure bacterial suspension (two most right columns) were incorporated as negative and positive controls respectively. Noticeably, the forth column from the left (in every rows) that had 2.5 mg/ml concentration, obtained as the MIC according to its turbidity

This type of propolis is quite important as one of the most important aims of the studies in natural medicine include discovering the most effective origin of each natural product for the specific property.^{9-14,19,20} In fact, it has been strongly documented that the geographic origin of the propolis could have noticeable effect on its antibacterial property.²¹ This fact is directly related to the nutrition of the honeybees that influence the chemical composition of the produced propolis.^{16,17}

The disk diffusion test in this study showed 14 mm zone of bacterial growth inhibition around the disks containing 5% EEP, however the 1% and 3% solutions did not show any inhibition zone. Therefore, regarding to observations in the present study, only the 5% EEP had antibacterial property and the other two solutions were too weak to have antibacterial effect.

Comparing the results of the present study with the literature confirm that the Kandovan propolis have superior effect compared to the other Iranian propolis types against *S. mutans*.

In this regard, Jafarzadeh Kashi et al. accomplished a study using propolis samples collected from Tehran, Iran.¹⁹ In this study, the inhibition zone around EEP was 16 mm

while they used 20% EEP. Therefore, the results of the present study showed a considerable stronger activity of Kandovan propolis compared to the samples in the latter study, which were collected from north-east of Tehran. During the extraction process, the propolis samples of the latter study were immersed in ethanol for only 48 hours, however, the samples in the present study experienced a longer period (7 days) of submersion, which could be reason for stronger effect in the present study.

Moreover, in an investigation by Moumen Beyt Elahi et al., the inhibition zone was only 7.8 mm in 30% EEP, which were collected from Hamedan, Iran.²⁰ Despite immersion of the samples into ethanol for 10 days in this study, which was too longer than the present study, the extracted solution was weaker even in higher doses like 30%.²⁰ In addition, the clinical mutans samples from the gingival sulcus were incorporated in the latter study, however the standard bacterial samples were used in the present study.

Moreover, stronger effect of EEP against *S. mutans* has been reported in other studies worldwide. Accordingly, Dziedzic et al. argued that the *S. mutans* growth was completely stopped in 4-hour activity of 3.0% EEP. However, in 24-hour activity, even the 1.6% EEP also inhibited the bacterial growth.¹⁵ It is noteworthy that the propolis samples in this study were collected from a region situated in the south of Poland.¹⁵

In addition, a randomized clinical trial was accomplished by Anauate Netto et al. on Brazilian propolis.¹⁴ 2% ethanolic propolis mouthwash was used in this study and the results revealed considerable quantitative reduction of *S. mutans* and *Lactobacilli* bacteria among patients.

Therefore, the antibacterial capacity of propolis is strongly supported by available evidences, however this property is directly related to the chemical composition of the

propolis, which is drastically dependent on its geographic origin.^{16,17,21}

The possible mechanism correspondence for antibacterial effect of propolis is related to its various compositions including flavonoids, caffeic acid, and cinnamic acid.^{15,22-25} These ingredients would disrupt the bacterial cytoplasmic membrane and cause bacteriolysis. Additionally, it has been documented that these chemicals could inhibit the process of protein synthesis in bacterial cell.^{15,26} However, the comprehensive mechanism behind the antibacterial property of propolis is not discovered yet.

In general, although the in-vitro tests do not reproduce the real clinical situations, it was demonstrated in the present study that the propolis extracted from the Kandovan region could be incorporated as an effective agent in preventive dentistry. However, further studies are strongly suggested to resemble the clinical effectiveness of Kandovan propolis. Furthermore, complementary investigations are recommended to detect the detailed chemical composition of different Iranian propolis samples and compare their antibacterial effects with each other.

Conclusion

Despite the limitations in this study, significant anti-bacterial effect against *S. mutans* was reported for 5% EEP, however the 1% and 3% EEP did not show any antibacterial capacity. In addition, the MIC was obtained as 2.5 mg/ml.

Conflict of Interests

Authors have no conflict of interest.

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