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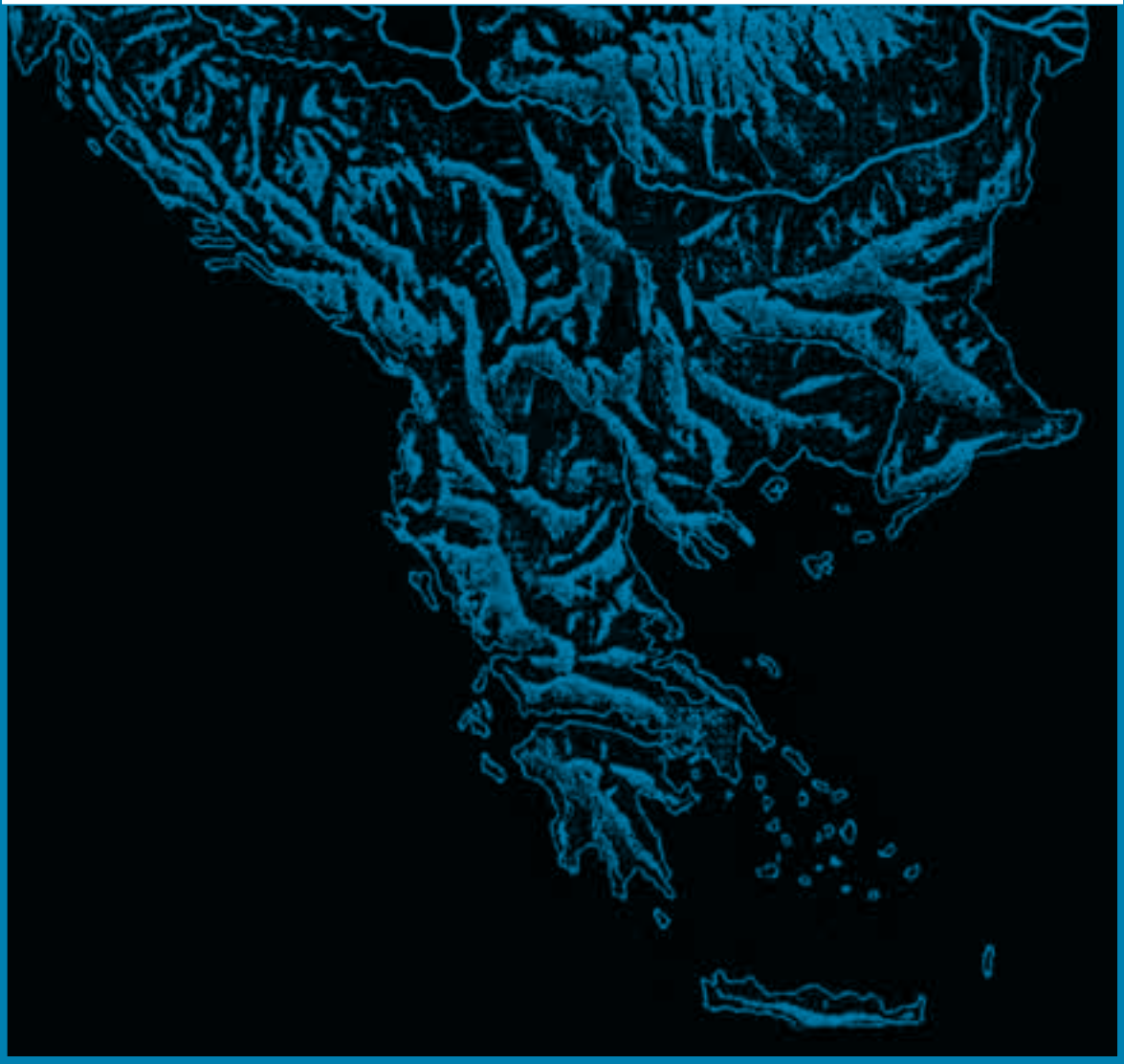

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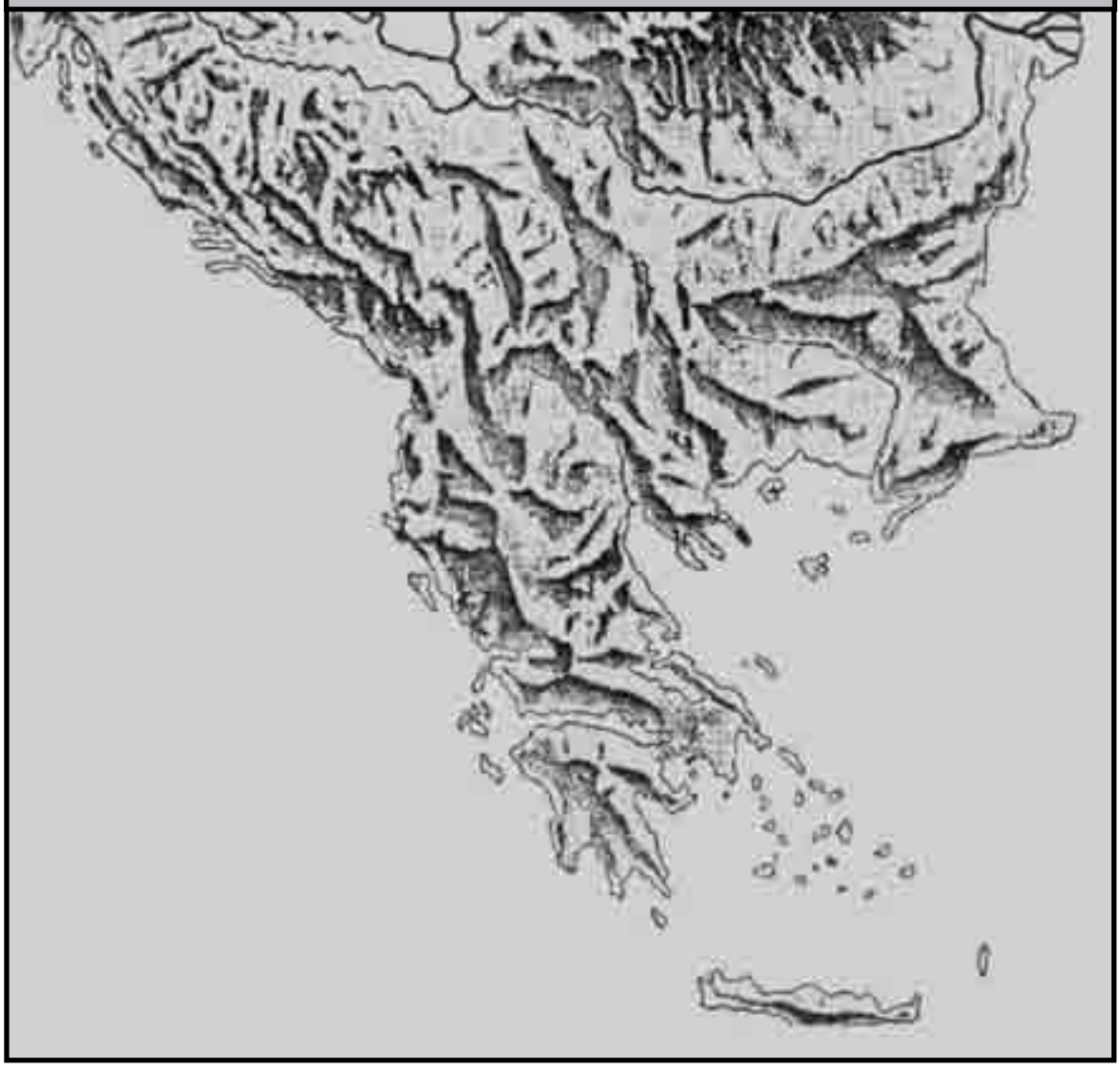

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Fabrication Processes of Mouth Guards

SUMMARY

Data from international literature indicate that injuries of children and adolescents in the orofacial region have increased during sport activities in recent years, as more and more children and adolescents participate. The use of mouth guards, nowadays, constitutes essential and necessary equipment in many sports and athletic activities. It is known that there are 3 types of mouth guards, which are fitted or are made to be fitted either on one jaw (the maxilla or the mandible) or on both jaws (bi-maxillary mouth guards).

The aim of this article is to describe the fabrication processes of some types of mouth guards. Firstly, the fabrication process of the bi-maxillary mouth-formed boil and bite mouth guard is described. These types of mouth guards are available commercially, but they need further modification. Secondly, the fabrication process of the custom made mouth guard, which is individually fabricated for each athlete, is described. Additionally, the peculiarities of fabrication of mouth guards for those who are wearing, simultaneously, fixed orthodontics appliances, as well as for athletes with mixed dentitions, are specified. Lastly, particular emphasis is given on fabrication processes of bi-maxillary custom made mouth guards and 3 methods are described.

Keywords: Mouth Guards; fabrication.

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Introduction

It is a fact that the sports-related injuries have increased during the last years, due to the popularity of sports and athletic activities in children and adolescents. As a result, orofacial injuries have also increased[1-3]. The orofacial injuries are very common injuries among children and adolescences participating in various sports[1,4-8].

The use of mouth guards by athletes has been shown to provide effective protection against injuries[1,4-6,9,10]. The general or specialist dentist has 3 types of mouth guards at his disposal and in proportion with each situation, namely each athlete's needs, can propose the adequate mouthguard[5,6,11-18].

The first type (type I) of mouth guards are stock mouth guards, which are available in sporting stores and ready to use, and there are in different sizes. They offer the least protection and adaptation, and the great interference with speaking and breathing activities. As this type of mouth guards is available commercially, it won't be described[6,14,15,18].

The second type (type II) of mouth guards is known as mouth-formed boil and bite mouth guards. This type of mouth guards is also available commercially, but they need further modification by the dentist, before the athlete wears it in the mouth. They offer better protection and adaptation than the type I, but less than the third type. They offer, also, less interference with speaking and breathing than type I mouth guards. They are made from thermoplastic material[5,12,16,18].

The third type (type III) of mouth guards are custom made mouth guards, which are individually fabricated for each athlete after they have been ordered. They are made in a dental practice or in a dental technician laboratory on a cast of the athlete's mouth according to the dentist's

instructions. The cast is made from an impression, which is taken by the dentist. They offer the best protection and adaptation and the least interference with speaking and breathing of the other 2 types of mouth guards, but they are the most expensive. Furthermore, they are made from thermoplastic material and can be single-layered or multi-layered (Figs. 1 and 2)[5,11-13,15,18,19].

Figure 1. Type III single-layered mouth guard

Figure 2. Type III multi-layered mouth guard

Each type of these 3 types of mouth guards can be fitted or are made to be fitted either on one (usually upper jaw) or on both jaws simultaneously (bi-maxillary mouth guards). The bi-maxillary mouth guard (Fig. 3) covers both dental arches when it is worn. A lot of authors allege that bi-maxillary mouth guards provide better protection in athletes during sports[9,19-22].

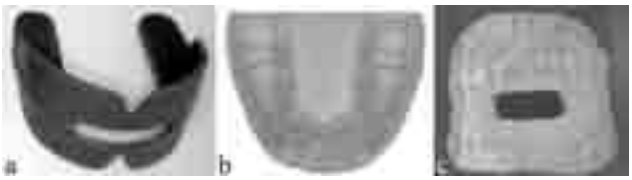

Figure 3. a) Type I bi-maxillary mouth guard; b) Type II bi-maxillary mouth guard; c) Type III bi-maxillary mouth guard

The mouth guards can be made from various materials and in various colours. Such materials are polyvinyl acetate-polyethylene or ethylene vinyl acetate copolymer (EVA), silicone rubber (poly-dimethylsiloxane), natural rubber, polyvinylchloride, polyurethane and others. Among these materials the most common used material is the EVA[5,6,12,23-32].

Fabrication of Type II Mouth Guard

The following steps are necessary for achieving an individualized adaptation of these mouth guards. Firstly, the adequate size of mouth guard is chosen as well as the desired colour from those which are available commercially (Fig. 4a). Then, it is immersed in boiling water for 10-45 seconds, according to the manufacturer's guidelines, in order to become smooth and soft, and easily adaptable (Fig. 4b). Afterwards, the temperature of the mouth guard is reduced in cold water (Fig. 4c) and, immediately, it is transferred in the athlete's mouth, where it is formed, in the beginning with the use of pressure by the dentist's fingers, and further with the use of the lips, tongue, cheeks and biting pressure by the athlete (Fig. 4d)[5,12,15,16,18,33]. After that, the mouth guard is ready for use (Fig. 4e).

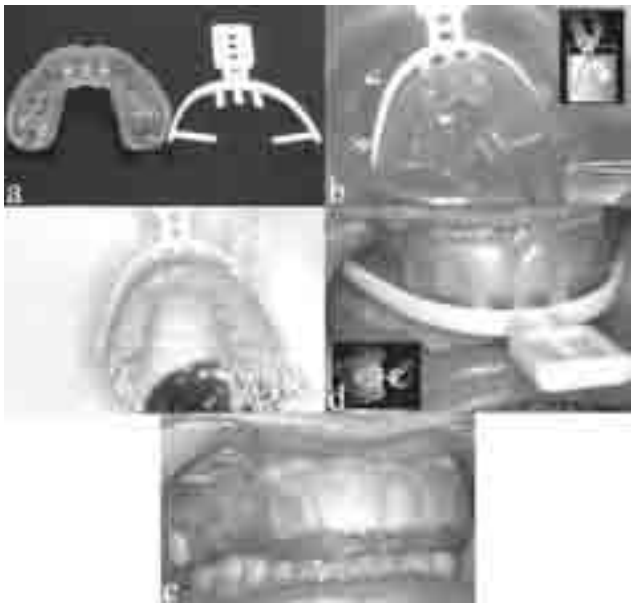

Figure 4. Fabrication process of type II mouth guard

Fabrication of Type III Mouth Guards

The basic stages for the fabrication of type III mouth guard are 6[12]:

a) The impression of the dental arches;
b) The fabrication of the casts;
c) The record of the relationship of the mandible to the maxilla that mouth guard will provide;
d) The fabrication of the mouth guard;

e) The trimming and the polishing of the mouth guard;
f) The placement and the equilibration of the occlusion through the mouth guard.

The receiving stage of the impression must be done very carefully, especially when the athlete is undergone an orthodontic treatment with fixed appliances (braces) in order not to distort the appliances during the removal of the impression. The more exact the impression is, the better adaptation the mouth guard will have. After receiving the impression, it is poured-in with a high-strength stone and the cast is fabricated.

The type III mouth guard can be fabricated with 2 methods in proportion to the 2 types of machine that will be used[12,14,15,17]. The former is based on a respectively high temperature and vacuum (approximately 1 atm), whereas the latter is based on very high temperature and high positive pressure (approximately 10 atm)[5,12,14,15,17,26,34]. The internal adaptation that the mouth guard will have after fabrication is directly dependent on the level of temperature and the amount of pressure of each machine. The new pressure machines, which operate with positive pressure, have significant differences from the conventional machines, which operate only with vacuum. The most important advantage of the pressure machines, due to the higher temperature and higher pressure which they provide, is the better internal adaptation of the material over the cast and, consequently, better adaptation of the mouth guard in the mouth. As a result, the mouth guard offers better protection and is more convenient for the athlete[5,17].

Vacuum Formed (Single-Layered) Mouth Guard

According to the first fabrication method, the cast is placed on the platform of the machine (Fig. 5a), while a single sheet of specific thermoplastic material is placed a little higher, in a specific case, with size 12.7 x 12.7 cm^2 and thickness 5 mm (Fig. 5b). The thermoplastic material should have approximately 5 mm thickness and, consequently, the mouth guard will have a 3 mm thickness after fabrication, taking into account a shrinkage between 25%-50% of the thermoplastic material during fabrication[5,6,12,17,25].

Before the placement of the cast over the platform of the machine, the vestibular borders at the bottom of the gingivo-buccal and gingivo-labial sulcus are marked with a pencil on the casts. Then, the cast is trimmed and the excesses of the stone are removed up to the marked borders. In this way the mouth guard will obtain better retention because of the increasing surface contact. Also, the protection at the alveolar bone will be greater[17].

Afterwards, the cast is dampened or it is spread with a separating medium (according to manufacturer's guidelines) so that the thermoplastic material won't stick with the cast[12]. The procedure commences by heating the material and as it gets warmer and warmer, it sags downwards. When this sag obtain approximately a depth of 2.5 cm, the material has warmed adequately (Fig. 5c). Then, the thermoplastic material is sucked down with power over the cast, using a button or a lever (Fig. 5d). The machine generates an intense vacuum (1 atm)[6,12], lasting from 30 to 60 seconds and the material is gravitated over the cast, on which it adapts accurately.

The material is left over the cast for approximately 10-15 minutes, so as to prevent possible distortion of the under fabrication mouth guard (Fig. 5e). To continue, the bulk excess of the material can be removed with a hot knife, a pair of scissors or a disc and an alcohol torch can be used to smooth the border-edges[12,17] (Fig. 5f). After this procedure, the mouth guard is removed from the cast when it cools completely (Fig. 5g) and the excesses of the thermoplastic material are removed with a pair of scissors (Fig. 5h). The final polishing is done by stone burs or polishing discs suitable for the material. It is important to trim the fraenum muscle attachments. The vestibular margins must extend to the previously marked extensions, whereas the mouth guard lingually must extend 1 mm from the teeth and distally must extend to the second molar or at least to the first molar[17].

The next step is the trial of the mouth guard in the athlete's mouth. Usually, an equilibration between the occlusal surface of the mouth guard and the teeth of the opposing arch is necessary. The equilibration, generally, is done on an articulator, otherwise the equilibration is achieved by heating gently the occlusal posterior surface (out of the mouth) of the mouth guard with a flame, the immediate placement in the mouth and the careful biting down so that all the posterior teeth of the opposite arch come simultaneously to contact with the mouth guard on the other jaw[12]. This stage of the procedure is very essential because the athlete must not bite down excessively and maintain the requisite thickness 3 mm of the occlusal surface of the mouth guard so that the absorption of the undesired injuring impact forces can be done. After that the mouth guard is ready for use by the athlete (Fig. 5i).

Figure 5. Fabrication process of type III mouth guard

According to this way of fabrication, the mouth guard is composed of 1 layer, namely it is a single-layered mouthguard[6,12,17]. This type of mouth guard is recommended for sports, in which athletes are not at risk to afflict each other[17].

A lot of scientists suggest that the proper thickness of the material of the mouth guard is not provided in all parts according to the first way of fabrication, without meaning that they reject this way of fabrication. These deficiencies can be faced by fabricating a multi-layered mouthguard[5,12,26].

Pressure Laminated (Multi-Layered) Mouth Guard

Therefore, many dentists use the second method to make a type III mouth guard that is based on a very high temperature and high positive pressure; these mouth guards are multi-layered (Fig. 2). A pressure-lamination machine is used for this method.

2 or 3 sheets of material in size 12.7 x 12.7 mm^2 and thickness 3 - 4 mm each are usually chosen for placement[6,9,17]. Mostly, the internal material is soft and resilient, whereas the external material is rigid and tough[18]. Moreover, each layer can be from different material, which is laminated under high pressure (approximately 10 atm) and temperature[12]. The placement of the layers is done one-by-one. The first layer is placed at the beginning, which is slimmer and there is the potential of better adaptation, then it is trimmed, polished at the margins and finished according to the above procedure. Afterwards, the same procedure for the next layer is done, namely the cast with the mouth guard is placed on the platform of a pressure-lamination machine, as well as a second sheet of thermoplastic material in the specific case, which is thicker and together with the other layer will provide better mouth guard and proper thickness in order to absorb any impact forces[5,12,15,17,26]. It is highlighted that this stage must be done carefully because the material must be warmed enough to achieve the lamination, otherwise the lamination won't be done sufficiently and in due time the layers will separate. The second layer is left under pressure to cool on the cast for 15 minutes[17]. Then, the under fabrication mouth guard is modified, trimmed and the margins are polished again in accordance with the first method of fabrication. It is noteworthy to refer that all layers of a multi-layered mouth guard must be done with the same machine.

Lastly, the equilibration of the occlusion between the mouth guard and the dental arch of the opposite jaw is necessary, with 1 of the 2 preferred ways. According to this method of fabrication, type III mouth guard is ensured better thickness (4-5 mm) of the material, owing to the fact that shrinkage 25%-50% is occurred[5,6,12,15,17,25]. Furthermore, this method allows the record of some athlete's data, as well as the placement of some decorative figures on the first layer before the lamination of the second sheet of the material.

Apart from this method of adhesion of the layers, namely adhesion by heating, there are, adhesion using a solvent, which melts the surface of the sheets of the material that are bound to come in contact with, and adhesion using a bond-retentive agent between the layers[9].

This type of mouth guard is suggested for contact sports[15].

Fabrication of Type III Mouth Guards in Patients Undergoing Orthodontic Therapy

It is important to refer that type III mouth guards are the best choice for patients who have already commenced orthodontic therapy with fixed appliances, or in children with mixed dentition[4,5,11,12,35-41]. Nevertheless, some special management must be done for fabrication the type III mouth guards (either single-layered or multi-layered) in athletes with fixed orthodontic appliances.

Firstly, utility wax (like string) is placed on the braces, compressing gently. Therefore the penetration of the alginate impressing material in the braces is averted by far and consequently, it is averted the tearing of the impression when the impression is removed from the mouth.

Secondly, a Mortite Weatherstrip and Caulking Cord is placed on the athlete's cast, which must cover the braces that are sticking out and wires, as well as must pouring the regions where the eruption of tooth or prospective tooth movements are going to be done. The using material must be resistant to high temperature during the heating of fabrication process so as not to change during the adaptation of the thermoplastic material of the mouth guard. It is separated from the thermoplastic material with a separating medium, such as vaseline. So, there is no problem from the prospective tooth movements during the orthodontic treatment and the continually eruption of permanent tooth, which would otherwise occur and, as a result, the initial impression, as well as the mouth guard, soon won't adapt to the dentition. The same is happened in mixed dentition due to growth of jaws. When a multi-layered mouth guard is suggested in athletes with fixed orthodontic appliances, the technique is the same as the conventional type III multilayered mouthguards[37,41].

Fabrication of Bi-Maxillary Mouth Guards

The fabrication of bi-maxillary mouth guards can be done, mainly, with 3 methods.

First Method

This method is described by Chapman (1986)[20]. The procedure is begun with the articulation of the athlete's casts, using wax or silicone for the record of the "heavy breathing position". This record involves the athlete to breath adequately, even under extreme exertion.

The record is done in accordance with the following procedure[20]: at the beginning, the mandibular opening is determined by placing the patient to sit upright on the ground and to look straight forward. Afterwards, a nose-clip is placed on the nose of the patient to close the nasal cavity and consequently to stop the nasal breathing so that the patient will breath only from the mouth. The patient is asked to start taking slow full breaths, making sure that each face inhalation-exhalation lasts approximately 5 seconds and the mouth should be closed after every exhalation. The breath should be held for 10 seconds after the first 2 exhalations, 15 seconds after the next 2 exhalations and 20 seconds after the next 2 exhalations. The process is repeated after 2 minutes, with the nose-clip on the nose. The mandible now should come to the prospective position, while the patient intermittently is breathing out all the air. In this point maxilla abstains from mandible. The opening between the upper and lower incisors of the jaws at the midline is measured with a Willis gauge or with another similar instrument. With this instrument the opening is recorded. Usually, the opening is fluctuated between 7 - 10 mm. This distance is not stable and varies in each person, depending on the anterior overbite of the patient. This record corresponds to another record in the internal scale of Willis gauge, from 4 to 7 mm.

Then, the nose-clip can be removed from the nose. Afterwards, the relationship of the jaws during the opening and the closing of the maxilla and the mandible is observed, which will later help the dentist during the record of the relationship of the jaws. After, the record is taken using 2 pieces made from sheets of bite wax, which can be softened with heat. The dimensions of these pieces are, approximately, 40 mm length, 20 mm width and 20 mm thickness. Each piece is placed backward in each side of the dental arch of the mandible and the athlete is asked to close slowly until the anterior teeth of the jaws come in contact with the blades of the Willis gauge, making sure that the patient closes his jaws at the right position as it's been observed before. It is very essential to ensure that the patient will close in the right position, so for this reason the last procedure is repeated.

The next step of the fabrication of the bi-maxillary mouth guard is the taking of the impression of each jaw and the casts are made. Then, using the casts, the fabrication of the mouth guards is done separately for each jaw. Sheets of thermoplastic material (usually EVA) are used, in which colour is desired and at the indicated thickness.

Each of the mouth guard should have incisally 3 mm thickness over the anterior teeth. If bigger thickness is required, 1 or 2 more sheets of the material are added. The thickness of each mouth guard, apart from the previous region, should have at least 2 mm thickness. Moreover, each mouth guard should extend backwards until the middle of each second molar, whereas buccally, labially and lingually should extend beyond gingivo-buccal, gingivo-labial and gingivo-lingual sulcus, and cover up to 2-3 mm soft tissues. Finally, palatally, it should extend and cover from the gingival margin from 10 mm to 15 mm.

Additionally, the thickness of each mouth guard is reduced occlusally from 3 mm, as it is made, to 1.5 mm approximately, namely it is decreased by 1.5 mm.

Afterwards, the mouth guard of the mandible is trimmed, only at the occlusal surface in the region of the incisors, so that the edges of labial and buccal surfaces of the incisors are uncovered approximately by 1.5 mm. This last step is done not only for the maximum comfort of the athlete but also for the airway to become bigger, which facilitates athlete's ventilation. Possible adjustments of each mouth guard are done before the wax-up and the flasking because the cast is destroyed during the deflasking.

According to the "heavy breathing position" of the athlete which recorded, the casts of the upper and lower jaws are articulated on an average value or semi-adjustable articulator, based on the wax records. The mouth guards are then placed on the casts and they are joined together with a modelling wax at each side. The material of each joining is extended, occlusally, from the distal margin of the mouth guard to the cusp or the distal surface of each canine, avoiding excess thickness where is not necessary and giving the material slightly concave shape on the other 4 surfaces.

Then, the bi-maxillary mouth guard, namely after joining the 2 mouth guards together with the wax, is removed from the articulator together with the casts and it is invested with the casts into the flask in order to remove the wax. The casts are trimmed back before flasking. The wax is removed with a spatula and the removal of possible remains of the wax on the surfaces of the mouth guards is cleaned with a cloth soaked in chloroform.

2 clean sheets of material (EVA) are carefully softened with heat in a metal chaffing dish, without overheating, over a flame until they become pliable and easily formed. The material is packed in big amounts at each half of the flask and then the flask is closed. For better adaptation a clamp is used and the flask together with the clamp is immersed in hot water (70ºC) for 15 minutes. After that the flask is tightened with more pressure, it is immersed again in hot water (80ºC) for other 15 minutes. This process is repeated until full adaptation of the material is obtained so that the flask is closed completely and the excess material is removed. Afterwards, the flask is left to cool at least for 4 hours, then it is immersed in cool water for 30 minutes, and

finally the flask can be opened to take out the bi-maxillary mouth guard.

The last step of the Chapman's method[20], prior to the use of the bi-maxillary mouth guard is its finishing and polishing with stone burs, polishing discs, and chloroform or trichloro-ethane. Nevertheless, sometimes additional adjustment of the mouth guard is necessary and it should be done approximately after 7 days from the wearing day.

Second Method

Another method of a bi-maxillary mouth guard fabrication is described by Jagger and Milward[21]. According to them, the impressions of the upper and the lower jaw of the athlete are firstly taken, poured with stone and the casts are made. Then, the extension on each cast is marked, which the bi-maxillary mouth guard will have after the fabrication. The bi-maxillary mouth guard should extend distally up to the middle of the second molars, whereas the labial, buccal and lingual margins should extend beyond gingivo-buccal, gingivo-labial and gingivo-lingual sulcus, and cover up to 2-3 mm the soft tissues. Furthermore, palatally should extend and cover 10-15 mm from the gingival margin.

Afterwards, the casts are articulated on an average value, or semi-adjustable articulator in centric occlusion, and the required vertical dimension is determined, from which the opening of the bi-maxillary mouth guard will depend. Usually, a 7-10 mm opening is made in the anterior region between the incisal edges of the upper and lower anterior teeth. Another technique for determination of the opening of the bi-maxillary mouth guard, namely the distance between the incisal edges of the upper and lower anterior teeth, can be done according to the Chapman's record of the "heavy breathing position" of the athlete, as it is described above.

Then, sheets of thermoplastic material (usually EVA) of required thickness are chosen, so that the mouth guards have approximately a 4 mm thickness and they are shaped on the cast of each jaw. Mouth guards which are under fabrication are shaped at the predefined dimensions. Before the next step, it is essential to remove material 1-2 mm approximately from the anterior teeth, labially and lingually, from the mandibular mouth guard in order to facilitate the athlete's ventilation.

To continue, the maxillary and mandibular mouth guards are joined together with extra material (EVA) between the occlusal surfaces. To achieve the conjunction between the occlusal surfaces of the 2 mouth guards and the extra material glue is used, which firstly is heated and then is placed. One long piece of the extra thermoplastic material is placed in each side occlusally of the mouth guards, which is shaped with heating. Usually each piece is extended from the distal margins of the 2 mouth guards to the distal surface or the cusp of each canine of the jaws.

The joined and almost finished bi-maxillary mouth guard is left to cool. It is important for to cool it enough in order not to distort, at the next stage, which is its finishing and polishing. Jagger and Milward's method[21] finishes with the polishing of the bi-maxillary mouth guard, using stone burs or polishing discs.

Jagger and Milward claim that their method of a bi-maxillary mouth guard fabrication is faster and easier in relation to the Chapman's method, which is more complicated and time-consuming.

Third Method

The third method of a bi-maxillary mouth guard fabrication is described by Milward and Jagger in 1995[22]. It has a lot of common data not only with the first method (Chapman) but also with the second (Jagger and Milward). According to this method, as with the other 2 methods, it starts with receiving the impressions of the maxilla and the mandible of the athlete. Then, the impressions are poured-in with dental stone and the casts are made.

The margins where bi-maxillary mouth guard will extend are marked on each cast (Fig. 6a). The bi-maxillary mouth guard should extend backward until the middle of the second molars. Furthermore, the labial, buccal and lingual margins should extend beyond gingivo-buccal, gingivo-labial and gingivo-lingual sulcus, and cover up to 2-3 mm the soft tissues. Palatally, as it is referred previously, the mouth guard should extend and cover 10-15 mm from the gingival margins. Then, the casts are mounted in an average value or semi-adjustable articulator, and the required vertical dimension is determined, which corresponds at the opening of the mouth guard after fabrication. Usually, an opening 7-10 mm is made in the anterior region between the incisal edges of the upper and lower anterior teeth. Alternatively, the opening of the bi-maxillary mouth guard can be determined according to the Chapman's technique record of the "heavy breathing position".

Afterwards, soft sheets of wax are taken, shaping them on the casts and the mouth guards of each jaw, making sure that each one is extended until the marked margins (Fig. 6, b and c). The required thickness, which the wax should obtain, is approximately 4-5 mm. The mouth guard of the mandible is trimmed only at the occlusal surface in the region of the incisors, so that the edges of labial and buccal surfaces of the incisors will be uncovered approximately 1.5 mm (Fig. 6d). Then, 2 wax models of the maxilla and the mandible are joined together, at the predetermined vertical dimension. The conjunction is done in each side of the mouth guards, adding extra pieces of wax. Each wax conjunction is placed occlusally of the wax models of the mouth guards in the posterior region, and usually extends from the distal margin of the wax model to the distal surface or the cusp of each canine of the jaws (Fig. 6e). The excess

thickness of the added wax is avoided where it is not necessary, and the wax is given a slightly concave shape on the surfaces.

Before the investing procedure, the whole wax assembly is smoothed and polished very well with a flame because as smooth and polished the wax assembly is, so smooth and polished will the bi-maxillary mouth guard be after flasking. Afterwards, the lingual and palatal part of the assembly is poured with stone and when the stone is hardened, it is trimmed back (Fig. 6, f and g).

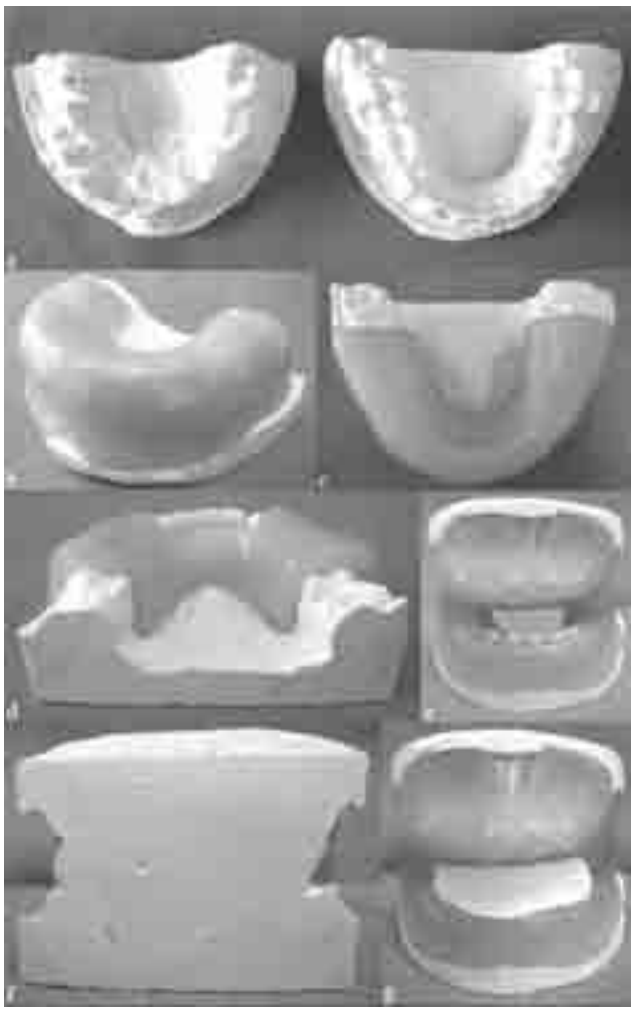

Figure 6. Fabrication stages of the wax model of type III bi-maxillary mouth guard

Next the assembly is placed vertically deep in the half of a dental flask (Fig. 7a). Then, the stone is smoothed and trimmed in order to uncover the maximum amount of wax labially and buccally, but not to form cavities in the cast, which will make the deflasking difficult. The whole stone is coated with a separating medium (according to the manufacturer's guidelines) and is left to dry (Fig. 7b).

To continue, the one half of the flask is placed over the other half of the flask and it is poured with stone and the flask is closed so as not to entrap air (Fig. 7, c and d). The flask is placed in a hydraulic press in order to remove the excesses of the stone (Fig. 7e). The minute the stone is hardened, the flask is boiled to remove the wax (Fig. 7f) and then 2 parts of the flask is separated (Fig. 7, g and h). After that, the space that is created (Fig. 8a) is packed with silicone and it should be made sure that the material fills the lingual as well as the palatal part of the assembly (Fig. 8, b and c). The flask is then placed, again, in a hydraulic press in order to remove the excesses of the silicone (Fig. 8d). The flask is closed and it is immersed in hot water. When the water comes up to boiling point, the flask is remained approximately for 1 hour, according to the manufacturer's guidelines. Then, the flask is left to cool and when it has cooled enough, the deflasking is done (Fig. 8, e and f) and the mouth guard is carefully removed from the casts.

The next step is the removal of the material excesses (Fig. 9a). At the end of the Milward and Jagger's method[22], the bi-maxillary mouth guard is smoothed and polished and then it is ready for use (Fig. 9, b-d).

Figure 7. a-e) Fabrication stages of the investment and flasking of type III bi-maxillary mouth guard; f-h) Fabrication stages of the wax elimination of type III bi-maxillary mouth guard

Figure 8. Fabrication stages of the silicone packing and polymerization of type III bi-maxillary mouth guard

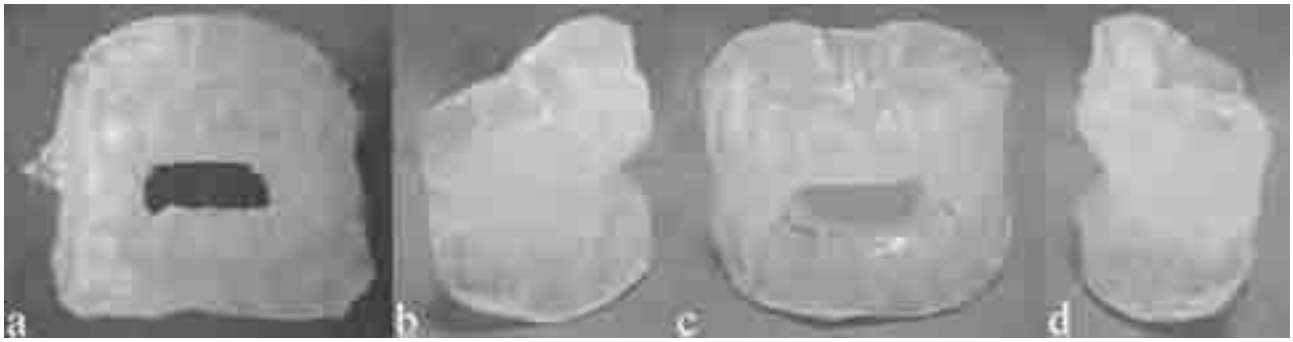

Figure 9. Type III bi-maxillary mouth guard before and after the final modification

The advantage of this method of fabrication a bi-maxillary mouth guard is that the material is quite resilient and adaptable, which is preferred from the majority of athletes. In contrast, the bi-maxillary mouth guard from EVA material is rigid and inflexible. However, it is a more time-consuming and expensive method than the other methods[22].

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Electronic Length Measurement in Teeth with Open Apex

SUMMARY

2 electronic apex locators were used to determine the working length in teeth with incomplete root formation. Electronic length measurements were performed in 20 maxillary incisors and 2 maxillary second premolars with open apex at the beginning of the apexification therapy. Calcium hydroxide was used to induce apexification. In the beginning of the apexification treatment, both electronic devices gave incorrect results. When the apical closure with the formation of calcified bridge was radiographically detected, and confirmed clinically, the results obtained with 2 electronic apex locators were correct.

The electronic apex locators evaluated in this study (Root ZX and Ray-Pex 5) may be useful in the treatment of teeth with incomplete root formation.

Keywords: Electronic Apex Locators; Ray-Pex 5; Root ZX; Incomplete Root Formation; Apexification

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Introduction

The usual cause of endodontic involvement in a tooth with an incompletely developed root is trauma. Unfortunately, traumatic injuries to young permanent teeth are not uncommon; it is said that they affect 30% of children[1]. The majority of these incidents occurs before root formation is complete, and may result in pulpal inflammation or necrosis[2]. The completion of root development and closure of the apex occurs up to 3 years after eruption of the tooth[3] (Fig. 1).

Hertwig's epithelial root sheath is responsible for determining the shape of the root or roots. The epithelial diaphragm surrounds the apical opening to the pulp and eventually becomes the apical foramen. The root sheath of Hertwig is usually sensitive to trauma, but because of the degree of vascularity and cellularity in the apical region, root formation can continue even in the presence of pulpal inflammation and necrosis[4,5]. Because of the important role of Hertwig's epithelial root sheath in continued root development after pulpal injury, every effort should be made to maintain its viability.

Figure 1.

Endodontic management of the pulpless permanent tooth, with a wide-open blunderbuss apex, has long presented a challenge in dentistry. Depending upon the vitality

of the affected pulp, 2 approaches are now possible - apexogenesis and apexification. Apexogenesis (calcium hydroxide pulpectomy) is a vital pulp therapy procedure performed to encourage continued physiological development and formation of the root end. Apexification is the process of stimulating the formation of a calcified barrier in a root with an open apex or the continued apical development of an incomplete root in teeth with necrotic pulp[6].

The apexification method involves opening the tooth, cleaning and rinsing properly the canal and then filling it with a temporary paste to stimulate the formation of calcified tissue at the apex. The temporary paste is later removed, after evidence of apical closure has been obtained, and a permanent filling of gutta-percha is placed in the canal[7]. In such cases with incomplete root formation, in order to allow the condensation of the root filling material and to promote an apical seal, it is imperative to create an artificial apical barrier or induce the closure of the apical foramen with calcified tissue (apexification). Calcium hydroxide pastes have become the material of choice to induce apexification. Studies have indicated mineral trioxide aggregate (MTA) as an alternative to calcium hydroxide. In many instances, after variable periods of time, further growth of the root and complete closure of the root end will appear.

One of the major difficulties in performing endodontic treatment in a tooth with incomplete root formation is evaluating the working length. The missing apical constriction causes a high risk of initial over instrumentation. The purpose of this study was to evaluate the usefulness of electronic apex locators in endodontic treatment of teeth with incomplete root formation (apexification).

Material and Methods

In this study, electronic length measurements were performed in 20 maxillary incisors and 2 maxillary second premolars. The age of the patients (8 male and 14 female) ranged from 7 to 13 years. All of the teeth showed radiographically incomplete root formation. Electronic measurements of root canal length for each tooth were undertaken at the beginning of the therapy, when the apical foramen was open. The results obtained with both the electronic apex locators were compared with the results from radiographs, taken to determine length. In 8 cases the pulp was necrotic and in 14 cases pulpectomy was carried out before the electronic measurement**.**

Each tooth was anaesthetized, isolated with rubber dam and a standard endodontic access opening was made. Vital or necrotic pulp tissue was carefully removed and the root canals were irrigated with sodium chlorite and dried with sterile paper points. This procedure was continued until bleeding had stopped. A single operator then applied both devices (Root ZX, J. Morita GmbH, Germany), and Ray-Pex 5 (VDW GmbH, Germany) according to the manufacturer's instructions. Working lengths were measured with K-files (F. KG. Dentaire, La Chauxde-Fonds, Switzerland) using both electronic apex locators. All the teeth were measured with both apex locators.

The Root ZX (3rd generation) was introduced by the J. Morita Corporation, Japan, and uses the ratio or division method for measuring the root canal length. The ratio method simultaneously measures the impedances of the canal contents using 2 signals of different frequency (400 Hz and 8 kHz) and calculates the quotient of the impedance, which is used to determine the position of the file inside the canal. This is a constant value that is reliable in the presence of electrolytes or pulp tissue. The Root ZX needs no calibration before measuring working length. A lip clip is attached to the patient's lip and the electrode connects to the file. The file is advanced into the canal until the display indicates that the minor diameter is reached.

Ray-Pex 5 (VDW GmbH, Germany) is a 4th generation device and records impedance measurement based on advanced multi-frequency system and uses the latest digital technology. According to the manufacturers, the combination of using only 1 frequency at a time and basing measurements on the root mean square values of the signals increases the measurement accuracy and the reliability of the device. There is no need for individual calibration, as the device has a pre-calibrated display of the apical constriction.

Measurements were considered as valid if the instrument remained stable for at least 5 sec. The clip was applied in the corner of the patient's mouth and the file holder was attached to a size 15 stainless steel K-file and advanced into the canal until the screen of the device showed the "apex" indication and the audible continuous signal indicated that the anatomical foramen had been reached. The results of the electronic measurements were recorded and compared to the results obtained from radiographs.

Only the root canals of the incisors were prepared using K-files and sodium chloride as an irrigation solution. After proper cleaning and rinsing, they were temporarily filled with calcium hydroxide paste (Merck & Co Inc, NJ, USA). The paste was prepared by mixing powder of chemical pure calcium hydroxide and powder of barium sulphate (4:1), with sodium chlorite solution. A temporary cavity filling (Alganol, Howmedica International Ltd, London UK & Harvard Cement, Dental-GmbH, Berlin, Germany) was placed and the calcium hydroxide paste was controlled radiographically.

The two premolars with incomplete root formation were scheduled for extractions due to orthodontic reasons and examined in scanning electron microscope (Fig. 2).

The incisors used in this study were considered to be ready for definite obturation when either the radiographic control revealed complete closure of the root end with

the formation of calcified bridge, or when the apical constriction could not be passed with size 15 K-file. The root canals were cleaned of calcium hydroxide remnants, irrigated with sodium chlorite and dried with cotton pellets. An endodontic instrument was inserted into the root canal until it reached the apical barrier. The working length of each root canal was measured with both electronic apex locators. The results of the electronic measurements were recorded and compared to the results obtained from radiographs. The root canals were permanently obturated with gutta-percha (Fig. 3).

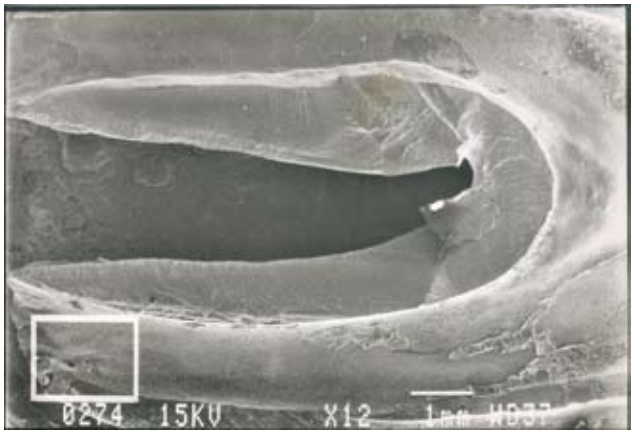

Figure 2a.

Figure 2b.

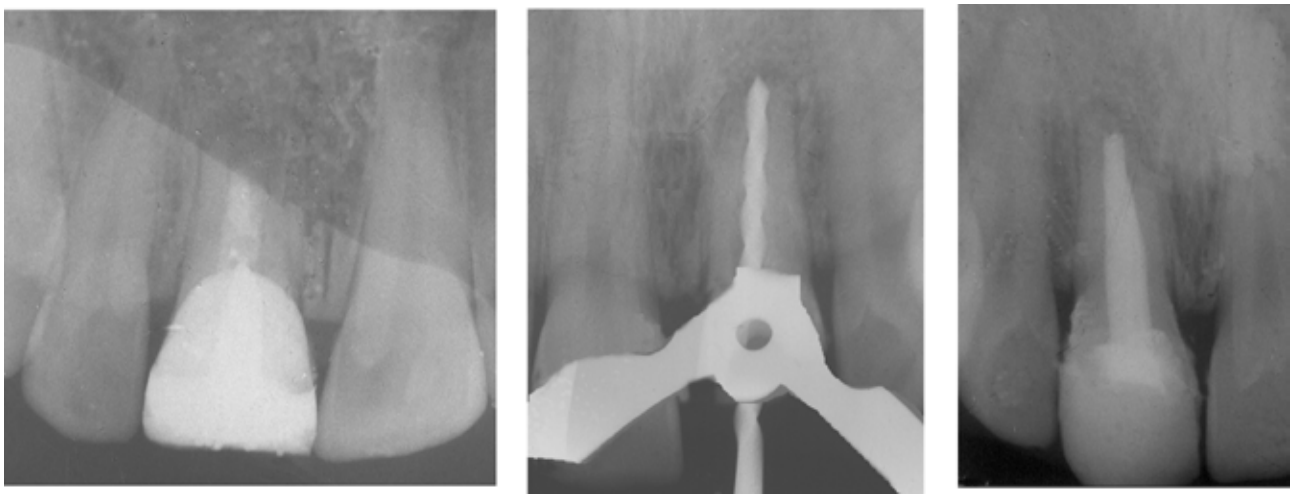

Figure 3.

Results

The results can be seen in tables 1-3, and diagram 1.

Table 1. Results of electronic measurements at the beginning of the apexification therapy

	Necrotic teeth n=8			Vital teeth n=14		
Electronic measurement	correct	too short	too long	correct	too short	too long
Root ZX	0	8	0	0	14	0
Ray-Pex 5	0	8	0	0	14	0

Table 2. Results of electronic measurements at the end of the apexification therapy

	Necrotic teeth n=8			Vital teeth n=12		
Electronic measurement	correct	too short	too long	correct	too short	too long
Root ZX	8	0	0	12	0	0
Ray-Pex 5	8	0	0	12	0	0

Table 3. Observed distances of the tip of the file from the radiographic apex at the beginning of the apexification therapy

	Root ZX	Ray-Pex 5
Necrotic teeth n=8	3mm, 4mm, 3mm, 3mm, 3mm, 4mm, 2mm, 3mm	3mm, 3mm, 2mm, 2mm, 3mm, 4mm, 3mm, 2mm
Vital teeth n=14	4mm, 3mm, 5mm, 5mm, 6mm, 5mm, 4mm, 5mm, 4mm, 6mm, 7mm, 4mm, 4mm, 5mm	5mm, 3mm, 5mm, 4mm, 7mm, 6mm, 4mm, 5mm, 5mm, 6mm, 7mm, 4mm, 5mm, 4mm

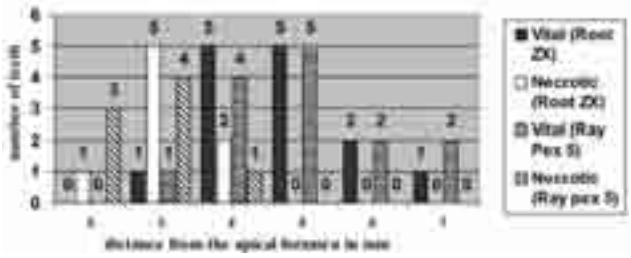

Diagram 1. Observed distances of the tip of the file from the radiographic apex at the beginning of the apexification therapy

Discussion

The use of electronic apex locators for calculation of working length during endodontic therapy provides the clinician with accurate and reliable measurements for each individual root canal. Several studies have demonstrated that the latest generation of electronic apex locators can accurately determine the working length in between 75% to 96.5% of the root canals with mature apices[8-10]. Moreover, it has been reported that electronic devices are ineffective in determining length in treatment of teeth with incomplete root formation[11-13].

Hülsmann & Pieper[11] demonstrated that an apex locator gave incorrect results in teeth with open apices. However, these authors used a first-generation apex locator, whereas a 3rd generation Root ZX device and a 4th generation Ray-Pex 5 device, that are less susceptible when used in similar conditions, were used in the present study.

Suchde and Talim[13] have achieved correct results in only 7 of 11 teeth with incomplete root formation. Berman and Fleischman[14] describe 5 cases in which measurements performed in teeth with open apices were too short. Huang[15] has demonstrated *in vitro* that the width of the apical foramen has great influence on the accuracy of endodontic measurements. When the diameter of the apical foramen is larger than 0.5 mm, the results from the electronic measurement differ from the correct working length. These results were again confirmed in our study.

Further clinical studies should be performed to evaluate electronic apex locators under different clinical conditions, such as the presence of severe apical root resorption or blunderbuss canals.

Conclusion

The findings of this study demonstrated that the electronic apex locators did not give correct results in teeth with incomplete root formation. No difference in the results was noted between vital teeth and teeth with necrotic pulps. However the electronic apex locators in all teeth at the end of the apexification therapy gave correct results and complete agreement was obtained between the radiographs and the electronic measurements. Even in teeth in which complete apical closure could not be obtained, the results of electronic measurements were correct.

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Anatomy of the Pulp Chamber Floor of the Permanent Maxillary and Mandibular Molars

SUMMARY

Objectives: *The purpose of this study was to evaluate the shape of pulp chamber floors of maxillary and mandibular molars.*

Methods: *A total of 111 maxillary and 248 mandibular extracted molars were used in the study The crowns of the teeth were removed from the cemento-enamel junction by the help of a diamond bur. Pulp chamber floors of the teeth were filled with temporary restorative material. The shape of the cavities were evaluated by 3 independent observers.*

Results: *Of the 111 maxillary molars evaluated, 32 teeth had triangular pulp chamber floor. 79 of them had rhomboidal pulp chamber floor like the occlusal form of these teeth. Of the 248 mandibular molars, 170 teeth had rectangular pulp chamber floor, 72 triangular, and only 6 teeth had oval shaped chamber floor.*

Conclusion: *The shape of the access cavity should be changed from the conventional triangular shape to rhomboidal shape in maxillary molars and to rectangular shape in mandibular molars.*

Keywords: Maxillary Molar; Mandibular Molar; Access Cavity, shape

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Introduction

One of the most important aspects in contemporary endodontics is a thorough knowledge of internal and external root anatomy[1]. Root canal anatomy has always been one of the most popular subjects in endodontics. In 1969, Weine et al[1] evaluated 208 maxillary molars and found 51.5% of them to have 2 canals in the mesiobuccal roots. A few years later, in 1971, Skidmore and Bjorndal[2] investigated 45 extracted first molars and found 4 root canals in approximately one third of the teeth. The fourth canal was located in the distal canal[2]. These 2 cornerstone studies were supported by many authors[3-7]. Studies, in which the root canal configuration of maxillary molars has been evaluated, frequently concluded that "the normal anatomy of the maxillary first and second molars is the 2 canals in the mesiobuccal root"[7,8]. It has been similar in mandibular molars: distal root of mandibular molars frequently has a root canal system containing more than 1 canal[2,7,9].

In the light of these findings, a discussion was born whether it is logical to prepare a triangular shaped endodontic cavity in posterior teeth or not. It was also proposed that endodontic access cavity should be dictated by the anatomy of pulp chamber floor to find the extra-canals[3,8,9,10]. The **aim** of this study was to evaluate the shape of pulp chamber floors of maxillary and mandibular molars.

Materials and Methods

A total of 111 maxillary and 248 mandibular extracted molars were used in the study. The age, sex and the reasons of the extraction were not recorded. The teeth were placed in 5% NaOCl for 30 minutes to remove the organic tissue. The crowns of the teeth were removed from the cemento-enamel junction by the help of a diamond bur under water coolant. To detect the borders of the pulp chamber floor, the cavities in the roots were filled with temporary filling material (Coltosol, Coltene, Germany). The shape of the cavities was evaluated by 3 independent observers.

Results

Of the 111 maxillary molars evaluated, 32 teeth had triangular pulp chamber floor; 79 molars had rhomboidal pulp chamber floor like the occlusal form of these teeth.

Of the 248 mandibular molars, 170 teeth had rectangular pulp chamber floor, 72 teeth triangular, and only 6 teeth had oval-shaped chamber floor.

Discussion

A major cause of failure in root canal treatment is the inability to locate, debride and fill the frequently present extra-canals. In 1990, Kulild and Peters[5] evaluated the incidence of second mesio-buccal canal in the extracted teeth. 51 first and 32 second maxillary molars were used in the study. It was found that the incidence of the second canal in these teeth was 54.2% by the investigation of hand files[5]. However, this ratio rose up to 95.2% by the help of burs and microscope[5]. A similar study was performed by Imura et al[8]. They studied 42 first and 30 second extracted maxillary molars were root canal had been treated by graduate students. The results demonstrated that 52.3% of the first and 40% of second molars had 2 canals obturated in mesio-buccal root[8]. On the other hand, after clearing process, the presence of second canals rose to 80.9% and 66.6%, respectively[8].

Today, it is accepted that maxillary molars frequently have a second canal in the mesio-buccal root, but it is difficult to be located clinically[3,5,6]. There is no doubt that this second canal, named "mesio-buccal 2" should be expected until radiographic and clinical evaluations show the contrary[3]. This fact is similar in mandibular molars. Considering the results of root canal configuration studies of mandibular molars, it is not a surprise to locate the second canal in the distal root[2,7,9].

According to this data, some authors advised to re-evaluate the design of endodontic access cavities of both maxillary and mandibular molars[5,9,11]. Actually, the endodontic access cavity should be prepared according to the borders of the pulp chamber floor. The results of our study clearly demonstrate that most of maxillary molars have rhomboidal pulp chamber floor. This result was supported by Vigoroux and Bosaans[10] who evaluated 134 maxillary molars and found that 52.24% of the teeth had trapezoidal shape. Only 6 of them had triangular pulp chamber floor. In our research, it is also shown that the pulp chamber floor of mandibular molars is frequently rectangular. All these internal anatomy studies showed that conventional triangular-shaped cavity is not enough to locate the fourth canal in both maxillary and mandibular molars[9-11]. A large opening needs to be made to ensure all morphologic details were accessed. To search the fourth canal, the first step should be to modify endodontic access cavity preparations[9-11]. The shape of the access cavity should be changed from the conventional triangular shape to rhomboidal shape in maxillary molars and to rectangular shape in mandibular molars. In addition to modified access cavity, radiographs from different angles, loops, dental operation microscopes, bubble test (warmed 2.6% NaOCl) are other facilities for finding the extra-canals[6,8].

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Matrix Metalloproteinase Levels in Chronic Periapical Lesions and Inflamed Dental Pulps

SUMMARY

The aim of this study was to accomplish quantitative measurement of tissue levels of collagenases (MMP-1, 8 and 13) in chronic inflamed tissues (pulp and periapical lesions), as well as to determine the dependence between collagenase level and the degree of tissue destruction of examined material. Chronic periapical tissues were collected by periapical surgery from 50 teeth with clinically and radiographically verified different chronic periapical lesions (20 granulomas, 20 diffuse periapical lesions, 10 cysts). Chronically inflamed pulps were obtained from 20 patients by endodontic treatment. Control group contained vital dental pulps from 10 impacted third molars. For rapid analysis of MMP-1, 8 and 13 collagenase activities in the examined material Chemicon Collagenase Activity Assay Kit was used.

The biggest values of concentration of MMPs were registered in chronic diffuse lesions (5.39 ng/mL). Expression and activity of MMPs in normal tissue of pulp from impacted third molars was from 0.00 to 0.02 ng/mL. Different concentrations of collagenases (MMP-1, 8 and 13) in chronic periapical lesions from different inflammation types showed different activity of MMPs, which was confirmed with high significant difference (ANOVA F=67.475; df=4; p=0.000). The concentration of collagenases (MMP-1, 8 and 13) in chronically inflamed pulp was from 0.1-1.28 ng/mL, which means that inflammation process was still localized in pulp tissue only, and periapical connective tissue was not affected.

We conformed the destructive role of collagenases (MMP-1, 8 and 13) in inflammation processes, which is directly dependent from the concentration of MMPs in pathologically changed tissue. With respect to conventional methods in everyday dental practice, this study recommended determination of MMPs (proteolytic enzymes) as the most sensitive markers in chronically inflamed tissues, which opens new opportunities to contemporary methods of evaluation and monitoring of inflammation activity in chronic periapical lesions.

Keywords: Chronic Periapical Lesions; Extracellular Matrix; Collagen; Collagenases

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Introduction

Matrix metalloproteinases (MMPs) are proteolytic enzymes capable of degrading almost all extracellular matrix (ECM) and basement membrane (BM) components[6]. MMPs form a family of structurally related, but genetically distinct endo-peptidases, expressed at low levels in normal tissues, but unregulated during inflammation[1]. Normal embryonic development and tissue remodeling needs a controlled balance between extracellular matrix synthesis and degradation, as well as a balance between MMPs and their natural inhibitors, tissue inhibitors of matrix metalloproteinases (TIMPs)[13,14]. This group of proteolytic enzymes has a role in many normal physiological events, like ovulation, embryo implantation, organ development, angiogenesis, wound healing and bone remodeling[19].

Disruption of the balance between MMPs and TIMPs contributes to pathophysiological processes, such as many chronic tissue destructive inflammatory and autoimmune

diseases[13,14]. The obvious destructive capability of MMPs initially focused most research onto diseases that involve breakdown of the connective tissues (e.g. rheumatoid arthritis, cancer, periodontal disease and periapical lesions)[19]. Leukocytes, particularly macrophages, are major sources of MMP production. MMPs released by leukocytes play vital roles in allowing leukocytes to extravagate and penetrate tissues, a key event in inflammatory disease[25].

MMPs are divided according to their substrate specificities and structures to interstitial collagenases, gelatinases, membrane-type MMPs, stromelysins, matrilysins and other MMPs[23]. Collagenases (collagenases-1, 2 and 3; MMPs-1, 8, 13) are named after their unique capacity to degrade fibrillar collagen types I, II, III, V and IX. In oral tissues, this first characterized collagenase, MMP-1 (collagenase-1, interstitial collagenase, fibroblast collagenase), is detected in gingival fibroblasts capable of disrupting ECM collagen. MP-8 (collagenase-2) represents the second collagenase, and was originally synthesized and stored exclusively in intracellular granules of human polymorphonuclear neutrophils (PMNs) in bone marrow[11]. MMP-13 (collagenase-3) was originally cloned from human breast tumor. It is also expressed by hypertrophic chondrocytes, osteoblasts, periosteal cells and fibroblasts during human fetal bone development[5, 20] and postnatal in bone remodeling[20].

With respect to other literature findings that underline the role of collagenases (MMP-1, -8, -13) in chronic periapical lesions, the **aims** of this study were formulated as follows:

- to accomplish quantitative measurement of tissue levels of collagenases (MMP-1, -8, -13) in chronically inflamed tissues: chronic periapical lesions and chronically inflamed dental pulps with enzyme method;
- to determine the dependence between levels of collagenases (MMP-1, -8, -13) and the degree of tissue destruction of the examined material (periapical tissue and pulp).

Materials and Methods

Examination material was collected on the basis of clinical diagnosis after thoroughly realizing dental histories and clinical investigation and analysis of radiological findings.

Chronic periapical tissues were collected by periapical surgery from 50 teeth with clinically and radiographically verified different chronic periapical lesions (20 granulomas, 20 diffuse periapical lesions, 10 cysts). Chronically inflamed pulps were obtained from 20 patients during endodontic treatment. 10 normal pulps that were obtained by extirpation of the pulp of impacted third molars after surgery used as control specimens.

Examination material was frozen at -80ºC as soon as possible and stored until the analysis, but not longer than 6 months.

Laboratory Analysis

For rapid quantitative analysis of MMP-1, -8, -13 collagenase activities in all thr examined material (chronic periapical tissues, chronically inflamed pulps and normal pulp tissue) Chemicon Collagenase Activity Assay Kit (ECM710) was used. The colorimetric kit is designed in order to achieve quick, convenient and sensitive evaluation of MMP-1, -8 and -13 collagenase activities in a 96-well microplate format. Biotinylated, native triple helical Type I collagen was used as a substrate and was cleaved from the activated MMP-1, -8, -13 enzymes.

Each sample was macerated in Phosphate-Buffered Saline - PBS (1.5 ml) and than homogenized samples were centrifuged with Eppendorf-Centrifuge at 10,000 g for 10 min. The supernatant was detected in new test tubes and used for following analysis. In homogenized mixture with Bradford micromethod using series of 5 standards of bovine-serum albumin, and than measuring the absorbance on 450nm with spectrophotometer, concentration of total proteins was determined. With interpolation from the standard curve, concentration of the proteins in samples was measured. A microplate reader (Anthos ht III) was used to measure the absorbance at 450nm. Values of the absorbance of each standard were corrected according to protein concentration.

By adding 100μL of Stop Solution to each well, the bright yellow convert to bright blue coloured product and the enzyme reaction was stopped. The MMPs concentration of each sample was normalized *versus* concentration of proteins in each sample. Standard curve was designed with soft wear program Curve Expert 1.3. With interpolation of the values, MMP-1, -8, -13 collagenase concentrations were calculated.

Statistical analysis for comparison of values to define the significance between specimens of the examined material used descriptive and analytical statistical methods from the programme Stat Soft Statistic 6.0.

Results

MMP-1, -8, -13 collagenase concentrations in the specimens of the examined material varied from undetectable values, increasing proportionally with the clinical picture of the inflammation and propagation of the infection from the root canal to the periapical tissue (Tab. 1).

Expression and activity of MMPs in normal tissue was very low. The measured concentration of collagenases (MMP-1, -8, -13) in normal tissue of pulp from impacted third molars was from 0.00 ng/mL to 0.02 ng/mL. The concentration of collagenases (MMP-1, -8,

-13) in chronically inflamed pulp tissue was from 0.1-1.28 ng/mL, which means that inflammation process is still localized only in the pulp tissue and had not affected periapical connective tissue. In the specimens of patients with chronic periapical granulomas, the concentrations of collagenases (MMP-1, -8, -13) in most of the cases (85%, 17 specimens) were in borders from 0.1-0.99 ng/mL. Concentration of collagenases in diffuse periapical lesions was in borders from 3-4.99 ng/mL (45%, 9 specimens). Concentration of the MMPs in all 10 specimens with clinical diagnosis of radicular cxst was in borders from 0.1-0.99 ng/mL. Similar concentration of collagenases from specimens with chronically inflamed pulp (85%, 17 specimens) was found.

Table 1. MMP-1, -8 and -13 collagenase concentrations (ng/mL) in the specimens of the examination material

Clinical Diagnosis	N	Min	Max	Median	$\bar{X}$	SD
Chronic Granulomatous Parodontitis	20	0.05	0.95	0.44	0.46	± 0.29
Chronic Diffuse Parodontitis	20	1.15	5.39	4.12	3.63	± 1.46
Radicular Cyst	10	0.10	0.64	0.19	0.25	± 0.16
Chronic Pulpitis	20	0.1	1.28	0.35	0.47	± 0.38
Dens Impactus	10	0.00	0.02	0.01	0.01	± 0.009

The highest values of the concentration of collagenases (MMP-1, -8, -13) between chronic periapical processes with different clinical diagnosis were detected in the inflamed tissue of the patients with diffuse periapical lesions (5.39 ng/mL). Different concentration of collagenases (MMP-1, -8, -13) in chronic periapical lesions from different inflammation type was found, which was statistically significant ($p<0.05$). The difference between various clinical diagnoses analyzed from the median values of collagenase (MMP-1, -8, 13) concentration was statistically significant (ANOVA $F=67.475$, $df=4$, $p<0.01$). High statistical significance was confirmed with Kruskall-Wallis test ($x^2=59.363$, $df=4$, $p<0.01$), as well as, with Mediana test ($x^2=37.400$, $df=4$, $p<0.01$).

Assessment of the median values of collagenase (MMP-1, -8, -13) concentration between different clinical diagnoses is presented in figures 1-4 and with box-plot diagram in figure 5.

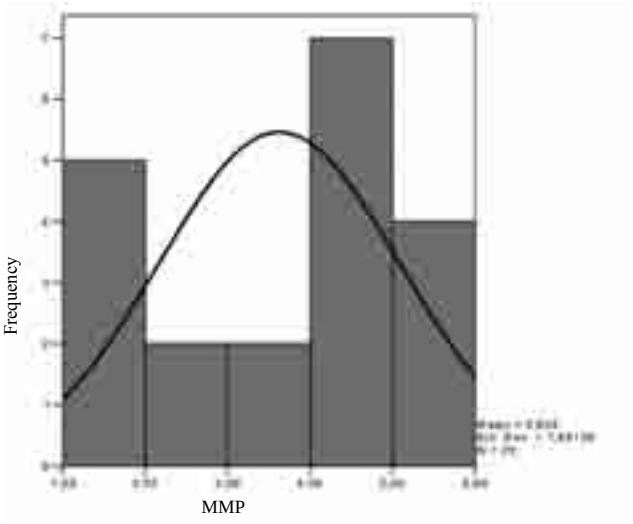

Figure 2. Median values of MMP-1, -8, -13 collagenase concentrations in diffuse periapical lesions

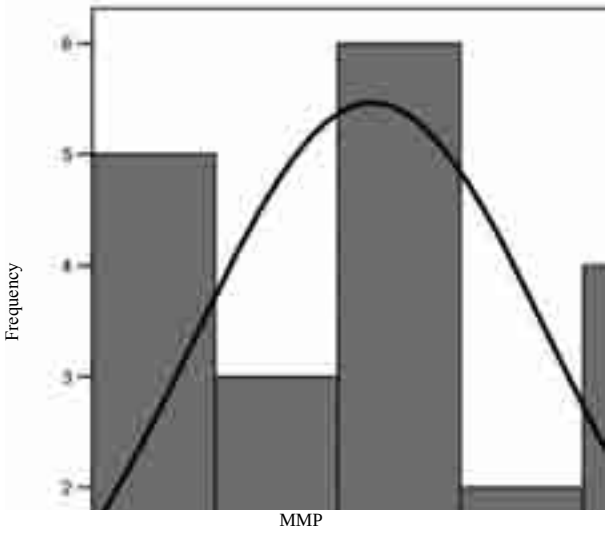

Figure 1. Median values of MMP-1, -8, -13 collagenase concentrations in chronic periapical granulomas

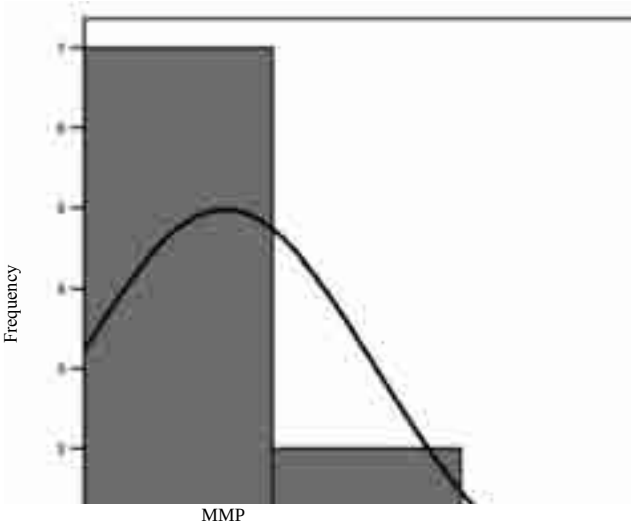

Figure 3. Median values of MMP-1, -8, -13 collagenase concentrations in radicular cysts

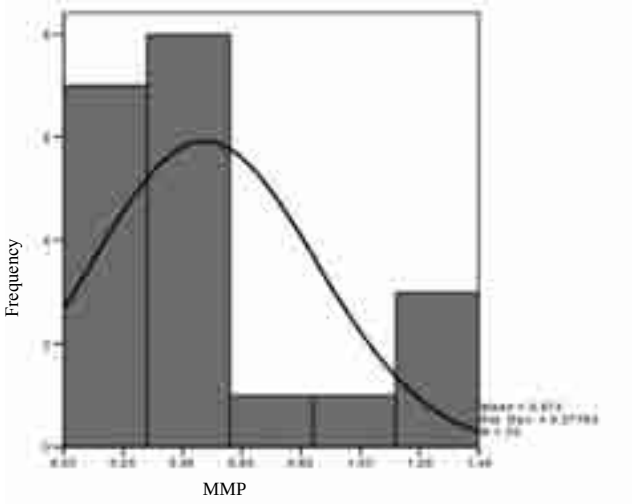

Figure 4. Median values of MMP-1, -8, -13 collagenase concentrations in inflamed pulp tissues

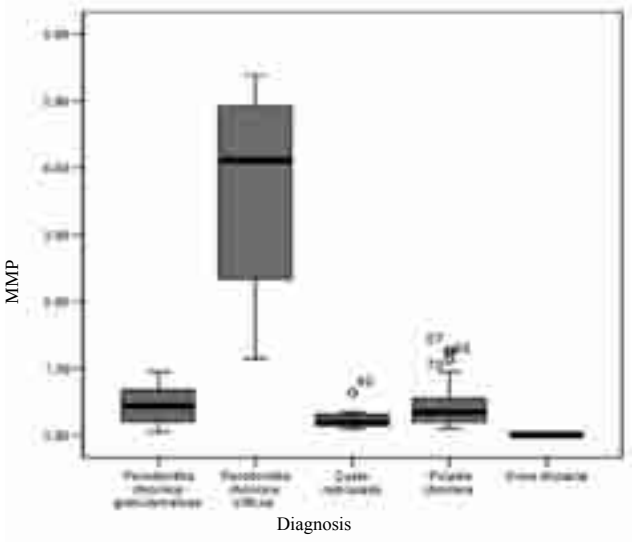

Figure 5. Box-plot diagram of median values of MMP-1, -8, -13 collagenase concentrations in different clinical diagnoses

Discussion

Most literature findings confirm that MMPs are present in inflammatory tissue of pulp and periapical lesions, like in other inflammatory tissues[19,26-28]. According to Vu and Werb[25], microorganisms and their products may act during the process of tissue inflammation through regulation of production of cytokines in order to increase the expression of MMPs or directly to stimulate the cells to produce MMPs. In chronic periapical lesions, beside elimination of infective material, there is a local destruction of tissue due to proteolytic enzymes release, including collagenases (MMP-1, -8, -13)[26].

Bacterial endotoxins, always present in radicular cysts, stimulate keratocystic proliferation, and therefore bacterial products activate the production of MMPs[2]. This proteolytic enzyme cascades, in most of the cases, are involved in degradation of bone matrix, basal membrane and epithelial cell processing during the time of cystic expansion. Degradation and synthesis of ECM components in normal, healthy tissue are in constant balance, and collagenases are expressed at very low levels, being precisely controlled[4].

MMP-1 can't be detected or is expressed in very low level in normal pulp tissue[16]. Our results confirmed the presence of small concentration of collagenases (MMP-1, -8, -13) in pulp tissues of impacted third molars, which varied from minimal value 0.00 ng/mL to maximal 0.02 ng/mL. This finding is in agreement with that of other authors[4,14,16].

During chronic inflammation, proliferation of fibroblasts and vascular elements, infiltration of leucocytes, macrophages and plasma cells, play essential role of cell mediator mechanisms involved in chronic periapical lesions[17]. Plasma cells, which enter the inflamed tissue after the PMNs (polymorphnuclear leukocytes), secrete immunoglobulins and express MMP-8 and MMP-13[27]. Monocytes/macrophages express MMP-8 and MMP-13, and these MMPs may work not only extracellulary, taking part in tissue destruction, but also intracellulary, in the phagocytic process[7,15].

Wahlgren et al[26] detected MMP-8 in the root canal exudates even after root canal was cleaned by chemical and mechanical means, which shows that the MMP-8 must be of periapical origin and that the inflammatory process in the apical area is diminishing slowly but clearly during 3 weeks. Detection of decreased MMP-8 levels during root canal treatment may lead to adjunctive chair-side or point-of-care diagnostic tools similar to the one developed for periodontitis gingival cervical fluid and peri-implant sulcular fluid to evaluate the periapical inflammation process[8,12,19,26]. Chemical compounds, such as chlorhexidine, often used as adjunctive medication in periapical and periodontal treatment, in addition to its antimicrobial properties, exert properties directly *in vitro* and *in vivo* to inhibit the MMPs[3,12,18,26].

In our study, results from quantitative enzyme method demonstrated that the concentrations of collagenases (MMP-1, -8, -13) in chronically pulp inflammation were significantly higher than those of the control group ($p<0.05$). In addition, concentrations of collagenases in patients with diagnosed periapical lesions were significantly higher than those of the control group and were higher from the patients with chronical pulp inflammation ($p<0.05$). Our findings are in agreement with findings of Shin et al[16], where ELISA results demonstrated that the concentrations of MMP-1, -2 and -3 in the all experimental groups were significantly higher than those of the controls ($p<0.05$); also, concentration of MMP-1 in the periapical lesion group was higher than that in the chronic pulp group. These authors[16] suggest that MMPs play a role in the progress of pulp inflammation and pulp tissue destruction, which is also our conclusion.

Collagenases (MMP-1 and MMP-8) and gelatinases (MMP-2 and MMP-9) have been detected in cyst fluid and cyst wall extracts[9,22]. Bacterial endotoxin, always present in radicular cysts, stimulate keratinocyte proliferation, and bacterial products activate MMP production[2]. These proteolytic enzyme cascades are most likely involved in the bone matrix degradation, basal membrane and epithelial cell processing during cyst expansion.

In Leonardi et al[10] study, the expression pattern of MMP-13 demonstrates that it was involved in the conversion of a periapical granuloma with epithelium into a radicular cyst. According to these authors, this property was related to the ability of MMP-13 to influence not only the migration of epithelial cell but also the invasion of granulomatous tissue.

MMPs inhibition has also been suggested to decrease bone resorption in pathological conditions and dental caries progression[21]. MMPs inhibition in root canals and periapical tissue may offer new opportunities to root-canal treatment in the future. MMPs are one of the important factors responsible for the kinetics of periapical bone destruction, and therefore it is possible for there to act on periapical bone regeneration after apicoectomy.

Conclusion

With respect to conventional methods that are present in everyday dental practice, this study opens new opportunities to a contemporary method for diagnostic of the chronic periapical lesions and monitoring of inflammation activity in tissue, based on destructive role of collagenases (MMP-1, -8, 13) in inflammation process, which is directly dependent on concentration of MMP in pathologically changed tissue.

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Etiopathogenetic Aspects of Radicular Cysts

SUMMARY

The aim of this study was to get more information on ethiopathogenetic mechanism of radicular cysts and eventual effect of local factors in the evolution and prognosis of the cystic lesion. For this purpose we performed radiological, pathohistological and microbiological examination. 50 patients with diagnosis of radicular cysts were examined. The results obtained from the examined group were compared with the controls (35). Clinical investigation was based upon dental history and clinical data, supplemented with radiological, microbiological and pathohistological examination.

Residual cysts were dominantly present in males (66%), compared to females, being predominantly present in the third and forth decade of life. Cysts were more frequent in the maxilla compared to the mandible. The prevalence of residual cyst in the upper jaw was 66%. Clinical findings were not sufficient to confirm the presence of cystic disorder; radiological data offered more precise data, showing marked transparency with a sclerotic ring in 86% of the cases. Several bacteria species were found in the study group: Streptococcus viridans in 38%, Staphylococcus epidermidis in 16%, Streptococcus β hemoliticus in 14%. Pathohistological investigation revealed a dominant chronically exacerbated infiltrate (56%), compared to common chronic infiltrate. In relation to epithelium, squamous epithelium was dominant (72%), while cylindrical epithelium was very rare.

Although the obtained results provide data based evidence of the nature of radicular cysts, many opened questions are still left behind and further investigation is necessary to obtain reliable answers.

Keywords: Cyst, jaw; Cyst, radicular; Oral Surgery

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Introduction

A cyst is a pathological cavity filled with fluid, semi-fluid or gaseous contents, which is not created by accumulation of pus. It is frequently lined by epithelium. Because of the severity of clinical features and many other reasons, radicular cysts are paid rather high importance, especially for complications from delayed or inadequate treatment, endangering general health and presenting potential foci. From etiopathogenetic aspect of view, it is accepted that the onset of inflammatory cysts, mostly radicular, could be traced into the root canal, which provokes initiation of proliferate processes[1]. Dominant role in cyst pathogenesis belongs to immune-pathological reactions. Suzuki[5], as well as many others, proved that appearance and development of inflammatory cysts are conditioned by immune-pathological reactions. Petrovic[6] suggests that cyst continues to grow independently and progressively after micro-cystic lesion formation, which is conditioned by different factors. Cystic growth cannot be arrested even after employing therapeutic procedures that influence its aetiology.

Experimental evidence point out periapical lesion immune components to be responsible for bone damage[17]. Torabinejad points that lost of bone results from the presence of complementary cascades, prostaglandin synthesis and many other neutrophil granulocytes[17].

Analysis of inflammatory cell infiltrate in periapical lesions and surrounding tissue supports the importance of complex immune reactions. Literature data differ, although there are certain agreements. Apart from immune mechanisms in radicular cysts etiopathogenesis, many

other factors are involved, such as infection, trauma and allergy. The **aim** of this study was to determine predominant microorganisms and possible influence of local etiopathogenetic factors to development and prognosis of cystic lesion, as well as obtaining data on surrounding tissue damage.

Material and Methods

We investigated 50 individuals with the diagnosis of radicular cysts and 35 healthy persons, representing a control group. Each of the patients was examined at Clinic for Oral Surgery, Faculty of Dentistry in Skopje. Supplemental examinations were carried out at the Institute of Microbiology and Parasitology, Institute of Pathology, and Institute of Radiology.

Data of dental histories, radiographic, microbiological and pathohistological findings in the study group were compared to those of the controls. Radiography of the patients of the study group were compared prior and after therapy (the interval being 4-6 months). Microbiological investigation included determination of the presence of aerobic and anaerobic bacteria in the cystic lesion. Pathohistological examinations were carried out on samples of the cystic wall, stained with HE, Gimza and van Gizon).

Results

The results are divided into 4 groups: clinical, pathohistological, microbiological and radiographic; surrounding tissue damage were noted, too.

According to sex distribution, it was found that radicular cysts were more frequent in males (66%) compared to females (34%). There was prevalence of maxillary (66%) related to mandibular cysts (34%). Cysts ere predominantly noticed in the third and forth decade of life.

Pathohistological investigation comprised inflammatory infiltrate, epithelium and granulation tissue examination. The cystic lesion was mostly lined by stratified squamous epithelium, with collagen tissue beneath (Fig. 1). Desquamation was registered in epithelial layer, with granulation tissue underlying it; cholesterol crystals and haemosiderin pigment could also be noticed (Fig. 2). Figure 3 shows numerous cholesterol crystals and inflammatory infiltrate revealing chronic traits and intra and intracellular haemosiderin pigment. Chronic exacerbation infiltrate prevailed (56.0%), but without statistical significance. Squamous epithelium was registered in 72% of the specimens (Tab. 1), which was statistically significant. Cylindrical epithelium was found in 9 cases (18%). As to granulation tissue, it was present in 43 cases (86%).

Figure 1. Pathohistological section of radicular cyst: (1) stratified squamous epithelium; (2) collagen tissue (HE; x 40)

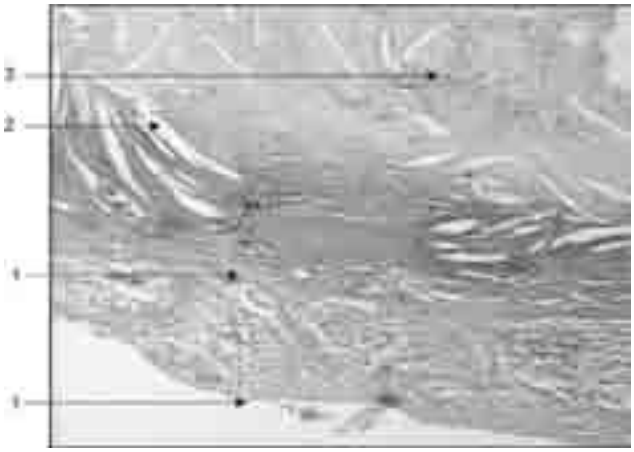

Figure 2. Pathohistological section of a radicular cyst wall: (1) granulation tissue; (2) cholesterol crystals; (3) haemosiderin pigment enlargement (HE; x 40)

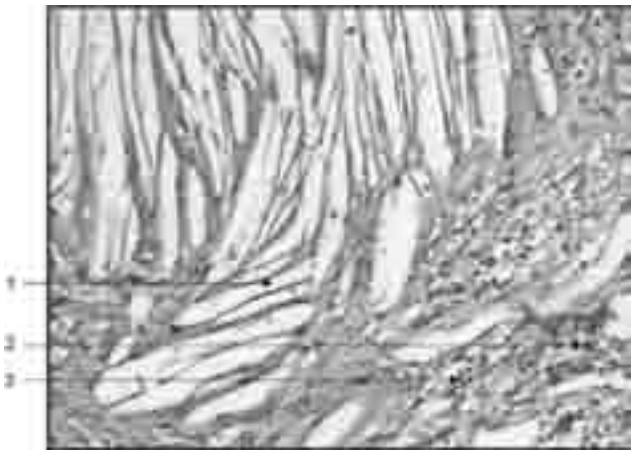

Figure 3. Pathohistological section of a radicular cyst wall: (1) cholesterol crystals; (2) haemosiderin pigment, lose and in macrophages; (3) inflammatory infiltrate (HE; x 200)

Table 1. Distribution of cell type in epithelial linings

Epithelial lining	N	%
Ø	4	8.0
Squamous epithelium	36	72.0
Cylindrical epithelium	9	18.0
Other	1	2.0

Microbiological investigation showed presence of different bacteria. Colonies of *Staphilococcus aureus* (Fig. 4), and *Streptococcus alpha haemoliticus* (Fig. 5) prevailed. Negative optohin test revealed presence of *Streptococcus viridans*. The incidence of different bacteria in the radicular cyst content is presented in table 2. The obtained results confirmed the presence of normal oral flora in the cystic content and that infection penetrates through the root canal up to the periapical space.

Figure 4. Macroscopic appearance of Staphilococcus aureus colonies

Figure 5. Macroscopic appearance of Streptococcus viridans colonies

Table 2. Microbiological findings in radicular cysts

Microbilological finding	N	%
Ø	7	14.0
Streptococcus β haemoliticus	6	12.0
Staphylococcus epidermidis	7	14.0
Streptococcus pneumonie	4	8.0
Staphylococcus aureus	6	12.0
Streptococcus viridans	17	34.0
Streptococcus viridans and Streptococcus β haemoliticus	2	4.0
Staphylococcus epidermidis and Streptococcus pneumonie	1	2.0

Radiographic findings are shown in figures 6 and 7. Cystic lesions were oval and clearly bordered from its surrounding structures by sclerotic ring. Statistical analysis of x-ray findings showed predominance (86%) of well defined bordered marginal radiolucency with a sclerotic ring. Based on the X-ray findings at 6 month interval postoperatively, complete healing was found in 70% of the cases.

Results related to the surrounding structures damage, obtained from X-rays analysis and intraoperative findings, pointed out the consecutive damage of the maxillary sinus (8%), mandibular canal (2%) and incisive canal (2%).

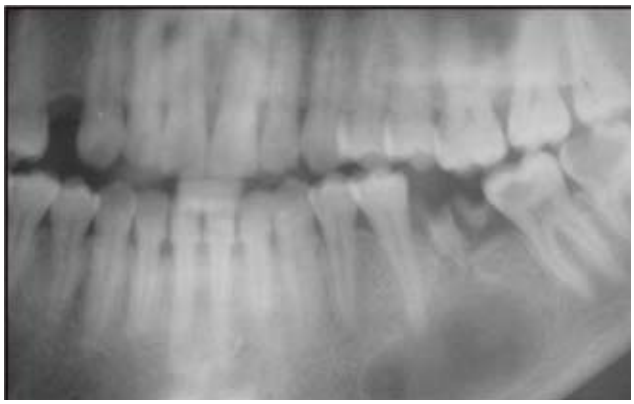

Figure 6. Panoramic radiograph of a radicular cyst in the lower jaw

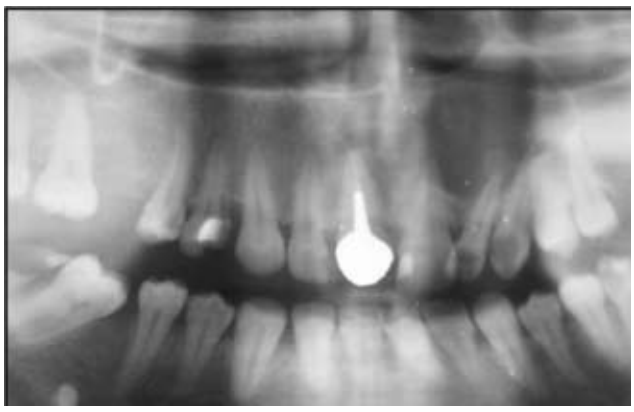

Figure 7. Panoramic radiograph of a radicular cyst in the upper jaw (left)

Table 3. Proportional distribution of surrounding structures damage

Surrounding structures damage	N	%
Ø	44	88.0
Maxillary sinus	4	8.0
Mandibulary canal	1	2.0
Incisive canal	1	2.0

Discussion

Dilemmas are still present relating possible etiological and pathogenic mechanisms responsible for the genesis and development of cystic formations. Available literature reveals multiple potential etiologic factors like microbiologic, allergic, immunologic, etc. Majority of authors came to the conclusion that all of these factors participate in their own unique and distinctive way in expression and development of cysts, regardless of their nature.

Due to the poor symptomatology and, frequently, only incidental diagnosis of cystic lesions in the upper and lower jaw, we made an effort to systemize the frequency of jaw cysts related to age, sex, and localization. Like many others[4,5,8], we provided evidence that radicular cysts are more frequently present in the upper than in the lower jaw; however, this finding disagrees with the results obtained in the Myoung's study[5].

It seems that the ongoing processes inside the cystic lesion can be classified as exacerbating chronic infiltrate. According to the acquired data from the literature we consider that epithelium is transformed into a cystic capsule constituted from infiltrative granulation tissue with a mixture of chronic inflammatory cells. The infiltrate does not have the same intensity along the whole cystic capsule. Cholesterol crystals and haemosiderin are frequently found in the cystic lumen, and Rast's bodies in 10% of the cases. This is in agreement with findings of Gordeeff[2] and Teronen[16], but is not with those of Yamamoto[18].

Our results show that the majority of cysts are coated with the straified squamous cell epithelium; its morphology depends on the degree of inflammation in the connective tissue layer surrounding it. In the presence of inflammation, epithelium expresses typical proliferations toward connective tissue, which gives the impression of being like arcades. Inflammation alters epithelial morphology of the cysts concerning its viscosity and density. Severe inflammation or infection can cause partial or total epithelial necrosis, going up to the total extinction. In the absence of inflammation, epithelium tends to decrease its size even without the presence of sub-basal proliferations, but with over expressed hyalinization, which is manifested through the appearance of hyaline bodies. Similar findings described Shear[13] and Sokolović[14], but not Redman[9]. Petrović[6] states that fibrous coating of the radicular cysts, in majority of cases, consists of granulation tissue affluently infiltrated with characteristic chronic inflammatory cells.

Numerous studies underline the connection between microbiological findings and the occurrence of inflammatory cysts. In reference to this, Ricucci et al[10] point out the fact that bacterial presence inside the cyst is similar to the findings from the necrotic tissue of the root canals and periapical lesions. In reference to the microorganism participation in etiologic and pathogenic events in the inflammatory cysts, Hrvacanin[3] confirms the presence of *Alpha haemolytic streptococcus*, *Streptococcus pneumoniae*, *and Staphylococcus epidermididis* in cystic lesions.

Our results suggest that accurate diagnosis cannot be determined only on the basis of clinical findings. Higher accuracy can be achieved if we add X-rays to the clinical examination. Consequently, more precise information about the presence of the cystic lesion and its type can be provided.

The majority of radiographic changes inside he surgical field postoperatively, including spear like or trabecular collection, can be detected between the first and fourth month after the cyst removal, and complete bone healing is verified after 4 months postoperatively. Therefore, it is recommended that optimal time for the radiographic control and early detection of residual lesions is 4 months after surgery.

Jaw cysts are frequently asymptomatic; consequently, they can cause damage of the surrounding anatomic and morphologic structures, such as maxillary sinus, mandibular canal, incisive canal and adjacent teeth. Massive maxillary cysts can expand toward the maxillary sinus and, after complete resorption of the cystic wall, they can fill up the sinus. As far as the mandible canal is concerned, during the expansion of the odontogenic cysts the neurovascular bundle is relatively well protected by the compact structure of the lower jaw, and also by the specific cystic growth pattern in this region.

We might presume that, under the influence of numerous chronic inflammatory stimulations, epithelial cells become to change their condition of metabolic inactivity increasing their own activity. As a consequence, the volume of cytoplasm increases mutually with accumulation of neutral lipids. Inflammation is especially influential during the mitotic cell division, and subsequently, the lesion becomes larger. Concentration discrepancies between oxygen and carbon dioxide in tissues, as well as the decreased pH values, are substantial for cystic formation. From this standpoint, contemporary interpretations about the role of microorganisms, as well as the aggressive bone resorption factors, undoubtedly confirm the key role of inflammation as the strongest initiator and inducer radicular cysts genesis.

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Analgesic Efficacy of 0.75% Ropivacaine for Lower Third Molar Surgery

SUMMARY

Introduction*: Since there is no data concerning local analgesic efficacy of ropivacaine for lower third molar surgery, the aim of this double-blind study was to compare local anaesthetic parameters and postoperative analgesic requirements after the use of ropivacaine and bupivacaine for the inferior alveolar nerve block.*

Materials and Method: *20 healthy patients were equally randomised into the ropivacaine (0.75%, 2 ml) or bupivacaine (0.5%, 2 ml) groups. The onset and duration of anaesthesia (the lower lip numbness and pinprick test) and intensity of anaesthesia (visual analogue and verbal rating scales) were determined. The postoperative pain reports and analgesic requirements were also recorded.*

Results: *There were no significant differences concerning parameters of the achieved anaesthesia. 2 patients in the bupivacaine group felt postoperative pain without the need for pain medication.*

Conclusion: *Ropivacaine is suitable for achieving local anaesthesia in lower third molar surgery, especially when prolonged analgesia is desired.*

Keywords: Local Anaesthetics; Ropivacaine; Lower Third Molar Surgery

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Introduction

Ropivacaine is an amide long-acting anaesthetic, which has been increasingly used for regional nerve blocks[1,2] as well as for epidural anaesthesia[3] because of its lower potential to induce cardiovascular and neural toxicity in comparison to bupivacaine[4,5]. Studies comparing ropivacaine 0.5% with bupivacaine 0.5% for brachial plexus block showed no clinical difference in onset or duration of sensory block after the injection of 30 ml of the solution[1]. Long-lasting analgesia of 10 to 12 hours was reported for both ropivacaine and bupivacaine used for peripheral nerve blocks[1], although ropivacaine exerted a slightly less potent analgesic effect than bupivacaine when used for epidural anaesthesia[6]. Used for intraoral block anaesthesia, 0.75% ropivacaine exerted an effective local anaesthetic action, producing long duration of inferior alveolar nerve block in volunteers, without surgical procedure[7].

Since there are no data concerning local analgesic efficacy of ropivacaine used for inducing intraoral block anaesthesia in dental or oral surgical practice, the aim of this study was to ascertain the achieved local anaesthetic parameters and postoperative analgesic requirements when 0.75% ropivacaine was used to induce the inferior alveolar nerve block for lower third molar surgery, and to compare them to the same parameters achieved with standard long-acting local anaesthetic (0.5% bupivacaine), sometimes used in the aforementioned indication.

Material and Method

After approval of the Ethical Board at the Faculty of Dentistry, 20 healthy patients requiring lower third molar surgery were randomly selected, in a double-blind fashion, into 2 groups: (1) a group of 10 patients receiving 2 ml of 0.75% ropivacaine for inferior alveolar nerve block; and (2) a group of 10 patients receiving 2 ml of 0.5% bupivacaine. No significant differences in patient characteristics, concerning the gender, age, body weight or difficulty of surgery concerning duration and need for root section, were reported between the groups (Tab. 1).

The onset of anaesthesia was evaluated using the patient's report of lower lip numbness and the pinprick test

performed immediately after the injection, and in 30 sec intervals, till the first sign of soft tissue anaesthesia of the lower lip were detected. The duration of anaesthesia was reported by the patient at the first control appointment. The response to visual analogue (VAS) and verbal rating scales (VRS), done immediately after surgery, determined the intensity of the achieved anaesthesia. The occurrence of postoperative pain and analgesic requirements were also recorded.

Table 1. Patient and Surgery Characteristics

Personal and Clinical Data	Groups	
	Ropivacaine 0.75%	Bupivacaine 0.5%
N	10	10
M/F	4/6	5/5
Age / yr (X ± SE)	23.2 ± 1.3	25.1 ± 2.4
Weight / kg (X ± SE)	72.4 ± 1.6	69.2 ± 3.4
Duration of surgery / min (X ± SE)	20.1 ± 2.4	18.3 ± 1.8
Impactions / partially impactions	3/7	4/6
Sections of molars (Yes / No)	4/6	5/5

Results

The inferior alveolar nerve block was successfully achieved in all 20 patients. Differences in onset time between groups were small and statistically insignificant (Tab. 2). Both groups of patients demonstrated duration of the long-lasting range, although the duration of bupivacaine induced anaesthesia was slightly longer, but not significantly different (Tab. 2).

Intensity of the achieved anaesthesia after the intraoral block was similar in both groups, estimated clinically by visual analogue and verbal rating scales, and no additional anaesthesia was needed in any of the cases (Tab. 3).

Postoperative analgesia, leading to a reduced need for administration of postoperative analgesics, was of long-duration; only 2 patients in the bupivacaine group felt some postoperative pain, without the need for pain medication (Tab. 4).

Table 2. Onset and Duration of the Inferior Alveolar Nerve Block

Groups	N	Onset/min (X ± SE)		Duration/min (X ± SE)	
		numbness	pinprick	numbness	pinprick
Ropivacaine	10	7.3 ± 3.5	5.6 ± 2.3	582 ± 67	450 ± 73
Bupivacaine	10	8.7 ± 2.2	7.4 ± 1.4	688 ± 85	550 ± 48

Table 3. Intensity of the Inferior Alveolar Nerve Block

Method of measurement		Intensity	
		Ropivacaine	Bupivacaine
V A S (mm)		12 ± 2	14 ± 3
V R S	no pain at all	7	5
	just noticeable pain	3	4
	weak pain	0	1
	moderate pain	0	0
	severe pain	0	0
	excruciating pain	0	0
Total number		10	10

Table 4. Postoperative analgesia

Parameters	Groups	
	Ropivacaine	Bupivacaine
Postoperative pain (No. of patients)	0	2
Need for pain medication No. of ibuprofen doses (400 mg)	0	0

Discussion

Ropivacaine 0.75% exerted good local anaesthetic properties to fulfil demands for painless oral surgery in the mandible, comparable with those obtained with bupivacaine. Differences in onset time between the groups were small which could be considered as clinically insignificant, because all the values were below the usual ones accepted for the onset of local anaesthesia achieved by long-acting local anaesthetics. A small reduction in the onset time noted after the inferior alveolar nerve block with ropivacaine could possibly be the result of the use of a higher concentration of the solution when compared to bupivacaine. Similarly, it was also reported that the onset of sensory block was shorter in the ropivacaine group than in the bupivacaine for cervical plexus block, again without significant clinical difference[2].

Concerning duration of the achieved inferior alveolar nerve block, both groups of patients demonstrated duration of the long-lasting range, although the duration of bupivacaine induced anaesthesia was slightly longer, but not significantly different. The slight difference in length of sensory anaesthesia following nerve blocks has also been reported when identical doses of ropivacaine and bupivacaine were applied for spinal[8], as well as for brachial plexus bock[9]. It was suggested that the shorter duration of anaesthesia achieved with ropivacaine, compared to that of bupivacaine, could be the result of

lesser lipid solubility of ropivacaine[10] and consequent lesser absorption by nerve tissue after local application.

The intensity of the achieved local anaesthesia is probably one of the most important concerns in dentistry. Probably due to the relatively shorter duration of anaesthesia, previous studies have established ropivacaine as a slightly less potent local anaesthetic compared with bupivacaine[6]. Our study, however, pointed to a similar intensity of the achieved anaesthesia after the intraoral block in both groups, estimated clinically by visual analogue and verbal rating scales. Profound block anaesthesia in the ropivacaine group, without any pain during surgery, was achieved in 70% of patients, which was even slightly higher than in the bupivacaine group. However, probably the most important result was that no additional anaesthesia was needed in any of the cases. Some favourable effects of ropivacaine, noticed in this clinical investigation, could be attributed to the slightly higher concentration of ropivacaine than bupivacaine used in the study and, additionally, by the already noticed vasoconstrictive properties of ropivacaine that interfere with the vascular resorption of the local anaesthetic[11,12], which is probably of special importance in intraoral use of this solution.

An advantage of using long-duration local anaesthetics in dentistry, especially oral surgery, is their longer postoperative analgesia, which leads to a reduced need for the administration of postoperative analgesic drugs. In this investigation, only 2 patients in the bupivacaine group experienced some pain postoperatively. If we have in mind that the duration of sensory block was longer in the bupivacaine group, and that both anaesthetics used in this study satisfied requests of postoperative pain control, we would possibly need a larger group of patients and further research to clarify the possible analgesic superiority of ropivacaine over bupivacaine when used in oral surgery.

On the basis of these preliminary results of this clinical study, ropivacaine seems to be suitable for achieving inferior alveolar nerve block during lower third molar surgery, exerting satisfactory intensity of local anaesthesia and prominent postoperative analgesic potency, similar to that of bupivacaine. Accordingly, ropivacaine could be recommended for use in oral surgery when a long-acting anaesthetic is indicated. Moreover, its faster onset and recovery of sensory block, as well as lowered cardio-toxicity[5], could be an attractive advantage over bupivacaine. However, further studies are needed to verify these favours.

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The Frequency and Outcome of Lip Cancer in Serbian Population*

SUMMARY

***Aim**: Lip cancer is one of the most common cancers of the head and neck region. Among all lip malignancies, squamous cell carcinoma is most common, whereas basal cell carcinoma accounts for only 1% of all lip carcinomas. The aim of this paper was to evaluate the frequency of lip lesions among Serbian population and to consider its outcome.*

***Material and Method:** The analysis encompassed 479 patients who were hospitalized at the Clinic of Maxillofacial Surgery (Faculty of Dentistry, University of Belgrade) during the period 1989-2005 for the treatment of lip lesions. The following parameters were analyzed: sex, age, size and localization of the lesion, duration of hospitalization, TNM classification, histopathologic analysis, type of surgical procedure, other possible treatment, and a recurrence rate.*

***Results**: There were majority of males (78%). Average age of our patients was 63.4 years. Lesions were most often localized in the lower lip (88%), and less frequently in the upper lip (8%) or at the lip angle (4%). Average size of the lesion was 24.3 mm. Data confirmed that the "W" excision was the most frequently used surgical procedure, and for bigger lesions, surgical reconstruction was performed by the technique suggested by Karapandzic. Histopathologic analysis confirmed the most frequent incidence of the squamous cell carcinoma.*

***Conclusion**: Squamous cell carcinoma of the lip generally has a favourable prognosis. Early detection is very important for its successful treatment.*

Keywords: Lip Lesions; Squamous Cell Carcinoma; Lip Reconstruction

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Introduction

Squamous-cell carcinoma (SCC) of the head and neck is one of the most common cancers, with a global incidence of 500,000 cases per year[6]. SCC of the lip is a relatively common malignancy of the head and neck region, accounting for approximately one quarter of all oral cavity cancers[10]. Basal cell carcinoma (BCC) accounts for only 1% of all lip carcinomas[11], while other malignancies of the lip have also been reported, but are less common[11].

The lip cancer is one of the most easily diagnosed, with a generally good prognosis[10]. Although this form of cancer is generally curable compared with other head and neck malignancies, regional metastases, local recurrence, and even death from this disease may occasionally occur[10]. Moreover, in some individuals, lip cancer may behave aggressively, which is manifested by recurrence of the lesion after surgical removal, or mortality rate up to 15% of patients[11].

The single most important prognostic factor for SCC of the head and neck is complete surgical removal of the neoplasm, because it is generally believed that failure to eradicate the primary tumour is the leading cause of death from this type of cancer. Surgical resection is the principal treatment for the majority of advanced-stage carcinomas of the upper aero-digestive tract and a frequent choice in treating early lesions as well[6]. Selection of a specific regional flap depends on the type of defect, i.e. its size and location, and on the intrinsic properties of the regional flap[8].

*Some of the presented results in this paper have been reported at the 12th Congress of the BaSS, held in Istanbul, 2007

Early cancers of the lip and oral cavity (stage I and stage II) are highly curable by surgery alone, or along with radiation therapy, and the choice of treatment is dictated by the anticipated functional and cosmetic results of treatment[8]. However, the behaviour of lip cancer generally resembles skin cancer more than carcinoma of mucosal origin in the oral cavity proper[11]. The presence of a positive margin of the resected lesion significantly increases the risk of local recurrence, as well as the depth of the tumour being >5 mm, suggesting that the combined treatment may be beneficial[2].

The **aim** of this investigation was to evaluate the frequency of lip cancers among Serbian population and to consider its outcome after surgical treatment.

Patients and Methods

The research is planned as a retrospective study, done at the Clinic of Maxillofacial Surgery at the Faculty of Dentistry, University of Belgrade, during the period 1989-2005. During this period 463 patient were admitted with the diagnosis "tumour of the lip". The data were gathered from medical histories of patients, and were entered in particular examination forms in Microsoft Access and Microsoft Excel programme.

The following parameters were analysed: sex, age, period between noticing first symptoms and the beginning of therapy, localisation and size of the lesion, presence of suspect lymph nodes, type of operation, histopathologic analysis, duration of hospitalization and recurrence rate.

Results

The lip lesion were found in 360 males (78%) and 103 females (22%). Average age of our patients was 63.4 (ranging between 11 and 96 years of age). We noticed that usually less then 6 months elapsed from noticing first symptoms and coming for the treatment (41%). Mean diameter of the lesion was 23.3 mm (2-82 mm in range).

The lip lesions most frequently developed at the lower lip, followed by the upper lip and lip angle (Fig. 1). We found suspect lymph nodes in 53 patients (11%) in the submandibular region, and in 9 patients (2%) in the submental region (Fig. 2).

The „W" excision was the most frequently used surgical technique, followed by „V" excision and lip shave procedure (Fig. 3). The lip reconstruction using Karapandzic's mioarterial flap was performed in 63 patients - 14% (Fig. 4), followed by Fries reconstruction, in 48 patients or 10%. Average duration of hospitalization was 12 days. 60 patients (14.9%) had infection in the postoperative period, 2 patients had necrosis, while in only 1 patient tracheotomy was required. During the follow up period of the study, recurrence developed in 49 patients (11.7%).

Histopathologic analysis of the resected lesions mainly showed malignancy (402 cases, 87%), and benign lesions were found in 61 cases, or 13%. SCC was the most common finding at the lower lip (354 patients or 86%), and BCC was found in only 4 patients (1%). At the upper lip, BCC has been more often reported (12 patients or 35%) than SCC (9 patients - 26%).

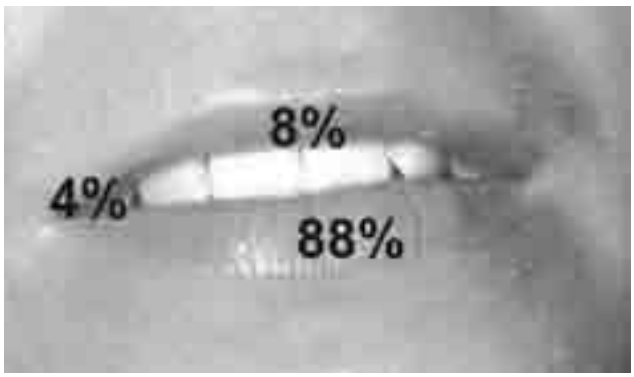

Figure 1.

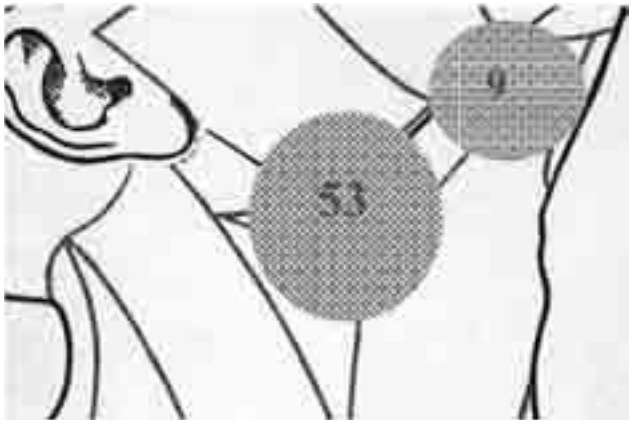

Figure 2.

Figure 3.

Figure 4.

Discussion

Lip cancer represents the most frequent malignant neoplasm of the oral cavity. This study provides information about the clinicopathologic features of patients with SCC of the lip and describes the treatment modalities performed.

A previous study[9] from the same institution (Clinic of Maxillofacial Surgery, Faculty of Dentistry, University of Belgrade) showed that total of 223 patients with SCC of the lip, were diagnosed and treated during a 10-year period between 1991 and 2000. We noticed that from 2001 to 2005, in a 5-year shorter period, 157 patients with SCC were surgically treated. This increased number of the patients from 2001 to 2005 could be explained by the fact that all patients with SCC of the lip were treated as in-patients at the Faculty Clinic; before that period (between 1989 and 2001), patients with "small" lip lesions were usually treated at the out-patient basis. We analyzed only the patients which were hospitalized. We found that the lip lesion developed in the lower lip in 88% patients with lip cancers. We also found suspect lymph nodes in 13% (62) of patients.

The retrospective study performed in 113 patient[11] shown that there were 74 men (65.5%) and 39 women (34.5%) with tumours of the lip, aged from 14 to 106 years. Several researches indicated the lower lip as the most common site for lip cancer (88-98%), with only 2-7% arising from the upper lip and 4% at the lip commissures[1,5,11]. The most common age at diagnosis is 54 to 65 years.

Although a condition seen in middle age, lip cancer occasionally occurs in patients under age 30 years. Lip cancer has a predilection for men, with men to women ratios ranging from 35:1 to 6:1, depending on the location of the lesion[5].

Early diagnosis and the surgical treatment are the only proper solutions in the diagnosis and therapy of these lesions. We need an urgent awareness campaign, and programmes for the prevention and early detection of lip cancer. The average time between the first symptom and therapy was less then 6 months. It is very important to distinguish precancerous lesions (leukoplakia, eritroplakia, and actinic cheilitis), which pathologically may correspond to intraepithelial dysplasia, hyperkeratosis, carcinoma in situ, or SCC[7].

Several methods for treatment of SCC of the lip are available, including surgery, radiotherapy, chemotherapy, and combination of these. The primary goals of treatment are the following: total removal of the lesion, prevention of relapse, and maintenance of quality of life[3]. With overall cure rates of 80 to 90%, lip cancers have a more favourable prognosis than most other head and neck cancers. The most performed surgical action was „ W "excision, followed by „ V "excision. We have particularly good experiences in the reconstruction of the lower lip using the Karapandzic mioarterial advancement flap, developed by Karapandzic in the early 1970s at our clinic[9]. The reconstruction made by Karapandzic mioarterial flap was performed in 10 % (48) of patients.

Approximately 85 to 95% of all oral cancer is SCC[8,9]. The study from Mexico[4] shown that there were 82 SCC (83.7%), 10 (10.2%) BCC, and 6 other diagnoses (adenocarcinoma melanoma, adenoid cystic carcinoma, Merkel cell carcinoma, lympho-epithelioma and angiosarcoma). Cervical lymph node metastases were found in 21% of patients with no previous treatment, and they developed in 5.3% after treatment[1].

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Correlation of the Gonial Angle Size with Residual Ridge Resorption in Edentulous Subjects

SUMMARY

It is a well known fact that gonial angles of the edentulous patients are wider than those of the dentate ones. However, the causative factor for this widening is unclear. It has been proposed that after extraction of all teeth the progressive resorption of alveolar ridge may have an effect on the widening of this angle. The purpose of this study was to investigate the relationship between mandibular ridge resorption and the size of the gonial angle. A total of 158 panoramic radiographs were analyzed retrospectively for mandibular ridge resorption and gonial angle size.

The results of the present study suggest that females have wider gonial angles and more alveolar ridge resorption compared to males. However, there was no statistically significant correlation between the gonial angle size and mandibular ridge resorption level. As a conclusion, the widening of the gonial angle in edentulous subjects appears to be independent of the alveolar ridge resorption.

Keywords: Alveolar Ridge; Resorption; Gonial Angle; Panoramic Radiographs; Age; Gender

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Introduction

The gonial angle is formed by the line tangent to the lower border of the mandible and the line tangent to the distal border of the ascending ramus and condyle[4,15]. The effect of the individual age and gender on the size of the gonial angle is controversial in the literature. Although some studies have shown a widening of the gonial angle with the increasing age[6,15], a lot of articles have reported differing results[3,17,19]. Moreover, most of the studies have indicated a wider angle in female subjects[3,8,19], while this finding has not been confirmed in some other studies[15,17].

Numerous articles have shown a statistically significant widening in the gonial angle of the edentulous subjects compared to the dentate ones[2,3,11,13,15]. The justification of this difference shows a discrepancy in the literature. While some authors have suggested that the decrease in masticatory force after extraction of all teeth may have an effect on the widening of the gonial angle[9,17], others have proposed that changes in mandibular bone after tooth extraction include a progressive resorption of the residual ridge that may cause the widening of this angle[3,18].

The design of the earlier studies, in which a difference in the gonial angle was determined between dentate and edentulous stages, was cross sectional[3,11,13,15,17,19,20]. However, a number of longitudinal studies indicate that the gonial angle size doesn't differ during the edentulous period[2,6,7]. Thus, the effect of the reduced muscle activity seems more relevant to justify this phenomenon. Ingervall and Thilander[9] have shown that dentate subjects with strong masseter and anterior temporal muscles have small gonial angles. It has also been found that the EMG activity and muscle density were lower in edentulous subjects than the dentate ones[16]. Additionally, in a study of Raustia and Salonen[17], it has been revealed that there is a correlation between increased EMG activity in the masseter muscle and small gonial angle size in a complete denture wearing population.

There are only a few studies wherein the correlation between the amount of the residual ridge resorption and gonial angle size was investigated[5,14,17,19]. Xie and Ainamo[19] have reported a negative correlation between the size of the gonial angle and the average height of the mandibular residual body of the edentulous subjects. On the other hand, Raustia and Salonen[17], Nissan et al[14] and

Engström et al[5] have pointed out that residual resorption of the mandible appears to be independent of the gonial angle.

The purpose of the present study was to investigate the relationship between the size of the gonial angle and the amount of the alveolar residual ridge resorption on the panoramic radiographs of edentulous subjects.

Materials and Methods

A total of 170 panoramic radiographs (Panoura 10 CSU, Yoshica Dental Co. Ltd. Tokyo Japan) from the collection of the Removable Prosthetic Department of Istanbul University were investigated retrospectively. These radiographs were obtained from the patients who referred to the university clinic for renewal of their complete dentures.

In 12 radiographs, it was not possible to detect the mental foramen bilaterally. Thus these images were excluded from the study. In 8 images from the remaining 158 radiographs, the mental foramen was detectible only in one side. These images were analyzed unilaterally. So a total of 156 right and 152 left side measurements were prepared.

The resorption of mandibular ridge was measured by the method of Wical and Swoope[21], in which the original height of the mandible is assumed to be 3 times the distance between the inferior border of the mandible to the lower border of the mental foramen. The amount of resorption from the original alveolar level to the measured level of the residual ridge was expressed as a percentage of the original height of the mandible (Fig. 1). All measurements were made with a digital caliper (Mitutoyo Corporation, Kanagawa, Japan).

Gonial angles were measured by tracing a line on the panoramic radiographs tangent to the most inferior points at the gonial angle and the lower border of the image of the mandible, and another line tangent to the posterior borders of the ascending ramus and condyle on each side. The intersection of these lines formed the gonial angle.

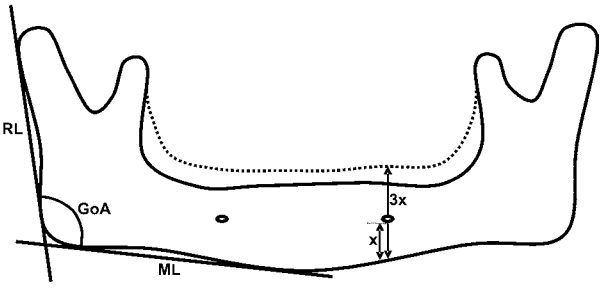

Figure 1. Gonial angle and mandibular ridge resorption measurements RL: Ramus Line; ML: Mandibular Line; GoA: Gonial Angle

15 panoramic radiographs were randomly selected and re-measured at an interval of 10 days to test inter- and intra-observer reliability.

Statistical analyses of the results were conducted on a personal computer with SPSS 10.0 for Windows (SPSS Inc., Chicago, Ill). A Spearman's Rho Test was used to analyze the correlation between the mandibular ridge resorption and the gonial angle values. To investigate the side differences of the above mentioned values a Wilcoxon matched pair test was applied. Additionally, a Mann-Whitney U test was used to analyze the gender differences.

Results

Inter- and intra-observer reliability results of the measurements of the mandibular ridge resorption and gonial angle are illustrated in table 1. Since there was no statistically significant difference between right (33.79% ridge resorption; 122.75° gonial angle) and left (34.34% ridge resorption; 122.99° gonial angle) side measurements, the data of both sides were put together.

The Mann-Whitney U test has shown that the female subjects had statistically significant larger gonial angles ($p<0.01$) and more resorption on the mandibular ridge compared to the male subjects (Tab. 2).

The difference of the mean ages of the male (62.15 ± 9.12) and female (63.23 ± 9.21) subjects was not statistically significant. There was also no correlation between age and gonial angle size, both in male and female subjects. However, in male subjects, a positive correlation between age and the amount of the mandibular ridge resorption was detected ($r = 0.528$ and $p = 0.000$). According to the resorption levels, the subjects were divided into 2 groups: minimal resorption (<33%) and severe resorption (>33%). The mean ages of the subjects for the minimal and severe resorption groups were shown in table 3. No statistically significant difference was detected in gonial angles of the subjects with minimal and severe alveolar ridge resorption. The Spearman's Rho Test showed also lack of correlation ($r = 0.037$, $p = 0.519$) between gonial angle and mandibular ridge resorption (Figs. 2 and 3).

Table 1. Inter- and intra-observer relibility of the measurements

	Mandibular ridge resorption		Gonial angle	
	Inter-observer	Intra-observer	Inter-observer	Intra-observer
Correlation coeficient (r)	0.833*	0.891*	0.872*	0.915*

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

Table 2. The alveolar ridge resorption and gonial angles in males and females

	Females	Males	P*
Resorption (%)	36.86 ± 14.16	30.00 ± 15.94	.000
Gonial Angle (in degree)	123.95 ± 6.96	121.28 ± 7.40	.004

**Mann-Whitney U Test

Table 3. The relationship between age and alveolar ridge resorption in males and females

		Age			
	Resorption	n*	Mean	SD	P**
Males	Minimal	73	60.42	8.60	.000
	Severe	53	72.29	6.15	
Females	Minimal	61	57.95	10,38	.139
	Severe	121	62.40	8.36	

*Right and left sides were computed together
**Mann-Whitney U Test

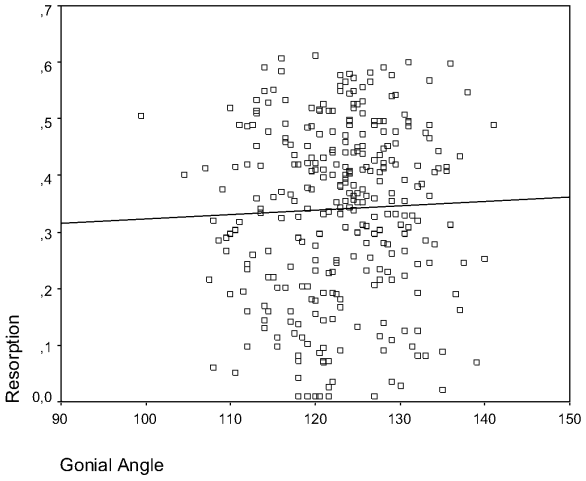

Figure 2. The correlation diagram between alveolar ridge resorption and gonial angle in females

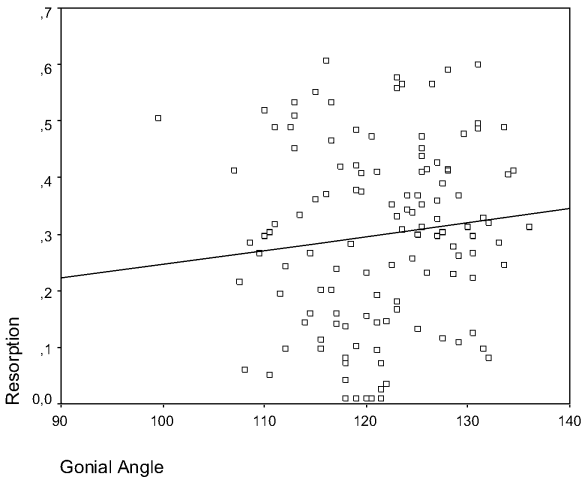

Figure 3. The correlation diagram between alveolar ridge resorption and gonial angle in males

Discussion

Several studies have reported that panoramic radiographs are reproducible and accurate for the linear and angular measurements on mandibles[4,12,22]. Larheim and Svanaes[12] have found that the gonial angle assessed from a panoramic film was almost identical that measured on the dried mandible. It has been shown that reliability of the panoramic radiography technique for imaging of the mandible is highly dependent on head position[19,20,22]. The panoramic radiographs in the present study were made by 2 experienced radiographers using the same panoramic unit.

Resorption of the residual alveolar ridge has been measured using various radiographic techniques[1,10,21]. Although the panoramic radiographs have several limitations to monitor the resorption of the alveolar ridges, like difficulties in standardization of the head position and controlling the distortion and magnification of the images, there is an important advantage of this technique. Panoramic radiographs are often a part of the routine examination of patients, thus their use for research purpose does not involve the patient in any additional exposure or cost, and they are a very good source for the retrospective studies[22]. The technique for the measurement of the alveolar ridge resorption used in the present study was described by Wical and Swoope[21]. In a study of Wilding et al[22], in which the reliability of this technique was tested, it has been concluded that the use of this technique is sufficient to provide information about resorption of the residual mandibular alveolar bone compared to a more complicated method.

Xie et al[19] have found that females have more alveolar ridge resorption than males, while Atwood and Coy[1] have presented a slightly higher rate in males. The results of the present study have suggested that alveolar ridge resorption is more noticeable in females. This phenomenon could be explained with the effect of the menopausal activity in women on the alveolar ridge resorption. The results of this study have also shown statistically significant larger gonial angles in female subjects compared to the males. This result is in accordance with several studies[3,8,19]. This could be a result of the lower masseteric activity, as well as the increased alveolar ridge resorption in females. Raustia and Salonen[17] have shown a negative correlation between masseteric activity and the gonial angle size, and it is well known that females have lower muscular activity than males. Otherwise, Xie et al[19] have found a negative correlation between gonial angle size and alveolar ridge height. The results of the present study haven't suggested a correlation between alveolar ridge resorption and the gonial angle size. This result is in accordance with some other studies[5,14,17]. Thus, within the limitation of this study, it could be speculated that the larger gonial angle in female subject is a result of the lowered masseteric activity - the widening of the gonial angle appears to be

more dependent of the increased muscular activity than the alveolar ridge resorption.

Conclusion

The results of this study showed that the female subjects have statistically significant larger gonial angles and more resorption on the mandibular ridge compared to the male subjects, and there was no correlation between size of the gonial angle and amount of the mandibular resorption.

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Occupational Practices of Dentists in 2 Provinces in Turkey: A Pilot Study

SUMMARY

Objective: *Little is known about the occupational practices of dentists in Turkey. This study is designed to evaluate the occupational practices of dentists in 2 provinces in Turkey.*

Methods: *The study was carried out among 150 dentists working in Zonguldak and Eskişehir in Turkey. A self-reported questionnaire was sent to each dentist. This information included infection control, radiation protection, mercury storage and disposal, previous training in occupational health at under/postgraduate levels.*

Results: *Out of 150 dentists who received the questionnaires, 106 returned it giving a response rate of 70.6%. The age of respondents ranged from 24-78 years; 47 were females (44.3%) and 59 were males (55.7%). Rate of working hours and continuing education of male dentists was found to be significantly higher than that of female dentists ($p<0.05$); however, female dentists used gloves and masks significantly more often than male dentists ($p<0.05$). 87 dentists (82.1%) had been vaccinated against hepatitis. 38.7% of dentists reported autoclaving alone and 3.8% reported autoclaving in combination with other methods. Unfortunately, dentists appeared not to take standard precautions when taking radiographs and more than half of the dentists did not check their radiographic equipment. In addition, storage of excess amalgam and mercury by dentists appeared not to be entirely consistent with the guidelines.*

Conclusion: *Our study indicated that education on occupational practices is lacking in Turkey. Therefore, occupational health in dentistry education must be mandatory.*

Keywords: Occupational Hygiene; Dentists; Turkey; Infection Control; Radiation Protection; Storage of Mercury

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Introduction

Modern dentistry has been described as probably among the least hazardous of all occupations, although there remain many hazards in dental practice, including exposure to infectious diseases, radiation and mercury. Dentists have a ethical and professional responsibility towards the dental as well as the general health of patients in their care. This should extend beyond the radiation safety procedures normally adopted within the dental office for specific procedures to a more generalized consideration of the environmental impact of the potentially hazardous waste products from these procedures[3,11,15]. Infection control in dentistry has become a topic of great interest worldwide at the beginning of the last decade. Governmental programmes and agencies worldwide have issued sets of regulations and recommendations concerning infection in dentistry[4,10].

The **aim** of this study was to investigate the prevalence and nature of infection control, radiation control and handling of mercury reported by dentists in 2 provinces in Turkey.

Material and Methods

In 2003, 150 dentists working in 2 provinces in Turkey (Zonguldak and Eskişehir) were selected for this study. A 3-page, A4-sized self-report questionnaire was sent to each dentist. The dentists were requested to sign a written informed consent statement. The study was carried out according to the recommendations of the Helsinki declaration.

Information on a range of occupational hygiene practices commonly employed by dentists was sought. This included infection control, especially through the use of gloves, masks, face protectors, eye protection, sterilisation or high level disinfection of handpieces; HBV immunisation, management of HBV and HIV patients; radiation protection, mercury storage and disposal, and previous training in occupational health at under/ postgraduate levels. Multiple choice, closed and some open-ended questions were used. Information was also collected on age, sex, number of years since graduation, place of graduation, field of dental practice, and number of hours worked per week.

Statistical analyses were conducted using a statistical package programme, GraphPad Prisma V.3, and quantitative data was evaluated by Chi square test.

Results

The questionnaire was delivered to 150 dentists, 106 of whom returned it giving a response rate of (70.6%). Missing data were excluded from the analysis. There were 47 female (44.3%) and 59 male (55.7%) dentists. The ages ranged from 24-78 years (mean 38.79±10.58).

Most dentists (45.3%) worked full-time over 8 hours a day (Tab. 1). Working hours of male dentists were found to be significantly higher than those of female dentists (Tab. 2). There were significant differences in reported training by sex - male dentists reported significantly higher continuing education rates ($p<0.05$). Reported patterns of use of the personal protective measures are also shown in table 2. There were significant differences in the reported patterns of use of gloves and masks by sex, female dentists were significantly more likely to use gloves and masks ($p<005$).

82.1% of dentists reported having HVB vaccination (Tab. 1). There were no significant differences according to sex (Tab. 2). All dentists reported using some form of high level disinfection procedure for handpieces. A variety of methods of high level disinfection were reported (Tab. 1), with the most commonly reported method of high disinfection being autoclaving in combination with other methods (38.7%).

Most dentists (71.7%) reportedly took precautions when radiographs were taken and measures are detailed in table 1. There were no significant differences in the use of these protective measures by sex. 57.5% of dentists reported that that they did not check the maintenance of their radiographic equipment. There were no significant differences in the reported maintenance of radiographic equipment by sex (Tab. 2).

49.1% of dentists used a variety of systems for storage of excess amalgam, 19.8% reported storing their excess amalgam underwater. There were no significant differences reported in the patterns of storage of amalgam by sex (Tab. 2).

Discussion

Of concern to both, health care workers and the public, is the risk of exposure to blood-borne pathogens, including HBV, HCV and HIV. It is clear that there is a very real risk of viral transmission in the dental office. Heightened awareness among dental practitioners of cross-infection risk means that barrier procedures (gloves, masks, eye protection) and the use of autoclaves are now commonplace in the dental surgery. Chemical disinfection of surfaces and instruments is an important aspect of infection control as routinely practised in dental units and elsewhere. The timing and method of chemical disinfection, the factors affecting the efficacy of germicides and the hazards posed by their use are important considerations in selecting disinfectant. A wide range of disinfectants is available for purchase, including halogen compounds such as sodium hypochlorite, alcohols, peroxygen compounds such as hydrogen peroxide, and aldehydes such as glutaraldehyde, all of which generally have a broad efficacy spectrum when used appropriately. Other types of disinfectants, such as phenols, quaternary ammonium compounds and biguanides (including chlorhexidine) are relatively ineffective against non-enveloped viruses and bacterial spores, and many have limited ability to kill mycobacteria[3,11,13,15]. It must be remembered that disinfection is only a tool - a helpful tool when used properly, but one that can not be relied upon to solve infection control problems. Ideally, disinfection forms just one component of an overall infection control strategy[12].

74.5% of the dentists included in this study employed gloves and face masks (78.3%) during dental procedures and changed gloves for each patient (91.5%), which is lower than that reported from USA[14], Canada[8], Southern Thailand[6] and Saudi Arabia[2], but in the republic of Ireland[5] routine face mask wearing during treatment was reported by 68% of dentists. In our study, female dentists were significantly more likely to report wearing gloves and surgical face mask.

82.1% of dentists reported having had HBV vaccination, which is higher than with Southern Thailand[6] and Saudi Arabian[2], but lower than with Canadian[8] dental practitioners. Unfortunately, the use of eye protection was low (31.1%) in this study.

Table 1. The prevalence and nature of infection control, radiation control, and handling of mercury reported by dentists

		Number of participants (n)	%
How many hours do you work daily?	4 hours	10	9.4
	6 hours	16	15.1
	8 hours	48	45.3
	Other	32	30.2
Do you employ protective measures against hepatitis?	Yes	99	93.4
	No	7	6.6
Type of protective measures against hepatitis	Vaccination	87	82.1
	Gloves	19	17.9
Do you treat patients infected with HBV?	Yes	91	85.8
	No	15	14.2
Method of high level disinfection	Autoclaving alone	4	3.8
	Autoclaving and other	41	38.7
	Alcohol	1	0.9
	Gluteraldehyde	14	13.2
	Alcohol&gluteraldehyde	9	8.5
	Iodine	0	0
	Alcohol&Iodine	2	1.9
	Hypochlorite	2	1.9
	Phenol	1	0.9
	Other	32	30.2
Precaution	Standing more than 6 feet away from source	48	45.3
	Use of lead-glass screen/shield	0	0
	Leave the room	13	12.3
	Stand behind lead-coated wall	3	2.8
	Wearing lead-apron	2	1.9
	Combination. including (1) above	3	2.8
	Combination of other methods above	4	3.8
	Other precautions	3	2.8
	Do not use precautions	30	28.3
Prevalence of reported checking of radiology equipment used by dentists	Yes	34	32.1
	No	61	57.5
	Don’t know	11	10.4
Prevalence of reported methods of storage of excess amalgam by dentists	Open box	3	2.8
	Closed box	18	17
	Underwater	21	19.8
	Under other solution	2	1.9
	Underwater in a closed box	10	9.4
	Other combination	52	49.1

Table 2. The prevalence and nature of infection control, radiation control, and handling of mercury reported by sex

		Male		Female		
		n	%	n	%	
Working hours	4 hours	4	6.8%	6	12.8%	
	6 hours	4	6.8%	12	25.5%	
	8 hours	35	59.3%	13	27.7%	χ^2:13.29
	Other	16	27.1%	16	34.0%	p=0.004
Continuing education	Yes	50	84.7%	32	68.1%	χ^2:4.14
	No	9	15.3%	15	31.9%	p=0.042
Training in occupational health	Yes	23	39.0%	13	27.7%	χ^2:1.49
	No	36	61.0%	34	72.3%	P=0.22
Frequency of wearing gloves	Always	38	64.4%	41	87.2%	
	Always except for screening	17	28.8%	3	6.4%	χ^2:8.81
	Sometimes	4	6.8%	3	6.4%	p=0.012
Frequency of changing gloves	Change every patient	54	91.5%	43	91.5%	
	Wash gloves between patients	2	3.4%	2	4.3%	χ^2:0.09
	Other	3	5.1%	2	4.3%	p=0.956
Frequency of wearing surgical face mask	Always	40	67.8%	43	91.5%	
	Always except for screening	9	15.3%	2	4.3%	χ^2:8.64
	Sometimes	10	16.9%	2	4.3%	p=0.013
Frequency of changing surgical face mask	Change every patient	15	25.4%	12	25.5%	
	Change at the end of the day	17	28.8%	13	27.7%	
	Change when feels dirty	20	33.9%	16	34.0%	χ^2:0.03
	At the end of the day + when feels dirty	7	11.9%	6	12.8%	p=0.99
Type of eye protection worn	Safety glasses	17	28.8%	16	34.0%	
	Prescription glasses	5	8.5%	7	14.9%	
	Face shield	5	8.5%	5	10.6%	χ^2:2.34
	Other	32	54.2%	19	40.4%	p=0.503
Frequency of wearing eye protection	Always	4	10.0%	3	8.6%	
	Sometimes	15	37.5%	15	42.9%	χ^2:0.23
	Other	21	52.5%	17	48.6%	p=0.891
Do you employ protective measures against hepatitis?	Yes	53	89.8%	46	97.9%	χ^2:2.74
	No	6	10.2%	1	2.1%	p=0.098
Type of protective measures against hepatitis	Vaccination	49	83.1%	38	80.9%	χ^2:0.08
	Gloves	10	16.9%	9	19.1%	p=0.769
Do you treat patients infected with HBV?	Yes	50	84.7%	41	87.2%	χ^2:0.13
	No	9	15.3%	6	12.8%	p=0.715

Dentists in this study universally reported high level disinfection of handpieces, which is similar to data reported in USA[14] and Canada[8]. Appropriate autoclaving of dental instruments as a means of high level disinfection is widely regarded as the gold standard. In this study 38.7% of dentists reported autoclaving alone and 3.8% reported autoclaving in combination with other methods. Remaining relied on chemical means of high level disinfection with agents such as alcohol, gluteraldehyde, iodine, hypochlorite and phenol.

The potential for undesirable effects must be balanced against the benefits obtained from radiographs. Dentists have professional obligations not only to limit the use of radiographs to potentially beneficial situations but also to take good quality diagnostic radiographs to limit the doses used, to use good radiation safety measures and to use modern equipment to achieve the best possible films[15]. A lead apron with at least 0.25 mm thickness of lead has been recommended. Lead aprons help to reduce the amount of primary radiation reaching areas of the body that are in the direct pathway of the primary beam. Further protection can be achieved with good radiographic and processing techniques and with quality control to ensure films are taken and processed to provide high quality and diagnostically useful information. Good surgery design, with large rooms and appropriate wall thickness, and materials will help protect dental staff. Well-maintained, modern equipment is essential for diagnostically acceptable radiographs and for radiation safety. Machines that are more than 10 years old may need maintenance, upgrading or even replacement[1,9,11].

In this study, most dentists appeared not to take standard precautions when taking radiographs (28.3%). 45.3% of dentists reportedly stand more than 6 feet away from source. Unfortunately more than half of the dentists did not check or know if their radiographic equipment had been recently maintained. However, in Southern Thailand[6], most dentists (94.3%) reported taking precautions when radiographs were taken, and 89.9% reported protecting their eyes with a UV/blue light shield or filter while using these units.

The greatest exposure to mercury for dentists comes from handling amalgam for restorations, although storage and disposal of amalgam and amalgam capsules is also important source of exposure. Storage of excess amalgam and mercury by dentists included in this study appeared not to be entirely consistent with the guidelines, which suggests that these materials need to be stored in a closed container under radiographic fixer[3,7].

In conclusion, we found that most dentists comply with use of gloves, masks, protective eyewear and HBV immunisation for themselves; however, many dentists do not utilise the full range of recommended infection control procedures that are necessary to minimize the risk of cross-infection in dental practice. Dentists also need to take more interest in whether radiographic equipment is checked. Our results lend support to the concept of mandatory continuing education on occupational health. It is concluded that education on occupational hygiene practices is lacking in Turkey and continuous supervision of the dental sector must be encouraged to evaluate and check the facilities for adherence to standard procedures.

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An Analytic Study of Oral Healthcare System in Some EU Countries

SUMMARY

The aim of this article was to present different models of oral healthcare systems in the EU countries and to analyze the mean national DMFT in 12-year olds and oral health expenditures in representative countries correlated with the model of oral healthcare system. Actually, this analytic study shows the relation of oral healthcare systems to one segment of oral health status. 6 countries were encompassed: Germany, Denmark, Netherlands, United Kingdom, Greece and Slovenia (as representatives of each model of oral healthcare system). Classification of EU/EEA members given by Widstrom and Eaton (2004) was used in this study.

For every country it is very important to follow up the oral health status of the population, control the expenditures and try to make them lower, which is possible only with combination of the preventive activities and the coverage in health insurance.

Keywords: Oral Healthcare System; Expenditures; DMFT

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Introduction

One of the basic principles of the European Union (EU) is that there should be free movement of goods, labour, products and services. For that purpose, provision of essential standards in oral health services is to be broadly comparable in all countries within Europe.

Within the EU provision and financing of healthcare has been, and is, a responsibility of individual member states and is not coordinated centrally by the European Commission (EC)[14,15]. Systems for the finance and organization of oral healthcare in EU/EEA countries have their own national, historical, political and socio-economical traditions. Nevertheless, healthcare decision makers make efforts to find some indicators which can be used for comparative analyses between the oral healthcare systems among the countries[2,17].

This study analyzes the mean number of DMFT for 12-year olds which is the main indicator for oral health status of population and expenditures on oral health, both as outcomes of different systems of oral healthcare.

Material and Method

The EU/EEA Member States have different models of provision oral health care. In this article oral healthcare systems were analyzed in 6 countries (as representatives of each model of oral healthcare system): Germany, United Kingdom, Denmark, Greece, Netherlands and Slovenia, using the broad classification between EU/EEA members given by Widstrom and Eaton[26]. The main characteristics of each model of oral healthcare system was briefly discussed, finance in oral health, and finally the outcome of appropriate systems analyzing the mean national DMFT level in 12-year olds, as major recommended indicator for dental caries[4,20].

The data for percentage of national GNP spent on oral health care in 2000 and mean national DMFT in 12 year olds children were reported to the CECDO (Council of European Chief Dental Officers) in 2003, and after that they were taken from an original article by Windstrom and Eaton[26].

Existing Oral Healthcare Systems in European Countries

In the most member states, oral healthcare system is financed through general taxation or social insurance and the role of private services is significant[1,3,24,29].

According to Widstrom and Eaton[26], oral healthcare systems in EU/EEA countries can be categorized under 6 broad headings. These are the Nordic, Bismarkian, Beveridgian, Southern European, Hybrid and Transitional models.

Nordic System (Denmark, Finland, Norway, Sweden and, in some aspects, Iceland)

There is a large public dental service, which is financed by general or local taxation[10]. The system is characterized by a universal access to free public oral healthcare for children and the facilitated access for adults. Oral health care data is collected by the governments and consequently the system is monitored for effectiveness and costs. There is also a private sector that may be subsidized by a public health insurance.

Bismarkian System (Austria, Belgium, France, Germany, Luxemburg)

It is based on the principle of obligatory social insurance that reimburses some or all of the costs of oral healthcare and it is financed by employers and employees[7]. Payment for oral health care are made by national and regional sick funds according to the negotiations with dental associations about fees.

Beveridgian System (United Kingdom)

General dental care is mostly provided by independent dentists in contracts with the National Health Service (NHS)[8,9]. Free care is provided for children and subsidized care for adults. In the last years growing proportion of oral healthcare has been provided outside the NHS under private contracts.

Southern European System (Cyprus, Greece, Italy, Portugal, Spain)

The system is predominantly private without governmental involvement. Limited insurance schemes, organized by the employers, are available for some groups. Most of the patients have to pay dentists directly. Public services may be available to provide some treatment for children and to treat dental emergences[11].

Hybrid (Netherland, Malta, Ireland)

The system is a mixture of the Bismarkian and or Beveridgian system with a private system. The Netherlands has privatized the provision of oral health care for adults, whilst retaining a predominantly "Nordic model" for children[16].

Transitional - East European countries (Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia)

In these countries highly centralized public co-ordination has been moved to small privately funded practices[12,13]. Some countries are already working with, or have plans for insurance based oral health care.

Discussion

Summarized Data on Oral Healthcare Expenditures

Many countries represent the estimate spent on oral health because it is very difficult to ascertain exactly how much is spent in private sector. The data for expenditures on oral health in 2000 in the analyzed countries represent oral health spending in both public and private sectors except data for Slovenia, which is only from private sector.

In 2000, the percentage of GNP spent on oral health care (public and private) in the analyzed countries varied from 0.33% in Denmark to 1.10% in Greece (Tab. 1; Fig. 1). This data cannot show the real proportion of expenditures on oral health between the countries because of their different values for GNP. Although the range is relatively narrow (from 0.33% to 1.10%), when this percentage is applied to the figures *per capita* GNP (in purchasing power parities – PPP), the range for actual spend *per capita* becomes far wider (from USA $50 in Slovenia to USA $234 in Germany - Fig. 2). The difference is more than 4 times[19]. The higher cost on oral healthcare in Germany reflects insurance covers the prosthetic treatment of all members of their population irrespective of age[18].

*Table 1. Gross National Product*** and Expenditure on Oral Healthcare in 2000 and DMFT levels in 12-year olds in analyzed EU countries*

Member state EU/EEA	Per capita National GNP $USA	Estimate % Spent on oral health	Estimate Spent per *capita	DMFT levels in 12 year olds
Denmark	27,250	0.33	99	0.9 (2002)
Germany	24,920	0.94	234	1.2 (2001)
Greece	16,860	1.10	184	2.2 (1998)
Netherlands	25,850	0.37	94	0.6 (1996)
UK	23,550	0.39	92	0.9 (2002)
Slovenia	17,310	0.62	50**	1.7 (2003)

* Total spend public plus private
** Public only
*** Expressed in Purchasing Power Parities

Source: *Widstrom E, Eaton KA.* Oral Healthcare systems in the extended European Union. *Oral Health Prev Dent*, 2004; 2:155-194.

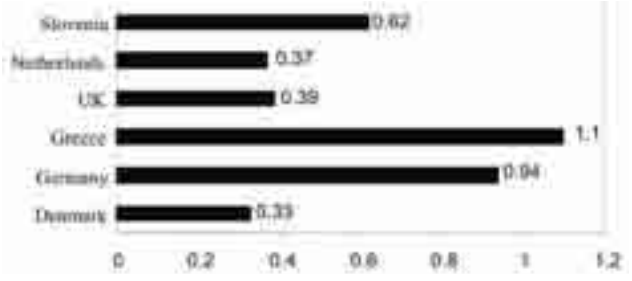

Figure 1. Estimate % Spent on Oral Health

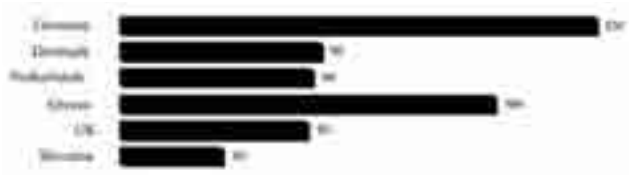

Figure 2. Estimated Spent on Oral Health Per capita

The variation in percentage of GNP spend on oral healthcare does not seem to be related to the purchasing power standards. The model of oral healthcare system is not strictly in correlation with the expenditures on oral health. It seems that the countries which follow the Bismarkian and Southern European model, as Germany and Greece, pay a higher proportion of GNP for oral healthcare than those which follow the other models[6].

In Germany (Bismarkian model), there are financial problems because health insurance funds offer wide population coverage, comprehensive treatment and benefits connected with frequent dental visits.

In the Southern European countries little is known of the total cost of oral health care provision, as the provision of oral healthcare is mostly in the private sector, out of insurance schemes[25]. In the countries where private dentistry dominates, the estimates on the total costs of the oral health care may not be very reliable[27,28].

Caries Prevalence in 12-Year Olds

Data for mean DMFT for 12-year olds were reported to the CECDO in 2003 (Tab. 1; Fig. 3) but they do not originate from the same year. A wide range of criteria for the diagnosis of caries and sampling techniques are used in different 'national' studies. That means that the results are not comparable between the countries[5].

Figure 3. DMFT levels in 12-year olds in the analyzed countries

Each description in this paper is focused on the most important database in every country and can be claimed to be more informative than strictly standardized.

So, we can find out that a high proportion of GNP spent on oral health does not necessarily mean better oral health if this is reflected by carious teeth in 12-year old children (Tab. 1). Although Greece and Germany spend the highest amount per capita for oral health, the DMFT levels for 12 year olds are not the smallest ones[21,23]. Netherlands with rather low level of oral health expenditures has the lowest level of mean number of DMFT in 12-year olds. This country belongs to Hybrid System model, which means that it creates its own best way to improve oral health status among the population without high expenditure for that purpose.

According to Nomura et al[22], mean number of DMFT at 12 years in National Health Services model (NHS) countries was well below that in Social Health Insurance model (SHI) or Private Health Insurance model (PHI) countries, and only NHS countries showed low levels of both DMFT and dental expenditures.

From this study we can find out that the model of oral healthcare system is not strictly in correlation with the oral health status, following the example on DMFT level for 12-year olds in representative EU countries.

Conclusions

1. Data on oral health status, used of services, and treatment results and costs should be collected in all countries in a way that makes comparisons reliable.

2. The oral health expenditures are very important for the oral health status of the population, as it has been shown on DMFT in 12-year olds, but it is not crucial.

3. The model of oral healthcare system is not strictly in correlation with the expenditures on oral health, or with the oral health status.

4. For every country it is very important to follow up the oral health status among the population, control the expenditures and try to make them lower, which is possible with combination of the preventive activities and the coverage in health insurance.

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Assessment of Dental Anxiety in Children: Effect of Oral Health Education

SUMMARY

The aim of the present study was to evaluate the effect of school-based oral health education on dental anxiety in children and to observe the efficacy of 4 different anxiety assessment tests, 2 of which were newly developed and dependent on observation of a professional. 142 children, aged 6 to 7 were included in the study. 70 children attended a school-based oral health education programme before they first visited the University's Paedodontics Clinic. The control group included the children who did not receive oral health education before or during the study period. All data were analyzed with χ^2-test, Student's t-test and Pearson's coefficient of correlation.

Children who received oral health education, showed less anxiety than the control group ($p<0.05$). In conclusion, the oral health education given before dental treatment could be useful to diminish dental anxiety in children.

Keywords: Dental Anxiety; Oral Health Education; Children

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Introduction

Dental anxiety constitutes a major problem for patients and dentists[5,13]. Especially in young children, dental visit represents a stressful experience[4,9-11,17,25]. Many measurement techniques, based on self report, state anxiety or behavioural measures, have been proposed to assess the dental anxiety[1-3,18,19]. Self report tests with non-verbal tools, like Venham Picture Test (VPT), were preferred in children because of the difficulty in expressing their anxiety by means of words[6,8,14,15,21]. The other method for assessing dental anxiety is using questionnaires. The Children's Fear Survey Schedule-Dental Subscale (CFSS-DS) is a well-known instrument which allows categorization of subjects according to their dental anxiety during dental treatment[2,19]. Studies where CFSS-DS was designed to be answered by parents on behalf of their young children have shown good results concerning reliability and validity[1,7,22]. On the other hand, observation is mostly a dependable tool in psychology where children are being evaluated.

Dentists play a major role to eliminate the dental anxiety level in patients. It has been reported that oral health knowledge can also diminish the dental anxiety level[25]. The **aim** of the present study was, firstly, to evaluate the effect of school-based oral health education on dental anxiety in children and, secondly, to observe the efficiacy of 4 different anxiety assessment tests, 2 of which were newly developed and dependent on observation of a professional.

Material and Methods

Subjects

142 children (68 girls and 74 boys), aged 6 to 7, who attended to a primary school located in the district with middle socioeconomic level, were included in the study. 70 children attended a school-based oral health education programme in the classroom. The control group included the children who did not receive oral health education before or during the study period.

All children were invited to University's Paedodontics Clinic for oral examination. Oral examination, in a standard manner using mirror and probe, was carried out by the second author (D.C.) who was blinded to subjects whether belonged to the study or the control group. Children with previous dental treatment experience, or urgent treatment needs, were excluded. From a total of 142 children, 53 children in the control group and 50 children in the education group were included in the study.

The study design was approved by the Ethics committee of the Ege University in Izmir, and informed consents were obtained from the parents of all children.

Oral Health Education

Oral health education was carried out in the classroom with slides for groups of 16 to 18 by the first author. The education included topics on the importance of teeth, etiology of dental caries and prevention methods and information about dentists. Equal amounts of time were devoted to these different topics in the classroom lessons. Then, children were invited to the clinic almost a week after the oral health education.

Survey Instruments

Dental anxiety was assessed by 4 different methods, namely: "waiting-room observation" (Fig. 1), "Venham Picture Test (VPT)"[24] (Fig. 2), "examination-room observation" (Fig. 3), and "Children's Fear Survey Schedule-Dental Subscale (CFSS-DS)"[7] (Fig. 4) for both groups and applied in the above order.

Items	Yes	No
1. Cry intensively		
2. Make a lot of noise, want to go		
3. Vomit		
4. Sweat		
5. Red face		
6. Refuse people in white uniforms		
7. Show high activity		
8. Look at everyone with fearful eyes		
9. Excessive and unnecessary talk		
10. Speak loudly		
11. Impatience		
12. Get angry easily		
13. Nail biting		
14. Swing while sitting		
15. Do not want to contact the dentist		
16. Always look in front of him/herself		
17. Do not want to leave parents		
18. Stands up just close to parents		
19. Behave timidly		
20. Tight and sulky face		
21. Fast and frequent eye movement		
22. Do not look around		
23. Do not speak with parents		
24. Lip biting		
25. Regressive behaviour		
26. Knead hands		
27. Always playing with something		

Figure 1. Waiting-room observation scale

Figure 2. Venham Picture Test

Items	yes	no
1. The mouth shut		
2. Showing panic attack signs		
3. Cry intensively		
4. Closing the mouth with hands		
5. Refuse treatment		
6. Sulk		
7. Draw himself back		
8. Obstruct dentist's hands		
9. Spit frequently		
10 Talk a lot		
11. Uncooperative		
12. Ask question to avoid treatment		
13. Unhappy		

Figure 3. Examination-room observation scale

Items	not at all afraid	a little afraid	somewhat afraid	fairly much afraid	very much afraid
1.Dentists					
2.Doctors					
3.Injections					
4.Having somebody examine your mouth					
5.Having to open your mouth					
6.Having a stranger touch you					
7.Having somebody look at you					
8.The dentist drilling					
9.The sight of the dentist drilling					
10.The noise of the dentist drilling					
11.Having somebody put instruments in your mouth					
12.Choking					
13.Having to go to the hospital					
14.People in white uniforms					
15.Having the nurse clean your teeth					

Figure 4. Children's Fear Survey Schedule

A waiting-room observation form was prepared with 27 items that defined anxiety by a psychologist (third author). The items were chosen from anxiety representing findings like physiological features, such as sweating or vomiting and behavioural expressions, like crying intensively, speaking loudly, or lip biting[12,16]. 2 psychology students who were calibrated before observed the child in the waiting room without the child being aware of them and filled in the data (r = 0.80). Scores were determined by summing the negative behaviour measures with the maximum score of 27. The observers were blinded to whether the child was in the study or the control group.

As the child entered the clinic, VPT was applied to the child in order to represent his/her feelings before the oral examination by the second author (VPT-before). VPT was applied again after the standard intraoral evaluation (VPT-after). The child was presented 8 pairs of pictures of children exhibiting various emotions and was asked to choose the child that best reflects his own emotions[1,19]. The instances where the child choose the picture showing negative behaviour were added up to represent VPT score. This scale has a range of "0" (no fear) to "8" (high fear) [1,19].

Second observation form (examination-room observation) was also prepared by the same psychologist that included 13 anxiety representing behaviours for the child during an intraoral examination. Similarly, 2 psychology students carried out the observation in the clinic independently all through the intraoral examination. Final decision was determined by summing the negative behaviours which add up to 13.

After the intraoral examination, the Turkish version of CFSS-DS was administered and it was answered by the parents on behalf of their children. In order to assure content validity, scale was translated from English by a single native speaker, pre-tested, and then back-translated by another native speaker to ensure comparability to the original form. It has been devised by 15 items, such as the "dentist drilling", "injection", and "people in white uniforms" rated on a 5-point scale, ranging from 1 (not afraid) to 5 (very afraid). Scale scores for each situation were added up to represent CFSS-DS score for each child, where scores above 38 indicated high dental anxiety[1,2,7,12,13,19,22,26].

Statistical Analysis

All data were analyzed statistically using SPSS for windows, version 11.0. Student's t-test, χ^2-test, and Pearson's coefficient of correlation were used to compare the study and control groups statistically.

Results

48.5% of the children attended a school-based oral health education program in their school before visiting our clinic. 46% of the children were girls, while 54% of them were boys.

Reliability of the Instruments

The newly developed instruments (waiting-room observation scale and examination-room observation scale) displayed high levels of internal consistency reliability,

Cronbach's alpha scores were 0.73 and 0.80, respectively. The Turkish version of CFSS-DS also displayed a high level of internal consistency reliability (Cronbach's alpha = 0.88).

Child's Dental Anxiety Status

The mean values of anxiety rating scales are presented in table 1. Statistically significant difference was found between educated and non-educated groups in all scales except examination-room observation by using Student's t-test. The non-educated group revealed a higher anxiety level.

The relation between anxiety level determined by all techniques and gender was evaluated by the Student's t-test. Only the relation between the value of examination-room observation scale and gender was found to be statistically significant (Tab. 2). Boys had more dental anxiety than girls ($p<0.05$).

Initial VPT scores were always higher than VPT scores after the examination. Therefore, the difference between the value of VPT before and after examination was compared to receiving school-based oral health education. The difference was found statistically significant (Tab. 3).

Comparison of anxiety assessment tests by Pearson's coefficient of correlation showed that CFSS-DS, waiting-room observation and examination-room observation scales were similar in stating the anxiety status of children (Tab. 4).

Table 1. The mean values (SD) of anxiety rating scales

	Waiting room	Examination room	VPT before	VPT after	CFSS-DS
Educated group	3.04 (0.37)*	2.24 (0.34)	0.92 (0.17)*	0.60 (0.15)*	26.92 (1.39)*
Non-educated group	5.81 (0.46)	2.98 (0.26)	2.45 (0.22)	1.60 (0.19)	33.19 (1.33)
p	0.030	0.064	0.013	0.021	0.032

* Statistically significant

Table 2. The relation between anxiety level assessed by examination-room observation and gender (t-test)

GENDER	Mean value (SD)
Male	3.02 (0.31)*
Female	2.17 (0.28)

* Statistically significant

Table 3. Comparison of the difference of VPT before and after the intraoral examination and receiving oral health education (Student's t-test)

	VPT before - VPT after (SD)
Educated	0.32 (0.16)*
Non-educated	0.84 (0.13)
p	0.014

* Statistically significant

Table 4. Inter-correlation among anxiety scales (Pearson's coefficient of correlation)

	VPT difference	Waiting-room observation	CFSS-DS total	Examination-room observation
VPT difference	1.000	0.173	0.119	0.126
Waiting-room observation	0.173	1.000	0.337 **	0.275 **
CFSS-DS total	0.119	0.337 **	1.000	0.356 **
Examination-room observation	0.126	0.275 **	0.356 **	1.000

** Statistically significant

Discussion

Dental anxiety is a common problem and is considered to be a significant barrier for people who are seeking dental care[1,10,17,23]. From the previous studies, it has been suggested that knowledge about dental procedures may play an important role for eliminating the dental anxiety[9,11,25]. Findings of our study, similarly, presented that children who had received an oral health education showed less anxiety than the control group ($p<0.05$).

In general, many different anxiety assessment techniques were used because of the multidimensional construct of dental anxiety. One way to assess the dental anxiety in children, in any age group, is to observe children's

responses to dental environment[6]. Therefore it was decided to use 2 newly developed behaviour observation methods in the present study. Our results showed that observation of a profession (waiting room observation scale, examination room observation scale) and parents view (CFSS-DS) were in accordance in stating the dental anxiety in children, while the VPT representing the state of anxiety was not showing an inter-correlation with the above 2 methods. The findings of this study would suggest that clinical observations might be a valid means of assessing child dental anxiety status.

In most children, dental anxiety shows a decrease after visiting the dentist more often[10,17,23]. Although we did not measure the effect of the dentist's behaviour in the present study, there was no difference found in the examination-room observations for educated and non-educated groups, probably because of the dentist's attitude. After confronting a paediatric dentist and painless dental experience, children's reaction was more relaxing, which was recorded in the examination room scale. However, boys were more anxious than girls without the effect of previous dental health knowledge level. The result of this study support the finding of Demiroz[8] and conflict with some other studies[20,22] which indicate that girls are more anxious than boys in the dental environment. The reason behind might be cultural, since there is an overindulgence for boys in the traditional Turkish family - boys are raised in a manner that they are very important in the progression of the ancestry.

The present study showed strong correlation between a commonly used anxiety scale (CFSS-DS) and 2 newly developed observing scales (waiting-room and examination-room observation scales) in stating dental anxiety status in children, which may provide a better understanding of anxious patients. The results of the present study also showed that oral health education given before the dental treatment could be useful to diminish the dental anxiety level in children. It could be concluded that, by increasing the knowledge on dental health, it is possible to alleviate patients' anxiety and provide less avoidance of dental health and less fearful dental treatment.

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The Relationship between Early Childhood Caries with Mutans Streptococci and Lactobacilli in a Group of Preschool Children. Comparison of Initial - First Year Results

SUMMARY

***Purpose*:** *The aim of this study was to examine the relationship between Early Childhood Caries (ECC) with Mutans streptococci (MS) and Lactobacilli levels in 2-4 year old children, by comparing the initial and first year results.*

Materials and Methods: *In this study, 30 children with ECC as a study group and 30 caries-free children as controls were examined. Dental caries was assessed by using the WHO methodology under standardized conditions. The df-scores in children who had ECC were calculated. Microbiological examinations were carried out in both groups for determination of the level of MS and Lactobacilli in supragingival plaque. This process was repeated at an 1-year follow-up examination.*

Results: *There were statistically significant differences on the mean levels of MS and Lactobacilli at both initial and first year results between the study and control groups. However, there was not statistically significant increase in the level of MS and Lactobacilli, whereas the difference between df scores were found to be statistically significant when initial and first year results in both study and control groups were compared.*

Conclusions: *These findings prove that the early MS colonization is correlated with high caries risk.*

Keywords: Early Childhood Caries; Mutans Streptococci; Lactobacilli; Dental Plaque

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Introduction

Contemporary dental profession aims for both the eruption of teeth as healthy and the challenge to keep them that way. Dental professionals are concerned about a condition, known as baby bottle tooth decay and nursing caries, which has recently been referred to as early childhood caries (ECC). General caries in primary teeth have been declining over the years in the developed countries. However, ECC is still a major threat to oral health of infants and toddlers[1-4].

ECC can be defined as the occurrence of any sign of dental caries on any tooth surface during the first 3 years of life[5]. It is widely accepted that early colonization of *Mutans streptococci* (*MS*), lack of oral hygiene routine, sweet drinks and infant formulas during bedtime or naptime, and parental education are associated with ECC[2,5].

MS colonization may occur shortly after the tooth eruption, and several studies have shown that the infection level increases with age[6]. High counts in mothers are associated with an early colonization of their infants, and the earlier the establishment of a cariogenic flora, the more caries is likely to develop in the primary dentition[5-8].

ECC may influence the development of caries in the future, both in the primary and permanent dentition[5-6]. The prevalence of ECC has been reported to differ among populations, varying from 1% to 70% in some ethnic

minority group, immigrants, and poor communities[9]. Therefore, ECC is a public health problem, and health planners should give high priority to oral health education of parents. Moreover, studies to reduce the transmission of cariogenic microorganisms have also been performed as methods to prevent ECC.

The aim of this study was to examine the relationship between ECC and *MS* and *Lactobacilli* among 2-4 year old children, by comparing initial and first year results.

Material and Methods

This study was performed in a rural area of Diyarbakır-Turkey. 30 children with ECC were examined as a study group. The ages of the subjects ranged from 2 to 4 years. The children were examined in terms of socioeconomic status, education of parents, dietary risk habits, oral hygiene practice (deprived of brushing habit), and potential fluoride sources, which were taken into account as common features in the selection of the group members. 30 caries-free children at the same age as study group were examined in the control group.

Oral examinations were carried out by using dental mouth mirror and explorer in order to record the df-scores. Dental caries was assessed by using the WHO methodology under standardized conditions. Microbiological examinations were performed in both study group and control group for determination of the level of *MS* and *Lactobacilli* in supragingival plaque at the Dicle University, Medical Faculty, Department of Microbiology.

Parents and children were instructed on oral hygiene methods after initial examination. Toothpaste and toothbrush were distributed to all patients in both, control group and study group.

Since all the subjects were chosen from the same area, we had the advantage of having same patients throughout the study.

Samples of supragingival plaque in maxillary incisor teeth were removed with a sterile dental flat plastic instrument and immediately transferred to a transport fluid containing 0.01 peptone. The samples in transport fluid underwent 10-fold serial dilution before 0.1 ml was plated Rogosa SL agar (RSL, Merck) for growth of *Lactobacilli* and Mitis Salivarius agar (MS, Difco) with bacitracin for growth of *MS*. The plates were incubated in anaerobic conditions at 37^0C in RSL for 4 days, and *MS* for 2 days, followed by 2 days of aerobic incubation. After incubation, total colony-forming units for each bacterial plates were separately counted. This procedure was repeated in an 1-year follow-up.

In statistical analysis, Student t-test was used to determine the relationship between initial and first year results.

Results

There was a statistically significant difference between the study group and the control group for the level of both, *MS* and *Lactobacilli* at the initial examination (Tab. 1). Similarly, there was a statistically significant difference between both groups for the level of *MS* and *Lactobacilli* at the end of the first year (Tab. 2).

However, there was no statistically significant difference between increase in the level of *MS* and *Lactobacilli* ($p > 0.05$), whereas the difference between df-scores was found to be statistically significant ($p < 0.05$) when initial and first year results in both groups were compared (Tabs 3 and 4).

There was a statistically significant difference between df-scores at initial and the first year results in both groups (Tab. 5).

Table 1. The relationship between the mean of level of MS and lactobacilli in the study group and control group at the initial examination

Initial Results	Study group N=30 X ± SD	Control group N=30 X ± SD	Statistical Significance
MS	6.57 ± 3.94	3.70 ± 2.79	P<0.01
Lactobacilli	2.43 ± 3.65	0.73 ± 1.20	P<0.05

Table 2. The relationship between the mean of level of MS and lactobacilli in the study group and control group at the end of the first year

First Year Results	Study group N=30 X ± SD	Control group N=30 X ± SD	Statistical Significance
MS	7.80 ± 2.34	4.06 ± 2.54	P<0.001
Lactobacilli	3.66 ± 2.95	1.03 ± 1.12	P<0.001

Table 3. The relationship between the mean of level of MS and lactobacilli at initial and first year results in study group

Study Group	Initial N=30 X ± SD	First year N=30 X ± SD	Statistical Significance
MS	6.57 ± 3.94	7.80 ± 2.34	P>0.05
Lactobacilli	2.43 ± 3.65	3.66 ± 2.95	P>0.05

Table 4. The relationship between the mean of level of MS and lactobacilli at initial and first year results in control group

Control Group	Initial N=30 X ± SD	First year N=30 X ± SD	Statistical Significance
MS	3.70 ± 2.79	4.06 ± 2.54	P>0.05
Lactobacilli	0.73 ± 1.20	1.03 ± 1.12	P>0.05

Table 5. The relationship between df-scores at initial and first year results in study and control group

Df %	Initial N=30	First year N=30	Statistical Significance
Study group	4.56 %	6.3 %	P<0.05
Control group	0	1.4 %	P<0.05

Discussion

Several microbiological tests have been performed in order to establish the number of people who have the sensitivity of teeth to dental caries. These tests are mostly focused on *MS* and *Lactobacilli* counts[10-12]. It has been known that there has been a positive correlation between the *MS, Lactobacilli* and caries prevalence[13-14]. Microbiological cultures taken from cariogenic dental plaque and shallow carious lesion indicate that *S. mutans* particularly is a pathogen for tooth caries. On the other hand, it was reported[15] that *Lactobacilli* were related with the development of caries lesions after their emergence.

The basic process is that cariogenic microorganisms act on fermentable carbohydrates to produce acids. A sucrose-rich diet facilitates the initial establishment of *MS* in plaque, and a prolonged exposure to carbohydrates enhances a further accumulation of acidic bacteria, such as *MS, Lactobacilli* and low pH[2,5]. This ecologic shift creates a long-term low pH environment that can demineralise tooth enamel rapidly. In early childhood, several factors are involved, which are unique for this age group, as[5]: (1) ***microorganisms*** (early colonization of *S. mutans*; lack of oral hygiene routines); (2) ***substrate*** (sweet drinks, milk, and infant formulas during bedtime or naptime; high frequency of sugar consumption from drinks and solid food; nursing bottles and pacifiers and sucking habits; prolonged feeding pattern); (3) ***host*** (low salivary flow rate at night; newly erupted, immature teeth; immature specific and non-specific defence system; high prevalence of hypoplastic defects in primary dentition; medical conditions); (4) ***social variables*** (parental education; socioeconomic status; siblings).

We thought that it would be appropriate to create a group which has similar features like nutrition, socio-economic conditions and educational level, in order to demonstrate the effective role of early *MS* and *Lactobacilli* colonization on ECC. As a result of our study, it was found that the level of *MS* and *Lactobacilli* in children having ECC was considerably higher than in those that were caries-free.

Köhler and Bjarnason[16] also showed the high existence of *MS* and *Lactobacilli* in saliva of children aged 11-12 years in Iceland, together with the accompanying high caries prevalence, and explained the high *Lactobacilli* rate with too many lesions. As confirmed in many studies, the direct relation between the microorganisms in saliva and existence of caries is compatible with the result of our study in terms of the relation between microorganism in plaque and the existence of caries[12,17,18].

In other study, the age at which *MS* could be detected in the plaque of Finnish children was a reliable predictor of subsequent caries activity. Children who harboured *MS* in their plaque by age of 2 years developed 10.6 dmfs by age 4. In contrast, children in whom *MS* were detected between ages 2 and 4 years developed 3.4 dmfs by age 4 and children in whom *MS* could not be detected were essentially caries-free by age 4[7]. Similarly, Chosack et al[19] stated that dmft in children between ages 3.5 and 5 involving *MS* in high concentration in their saliva increased with age.

Different studies have also investigated the relationship between dental caries in the primary dentition and subsequent dental caries in the permanent dentition. Hill et al[20] reported that caries rate at the age of 6 years was a good indicator of future caries. The same conclusion was suggested by Gray et al[21], who concluded that caries in 3 or more primary molars at the age of 5 was the best predictor of caries development in the first permanent molars in 565 children.

These data indicate the diagnostic value of early *MS* detection, suggesting that treatment strategies and tactics that delay the colonization of *MS* could cause a reduction in decay. Furthermore, these findings prove that the early *MS* colonization, both in the primary and permanent dentition, is correlated with high caries risk. Therefore, we firstly aimed to educate all our patients about oral hygiene. The objective of education was to improve the dental habits of parents and children by increasing their knowledge about ECC. We distributed toothbrushes and toothpaste to all our patients in the selected area, which was thoroughly deprived of oral hygiene instruction and facilities for toot-brushing.

There was an increase in the level of *MS* and *Lactobacilli* at the end of the first year. However, there was not statistically a significant increase in the level of *MS* and *Lactobacilli*, when initial and first year results in both study and control group were compared. Moreover, there was a statistically significant difference between df-scores when initial and first year results in both study and control group were compared. This result also showed that only oral hygiene would not be sufficient. In paediatric dentistry, this conclusion has emphasized the importance of preventive measures and education in order to be protected against ECC.

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Amelogenesis Imperfecta - Multidisciplinary Approach: A Case Report*

SUMMARY

In this case report, the rehabilitation of amelogenesis imperfecta patient was performed in 2 stages. During the first phase, none of the unerupted teeth were removed in the maxilla and the mandible, and the vertical dimension of occlusion was increased. It is essential to monitor this new occlusion closely over several months. The second stage involved the clinical crown lengthening surgery and metal-ceramic FPDs making for maxillary and mandibular teeth. The goal was to establish an aesthetic appearance and efficient masticatory function.

Keywords: Amelogenesis Imperfecta; Prosthetic Rehabilitation

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CASE REPORT (CR)
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Introduction

Inherited conditions of the enamel and dentin are determined by genes that regulate functions unique to the highly differentiated and specialized odontogenic cells. Some gene mutations that affect the structure or composition of enamel usually result in alterations that are detectable only in enamel, and the resultant inherited basic defects present at birth are described as *amelogenesis imperfecta* (AI).

Gene mutations in the enamel matrix produce 1 of the following results: insufficient enamel being formed (hypoplasia), a marked deficit of initial calcification of the organic matrix (hypo-calcification), or a defect in the formulation of crystalline apatite in the enamel rods (hypo-maturation). The term enamel maturation means progression of enamel mineralization. Water and protein are removed from the enamel extra-cellular matrix coincidently with increasing calcium hydroxyapatite crystal formation. Sometimes, mature enamel is formed that contains 96% inorganic substance. Structural and/or regulatory genes associated with enamel code for types I, IV, and VII collagen, amelogenins, enamelis, and enamel peptidases.

The human amelogenin (AMEL) gene is located on the distal portion of the short arm of the X chromosome in the p22.1 to p22.3 region. This locus is also near the centromere on the Y chromosome (possible at the proximal long arm Yq11 region)[3,4]. It is hypothesized that mutations of the human amelogenin gene are associated with the various X-linked types of AI. The Y chromosomal localization might be associated with genes that participate in regulating tooth size and tooth shape[8]. The estimated prevalence for all types of AI combined is 1 in 14,000[4]. An excellent classification of AI based on the clinical and radiographic appearance of the enamel defect and on the mode of inheritance of the trait has been recently proposed[6].

The treatment plan for patients with AI is related to many factors, including the age of the patient, the socioeconomic status of the patient, the type and severity of the disorder, and the intraoral situation at the time the treatment plan is developed[1,2]. According to Seow[5], important clinical problems of AI are aesthetics, dental sensitivity, and loss of occlusal vertical dimension. However, the severity of dental problems experienced by patients varies with each type of AI. Historically, treatment of patients has included multiple extractions and the fabrication of complete dentures[5]. These options are psychologically harsh when the problem must be addressed in adolescent patients[2]. This case report

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describes the treatment of a 24-year-old female patient with AI using metal-ceramic fixed partial dentures (FPDs) in the full mouth coverage.

A Case Report

A 24-year-old female patient was referred for treatment of attrition and aesthetic problems of her teeth. She was very self-conscious about the appearance of her teeth. A detailed medical, dental, and social history was obtained. Photographs and dental radiographs were made.

Physical examination revealed a person who appeared healthy, well developed, and well nourished, and who had normal skin and adnexa. No facial abnormality or asymmetries were noted. The patient's oral hygiene was extremely good. The lips, tongue, palate, floor of the mouth, and cheeks exhibited no abnormalities. The enamel layer was absent in the full portion of the teeth. The gingival tissue and interdental papillae were good. Pocket depth was normal. The patient was caries-free, and did not exhibit any periodontal problems. The patient had bilateral-balanced occlusion. It was determined that the patient's inter-occlusal distance was reduced because of an absence of teeth and enamel hypoplasia. Therefore the patient's vertical dimension was altered (Fig. 1).

Figure 1. The intraoral view of the patient before treatment

Radiographically, both maxillary canines and first premolars, and mandibular right first premolars were congenitally absent. The enamel layer was absent in the full portion of the teeth. The maxillary right second premolar, second molar and third molar, maxillary left second and third molars, mandibular right canine, second premolar, second molar and third molar were unerupted. Maxillary and mandibular permanent canines were in the alveolar region. It was concluded that the patient suffered from a hypo-calcification type of AI very likely (Fig. 2).

Figure 2. The radiographic view of the patient before treatment

Laboratory studies were not remarkable. Blood chemistry included serum calcium, phosphorus, and alkaline phosphatase. Other tests used were urine-analysis, serology, fasting blood glucose, and haematology.

The patient's diagnostic casts were made, as were face-bow and protrusive records. Casts were mounted in centric relation.

None of the unerupted teeth were removed in the maxilla and the mandible for preventing the clefts instead of bone loss and also patient did not accept the removal of unerupted teeth.

A treatment plan was developed with the following aims: to improve the aesthetics and to restore masticatory function. Fabrication of metal-ceramic FPDs for maxillary and mandibular teeth was planned. The patient was informed of the diagnosis and the treatment plan, which she accepted.

The vertical dimension of occlusion was determined by the usual clinical tests and was set on the articulator (Dentatus Type ARH, Sweden). No tooth reduction was made except minor preparations to remove undercuts. Impression for teeth were made with elastomeric impression material (One Time Perfect®, Type 3, Detax, Germany). Temporary restorations were made with self-curing acrylic resin (Temdent Classic®, Weil-Dental GmbH, Germany) and were luted with temporary luting agents (Cavex Temporary Cement®, Cavex Holland BV, Holland) for 3 weeks to tolerate new vertical dimension of occlusion (Fig. 3). The patient was then monitored systematically over a 2-month period to check for any functional or articulation problem following the change in vertical dimension of occlusion. After 2 months of monitoring, the patient had no problem.

Thereafter, a clinical crown lengthening surgery was made for maxillary anterior right and left central and lateral teeth. A periodontal pack was placed for the first postoperative week, and the patient was instructed to use 0.2% chlorhexidine mouthwash twice daily for 2 weeks. Postoperative healing was rapid, and the patient experienced no discomfort. The resulting gingival contour was an enormous improvement, and the patient was pleased with the result (Fig. 4).

Figure 3. The intraoral view of the temporary restorations before clinical crown lengthening surgery

Figure 4. The intraoral view of the patient after clinical crown lengthening surgery

Figure 5. The intraoral view of the final restorations

2 weeks later, healing was sufficient to continue treatment. Impression for teeth were made with the same elastomeric impression material. Casts were fabricated. A trial evaluation of the metal substructure, prior to glazing of the ceramic material, enabled final occlusal refinement. Metal-ceramic FPDs for maxillary and mandibular teeth were cemented with zinc-policarboksilate cement (Adhesor® Carbofine, Spofa Dental, Frankfurt, Germany) using the manufacturer's recommended power/liquid ratio (Fig. 5). The patient was observed at intervals of 3 months and then once a year (Fig. 6).

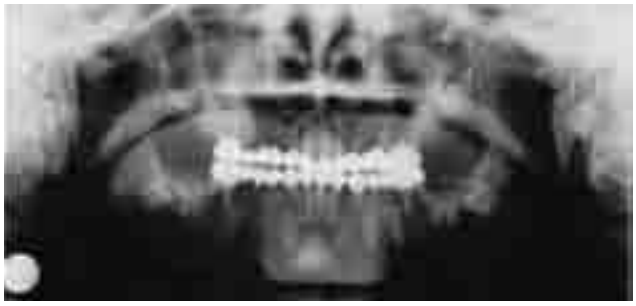

Figure 6. The radiographic view of the patient after 1 year

Discussion

The complexity of the management of patients with AI supports the suggestion that the prosthodontic profession should have a key position in the rehabilitation of rare disorder[1]. Treatment of patients with AI should start with early diagnosis and intervention to prevent later restorative problems. However, some patients may not seek treatment until young adulthood, after advanced tooth wear and associated tooth sensitivity, functional, and aesthetic problems that have already occurred, leading to the need for complex restorative treatments. Fixed restorations also allow these patients to avoid social problems that are associated with partial or full dentures, particularly in young people[7].

Patients with AI need not to be faced with extraction of their teeth at an early age. A definite advantage is gained by combining the disciplines of periodontology and prosthodontics.

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