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EDITORIAL

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Enamel matrix derivative proteins used for regeneration of bony defects in periodontitis.

Alexandru Vlasa[1]

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Introduction

Various therapeutic options incorporating nonsurgical treatments, as well as conservative and regenerative surgical techniques, have been used for the treatment of intrabony defects throughout the last three decades, with varying degrees of success [1]. Since the early 1970s, to achieve predictable periodontal regeneration, an evolution of different treatments has been studied such as: various types of bone grafts and/or substitutes applications; guided tissue regeneration growth and differentiation factors; enamel matrix proteins [2,3]. The major goals of periodontal treatment are to eliminate infection and resolve chronic inflammation in order to stop the progression and prevent it from recurring [4]. A lack of bleeding on probing and minimal probing pocket depths (less than 4 mm) are the clinical signs of this [1]. Nevertheless, despite the presence or absence of bleeding on probing, the persistence of residual periodontal pockets of >5 mm after active periodontal treatment is linked to an increased risk of disease development like an additional loss of attachment and a tooth loss [3]. Increased probing depths after treatment have been linked to the existence of intrabony or angular periodontal abnormalities, a symptom of periodontitis, and have been proven to affect the long-term prognosis for teeth [5]. Clinical studies have shown that traditional periodontal surgery [6], which includes a variety of access flap methods, can result in probing depth reduction, hard tissue filling, or even the removal of the intrabony aspect [3,5,7]. Even though such techniques may optimize clinical outcomes, the rehabilitation is primarily characterized by the formation of a long junctional epithelium with a limited or no regeneration of root cementum with functionally periodontal ligament fibers connected to new alveolar bone [2,3].

One of the products commonly employed for periodontology treatment is called Emdogain® (Institute Straumann, Basel, Switzerland), and this is a combination of freeze-dried DMA (powder) and a hydrogel (propylene glycol alginate) to complete the formulation [8]. The pure protein complex, freeze-dried and enriched with amelogenins, isolated from the amellar matrix collected from dental swine germs is referred to as "Enamel Matrix Derived" (EMD) [9,10]. Amelogenins, present in EMD, represent an extracellular matrix protein complex that induce the formation of acellular cementum [11]. Amelogenins activate the proliferation and differentiation of periodontal fibroblasts and osteoblasts when absorbed on the root surface. The regeneration of the periodontal ligament and cementum is the primary function of amelogenins in periodontal regeneration [12]. The EMDs then promote the reconstruction of the periodontium in a complex mechanism of activation of osteo-regeneration through the bone cells while inhibiting the epithelialization of the damaged sites [13].

Lars Hammarstrom's pioneering research showed that enamel matrix proteins might act as essential regenerative proteins capable of supporting periodontal regeneration, including the development of new cementum, functionally oriented periodontal ligament

fibers, and new alveolar bone. There have been a good number of articles about the biological basis and therapeutic application of Lars Hammarstrom's innovative work [11-13].

A crucial factor that may lead to bias during the histopathological analysis and that must be taken into account for a fair interpretation of the healing outcome, also for an equitable comparison between treatment modalities, refers to the variation in morphological characteristics and dimensions of naturally developing periodontal defects [14]. For a fact, the vascular and cellular resources of the periodontal ligament, alveolar bone, and gingiva that surround the defect appear to have a significant impact on the repair of deep three-walled intraosseous lesions and deep dehiscence or gingival recession defects. Contrarily, it is clear that in two- or one-walled intraosseous defects, the distribution and contribution of tissue resources are drastically changed and diminished. Actually, the proportions of the defect seem to be a significant factor in predicting healing achievements in the clinical setting, both after conventional surgical therapy. Where wide defects responded with less bone gain compared to narrow defects, and after periodontal regenerative surgery, better clinical outcomes, in other words, larger clinical attachment level (CAL) gain and bone fill, are achieved in deep, narrow intrabony defects compared to wide, shallow defects.

Miron et al. [15] pointed out the effects on early wound healing. All sites were reevaluated using a visual analogue scale to determine the level of post-treatment discomfort after a median of 4 weeks. EMD administered had a beneficial impact on intraosseous defects, as shown by an evaluation of postoperative regeneration, healing, and morbidity.

Regarding the clinical outcomes following in intrabony defects using EMD alone, Miron et al. [15-16] highlighted among his clinical research studies that EMD significantly improved CAL gains and pocket depths. Those results were mainly conducted by an open flap debridement (OFD) surgical technique.

Despite the fact that the enamel matrix derivative has been around for more than 25 years as a periodontal tissue regenerator [10-12], it is also astonishing that it is still one of the few biomaterials that can histologically show genuine periodontal regeneration with the production of new cementum, periodontal ligament, and alveolar bone that is still readily available for clinical usage. Specific enamel matrix proteins have several biological functions, and more study is being done to characterize how these activities affect the behaviour of cells and tissues.

Conclusions

Using a range of techniques and materials, periodontal regeneration in human intrabony defects can be accomplished to varying degrees, according to the findings of the current editorial. Following the application of various bone grafts and analogues, guided tissue regeneration, biological agents, and other combinations, periodontal regeneration can be observed. From a clinical standpoint, it is also increasingly crucial to continue researching the use of EMDs to see if bone regeneration outcomes may be further enhanced by minor adjustments to EMD support systems or by minimally invasive surgical techniques, EMD continues to be one of the benchmarks for biologic-assisted periodontal regeneration.

Conflict of interest: None to declare.

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ORIGINAL RESEARCH

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Assessment of lingula and foramen mandibulae morphology and their implications for inferior alveolar nerve block: a comparative study of contemporary and medieval individuals.

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Abstract

In this study, we conducted a detailed morphological analysis of the lingula and foramen mandibulae, aiming to examine their anatomical characteristics and relationships within contemporary and medieval individuals.

Our primary objective was to provide valuable insights to assist clinicians in minimizing potential intraoperative complications during anesthesia procedures targeting the inferior alveolar nerve.

To accomplish this, we examined the mandibular structures of 22 adults, 11 children aged 6-12 from archaeological findings in the Târgu Mureș area, and 14 contemporary adults. Our observations encompassed the size, shape, and spatial relationships of the lingula and foramen mandibulae concerning various points along the ascending branch of the mandible.

The study revealed a distinct order of lingula shapes among medieval children and adults, with the triangle, trapezoid, nodular, and assimilated shapes being most prevalent. In modern adults, the order of nodular and assimilated shapes was reversed. Additionally, oval foramina were more common in adults, while round foramina predominated in children. Notably, there was no statistically significant difference between children and adults in the distance from the most prominent point of the lingula to the anterior edge of the ascending branch.

Our findings imply that the depth at which the inferior alveolar nerve can be accessed remains relatively consistent between children and adults. Furthermore, we identified a correlation between the relationship of the shape of the lingula and the position of the mandibular foramen, providing valuable insights for clinical practice.

Keywords: lingula, foramen mandibulae, morphology, inferior alveolar nerve block.

Introduction

The front edge of the foramen mandibulae is covered by a bony formula, the lingula, which was described by Johannes-Baptist Spix in 1815, and is therefore also called Spix's process [1,2]. On the medial surface of the ascending branch is the foramen mandibulae, and sometimes an additional opening (foramina accesoria) can be found [3].

The above-mentioned structures are located in the medial surface of the mandibular ramus, approximately in its central part, and the lingula, if present, is located in front of the foramen mandibulae, which provides passage for the lower alveolar neurovascular bundle to the mandibular canal [4].

Inferior alveolar nerve block is the main technique for anesthesia of the mandible, it is the most important method for hemilateral anesthesia of the jaw [5,6]. The first succesful use of the conventional inferior alveolar nerve block was reported in literature in 1885 and it is also referred as the Halsted approach [7]. During the anesthesia of the inferior alveolar nerve it is necessary to deliver the anesthetic solution into the pterigomandibular area. In order for the anesthesia to be succesful, it is required to place the anesthetic solution as close as possibile to the foramen mandibulae [6,8].

The succes rate of the inferior alveolar nerve block is around 60-80%, due to the great variation of the position of the mandibular foramen and the position and form of the lingula, on which the sphenomandibular ligament attaches causing further difficulties in the lower nerve block [8,9].

The morphology and the position of the foramen mandibulae and lingula is influenced by genethics, the type of the growth, age, sex, the activity of the muscles, tendons and

ligaments attached to it, mastication type [10,11,12].

The shape, length, thickness, and nature of attachment of the sphenomandibular ligament varies considerably between individuals. It can be ranged in shape from a thin band that descended for a short distance from the spine of the sphenoid to a broad bi-concave ligament with prominent insertions. Some sphenomandibular ligaments can attach to the medial surface of the mandibular ramus anterior and posterior to the lingula, in addition to their direct attachment to this structure [13,14].

Several authors have tried to classify the form of lingula. For the first time in India [8] the lingula was classified in the case of adult, dried jawbones into four groups: triangular, trapezoidal, nodular, the absence of the lingula is defined as assimilated [12,15]. According to another classification, the lingula can be divided into 5 main groups based on its size and shape: large nodular, small nodular, large triangular, small triangular, and small bony spinous types, which are located in front or behind the mandibular foramen [16].

The mandibular foramen moves anteriorly with age concomitantly with the decreasing size of the gonial angle (GA) and it is hypothesized that the change in the mandibular foramen position with age results from bone apposition in the posterior border of the ramus, and the decrease in the GA results from functional forces exerted from the masseter and medial pterygoid muscles [17]. The shape, size, and the morphology are highly influenced by the development of the person and is characteristic for certain communities [18].

The purpose of the study is to investigate the form and the position of the lingula and the foramen mandibulae in order to assess significant anatomical differences which might reduce the succes rate of this type of anesthesia and indicate the adoption of another inferioar alveolar nerve block tehnique with a higher succes rate. The aim of the study is to provide information about the detailed anatomical proprierties regarding the medial surface and size of the mandibular ascendent ramus in order to help the clinicians to avoid intraoperative injuries.

In this study, several measurements and investigations were made on contemporany human mandibles of different sex, age. In order to inspect a larger distribution of anatomical variations of these elements we studied medieval mandibles of different age and sex. It is known that the mastication type and consistency of food was much higher in medieval ages than nowadays, the abrasion of the occlusal surfaces of the investigated medieval mandibles sustain this fact also in our paper. Higher masticatory forces had a bigger impact on the growth of the anatomical surfaces.

Material and methods

During our study, we examined the anatomical formations and their morphology and location on the medial surface of the ascending branch of 47 dry mandibles. Of these, 14 originated from contemporary adults, which came from the anatomy department of George Emil Palade University of Medicine, Pharmacy, Science, and Technology of Targu Mures. Of the remaining 33, 22 belonged to medieval adults and 11 belonged to medieval children (aged between 6 and 12 years old), which came from the Muzeul Archeologic Târgu Mureş. The mentioned mandibles were unearthed during excavations in Fântânele, Teiuş, Micăsasa, Ghidfălău, Săvădisla, and Târgu Mureş. The approval of the ethics committee was not necesary because the study was not performed on living individuals.

The study took place between February and March 2023.

In the study, we only included mandibles whose ascending branch was preserved on both sides.

Photographs of the mandibles were taken using a 10 cm scale using a Canon 80D DSLR camera equipped with a 100 mm macro lens and RingFlash.

For the morphological classification, we used the classification described by Tuli, as this type of classification is the most frequently found in the literature, which is as follows: 1. triangle, 2. trapezoid, 3. nodular, 4. assimilated. We also took into account where the lingula was located in relation to the alveolar ridge level in horizontal plane and the occlusal plane.

We also classified the shape of the foramen mandibulae (round or oval) and examined the relationship between the foramen and the lingula.

Figure 1: Variations of lingula shapes: A. triangle, B. trapezoidal, C. nodular, D. assimilated

We also measured the distance of the most prominent point of the lingula to our various reference points using callipers with an LED display along imaginary lines drawn through the most prominent point. The distance was measured in the antero-posterior direction related to the anterior and posterior edges of the ascending branch, and in the caudo-cranial direction related to the base of the mandible and the deepest point of the incisura sigmoidea. We also measured how far this point was from the tip of the processius coronoideus and from the Gonion point.

With the help of Adobe Photoshop CC 2017 software, we measured the Gonion angle and the angle formed by the most prominent point of the lingula and the deepest point of the incisura sigmoidea, which we designated as the incisura angle of the mandible.

Figure 2 : The relation and the distance of the most prominent point of the lingula related to the various reference points: A. the relation with the occlusal surface and bone level, B. the distance from different ponts of the ascending branch of the mandible, C. the gonial and incisura angle

Afterwards, we introduced our results into a Microsoft Office Excel software sheet, dividing them into the groups of medieval children and adults and modern adults, and then we prepared descriptive statistics with the help of the software, according to each group. Analytical statistics were then performed using Graphpad InStat software. In the case of qualitative values, we used the Chi square test. In the case of quantitative values, outliers were excluded using the Grubbs test, and then the Kolmogorov-Smirnov test was used to examine the distribution of the data. In the case of numerical values with a normal distribution, parametric even and odd t tests were used, while in the case of values showing a non-normal distribution, nonparametric Wilcoxon, Mann Whitney U, and Spearman tests were performed. During all statistical analyses, the value of α was 0.05.

Results

Table 1. Average value in mm, standard deviation and p-value when comparing the two rami of the mandible in terms of the location of the tip of the lingula from the reference points

Parameters		Right side		Left side		*p*
		Average value	Standard deviation	Average value	Standard deviation	
Medieval children	ML-AM	11.09	2.50	11.90	2.46	*.0425**
	ML-PM	13.45	1.12	13.2	1.22	*.313169*
	ML-IM	23.90	6.84	25.45	5.10	*.30902*
	ML-MN	14.5	1.84	15	2.23	*.300002*
	ML- procc. CORONOIDEUS	24	10.28	33.58	4.50	*.342316*
	ML-GONION	22.7	5.27	22.6	5.58	*.483799*
Medieval adult	ML-AM	12.45	1.99	11.90	1.94	*.1559*
	ML-PM	16.09	2.44	15.5	2.22	*.19807*
	ML-IM	31.5	5.83	31.09	4.82	*.402558*
	ML-MN	16.76	2.82	16.95	2.57	*.410348*
	ML- procc. CORONOIDEUS	33	3.86	32.77	2.36	*.475334*
	ML-GONION	26.05	6.05	28.27	3.54	*.09231*
Contemporary adult	ML-AM	11.14	1.40	11.42	1.50	*.30194*
	ML-PM	14.28	1.54	15.57	0.93	*.00407**
	ML-IM	31.64	4.66	31.14	6.04	*.77022*
	ML-MN	19.46	3.40	17.64	3.99	*<.00001**
	ML- procc. CORONOIDEUS	34	3.19	33.58	4.50	*.808772*
	ML-GONION	27	4.73	27.92	4.95	*.625188*

ML-AM: Distance from the most prominent point of the lingula and the anterior margin.
ML-PM: Distance from the most prominent point of the lingula and the posterior margin.
ML-IM: Distance from the most prominent point of the lingula and the inferior margin.
ML-MN: Distance from the most prominent point of the lingula and the mandibular notch.
ML-procc. CORONOIDEUS: Distance from the most prominent point of the lingula and the proccessus coronoideus
ML-GONION: Distance from the most prominent point of the lingula and the gonial angle.

There is no statistically significant difference between medieval children and adults for the ML-AM distance (p=0.113811).

There is a statistically significant difference between medieval and modern adults for the ML-AM distance (p=0.041165).

We did not find any statistically significant differences between the right and left sides in the gonion and incisura angles for any of the examined groups.

Table 2. The p-value, which is created when the right and left sides of the mandible are compared, in terms of the incidence rate (in percentage) of the anatomical form of the mandibular foramen and lingula.

Parameters		Shape	Right side	Left side	*p*
Medieval children	Foramen mandibulae	Oval	36.4%	36.4%	*1.*
		Round	63.6%	63.6%	
	Lingula	Triangular	36.4%	36.4%	*.753004*
		Trapezoid	18.2%	36.4%	
		Nodular	27.3%	18.2%	
		Assimilated	18.2%	9.1%	
Medieval adult	Foramen mandibulae	Oval	72.7%	63.6%	*.517413*
		Round	27.3%	36.4%	
	Lingula	Triangular	40.9%	31.8%	*.585856*
		Trapezoid	27.3%	36.4%	
		Nodular	27.3%	18.2%	
		Assimilated	4.5%	13.6%	
Contemporary adult	Foramen mandibulae	Oval	66.7%	83.3%	*.345779*
		Round	33.3%	16.7%	
	Lingula	Triangular	35.7%	50%	*.801252*
		Trapezoid	28.6%	14.3%	
		Nodular	21.4%	21.4%	
		Assimilated	14.3%	14.3%	

In the case of medieval children and adults, there is a statistically significant difference in the shape of the foramen mandibulae, in the case of children the round shape is more common (p=0.01368), but we did not find a statistically significant difference in the shape of the lingula (p=0.943178).

The lingula covers the foramen to a statistically significant higher rate in medieval adults compared to medieval children (p=0.006647) and modern adults (p=0.003674).

Table 3. The p-value of the relation of the lingula to the alveolar ridge level in horizontal plane when comparing the right and left sides.

Parameters		Right side	Left side	p
Medieval children	Above bone level	83.3%	83.3%	1.
	At the same level as the bone level	8.3%	8.3%	
	Below bone level	8.3%	8.3%	
Medieval adult	Above bone level	91.3%	81.8%	.546308
	At the same level as the bone level	4.3%	13.6%	
	Below bone level	4.3%	4.5%	
Contemporary adult	Above bone level	78,6%	85,7%	.621705
	At the same level as the bone level	21,4%	14,3%	
	Below bone level	0%	0%	

There was no statistically significant difference in the relation of the lingula to the bone level between medieval children and adults (p=0.719472).

There is no statistically significant difference between the size of the lingula on the two sides for any of the examined groups.

The lingula was statistically significantly larger in the case of medieval adults than in the case of medieval children.

We did not find a statistically significant correlation between the value of the gonion angle and the location of the lingula in the antero-posterior direction, neither for medieval children (p=0.11029), nor for medieval adults

(p=0.9339), nor for contemporary adults (p=0.80468).

Discussions

In our study, a total of 47 mandibles were examined, with particular attention to their ascending branch. Eleven of the examined jawbones (23.4%) were of medieval children, 22 pieces (46.8%) were medieval adults, and 14 pieces (29.8%) were a contemporary adults.

According to the present study, the shape of the lingula, both in children and in medieval adults, in order of frequency: 1). was a triangular, followed by 2). trapezoid, then 3). Nodular, and finally 4). assimilated form. In today's adults, the order of occurrence of the first two forms was unchanged, but the third most common was the assimilated form, followed only by the nodular form. To achieve successful anesthesia, it is necessary to reach the foramen mandibulae, which is more difficult to approach if the shape of the lingula is triangular or trapezoid; the size of the lingula and whether it covers the foramen or not also play an important role. A statistically significant correlation was found between the shape and size of the lingula in the medieval (p=0.0033) and modern adult (p=0.0224) groups, and the correlation was even more significant in the case of all adults (p<0.0001), but we did not find a correlation for medieval children (p=0.7037). The lingula covered the foramen in a statistically higher rate, if it was triangular or trapezoid in the medieval (p=0.001) and modern (p=0.0021) adults, as well as in the group of all adults (p<0.0001), but not for children (p=0.3547). In terms of shape, we found no statistically significant difference in the case of children and adults, but in terms of size, we did. This can be explained by the fact that the shape of the lingula may be genetically determined, but its size is influenced by the type of chewing and the adhesion of the ligamentum sphenomandibulare [12].

In a study carried out by the University College London Institute of Archeology which aimed to compare medieval mandibles with post-medieval mandible finds, a total of 279 finds (135 mediaeval, 144 post-mediaeval) were used, which were also grouped by gender. According to the results of the study, regarding the width of the ramus anteroposterior (AM-ML-PM), a significant difference can be detected between the two groups, both in the case of women (p<0.05) and men (p<0.005). Their research, in contrast to our present study, found that in addition to the ML-AM section, there are also significant differences in other sections. This allowed the researchers-archaeologists to conclude, knowing that the requisition of muscles and their strength affects the development of bones and is the result of a change in eating habits (uncooked food and a lot of chewing, which was required to cut it up, were replaced by soft, cooked and fried foods and therefore less chewing was necessary) is that the larger and more robust mandible was replaced by a smaller posteriorly rotated mandible. These changes were mostly observed in the region related to the muscles of mastication and the most striking changes observed were: a decrease in the width and in the height of the ramus of the mandible and an increase in the value of the gonion angle [19].

Ligaments mediate bone to bone attachments to transfer the strength and make structures as a whole in the musculoskeletal system. Heterotopic ossification commonly happens at all sites of the body. In pathology of heterotopic ossification of tendons and ligaments mechanical factors, such as overload, may be an essential factor. Besides the role of mechanical stimulus in inducing injury, it was reported to contribute to chondrogenic/ osteogenic differentiation, which may be an essential factor for heterotopic ossification of the ligaments. Pronounced masticatory forces can trigger ossification of the sphenomandibular ligament attached to the lingula, thereby increasing the size of the lingula. This fact may explain why we found statistically significantly larger lingulae in medieval adults. At the same time, based on this, individuals with stronger chewing forces like masseter chewing type are more likely to encounter a large lingula, which can make anesthesia difficult [20].

When comparing the right and left side, we found no statistically significant differences regarding the location of the lingula and foramen mandibulae from the different reference points or compared to the bone level

(except for the ML-AM distance in medieval children and the ML-PM and ML-MN distances in modern adults) regarding the gonion and incisura angles or the shape and size of the lingula and foramen. According to this, if there are no problems during anesthesia on one side, there will probably be no problems with anesthesia on the other side either.

We did not find a statistically significant correlation between the most prominent point of the lingula and the value of the gonion angle. Based on the result, we can assume that the inferior alveolar nerve can be reached at a similar depth, regardless of age or skeletal type (we find an increased value of the gonion angle in children, the elderly and hyperdivergent growth type patterns) [21,22]. A study conducted on CBCT of 407 Chinese adults, in contrast to our study, found a correlation between the gonion angle and the foramen mandibulae, with the foramen being more posterior and inferior in individuals with higher gonion angle values [23].

Conclusions

Comparing the distance of the most prominent point of the lingula to different reference points between children and medieval adults, we found statistically significant differences at all stages except for the anterior edge of the ascending branch. Based on this, the inferior alveolar nerve can be reached at a similar depth in children during anesthesia of the lower jaw.

We found a correlation between the shape of the lingula and the foramen-lingula relationship, triangular and trapezoid processes more often cover the foramen mandible. At the same time, significantly less often in the case of medieval children and contemporary adults, the lingula, regardless of its shape, blocked the entry of the nerve into the mandible than in medieval adults.

Since pronounced masticatory forces can cause the ossification of the sphenomandibular ligament and, as a consequence, the growth of the lingula, it is more likely that patients with stronger masticatory forces have a larger lingula, so it will be more difficult to perform anesthesia of the lower jaw.

Conflict of interest: None declared.

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ORIGINAL RESEARCH

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Comparison of the effectiveness of sodium hypochlorite, citric acid, and diode laser in disinfection of the root canal system.

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Abstract

Introduction: To achieve a proper disinfection of the root canal system, besides many irrigant solutions, laser has become increasingly popular in recent years. Bacteria that penetrate deep in the dentine can be destroyed by laser up to 1150 µm. The aim of the study is to investigate and to compare the efficiency of conventional chemical disinfection using cleaning solutions - sodium hypochlorite (2%), citric acid (20%) - and the physical disinfection using a diode laser (940 nm, 1 W) in vitro using extracted teeth. Material and Methods: 23 intact, single rooted teeth were prepared and inoculated with Enterococcus Faecalis. Afterwards samples were taken from each group and placed on solid mediums. The following were applied to members of each group prior to sampling: 2% sodium hypochlorite, 20% citric acid and diode laser (940 nm, 1W). To evaluate the results, so that the bacterial strains on the medium could be counted, quenches were performed from 1/10 and 1/100 dilutions. Statistical analysis was performed using Kruskall-Wallis and unpaired T-test with a value of $p>0.05$. Results: Statistical analysis on the 3 groups (NaOCl, citric acid, and diode laser) showed significant differences between the counted remaining colonies after disinfection. Conclusions: The diode laser used for disinfection under the used settings is not effective enough, but as an adjuvant, associated with conventional irrigation effective disinfection can be obtained.

Keywords: root canal, E. Faecalis, sodium hypochlorite, citric acid, diode laser.

Introduction

To perform a correct and successful root canal treatment, proper mechanical cleaning and shaping of the canals is essential prior to the final obturation. Cleaning and shaping are important to minimize the number of remnant bacteria and prevent subsequent complications that would require retreatment of the tooth [1, 2].

Many studies have focused on the effectiveness of conventional irrigating solutions, but according to the obtained results, no agent meets all expectations [3, 4].

To achieve proper disinfection, the use of laser as an adjuvant in root canals has become increasingly popular in recent years [5]. One of the main reasons for this is that laser light is able to kill bacteria that penetrate deeper into the dentin than the solutions used. Bacteria that have penetrated deeper than 100 µm can be destroyed by the laser up to 1150 µm [6].

The most often used laser types in decontamination of the root canal are Er: YAG, Nd: YAG and diode lasers. Wavelength of the Er: YAG laser is well-absorbed in tissues containing water and hydroxyapatite, therefore it is effective in removing the smear layer. Its energy is absorbed at the first 400 µm, therefore it is not able to kill bacteria located deeper. Nd: YAG laser is mainly used for disinfection due to its deep penetrating light (1000 µm), but is not able to remove the smear layer [7, 8].

The use of a diode laser in dentistry is common in everyday practice due to its low price, small size, ease of operation, and versatility. Its wavelength is in the infrared range (800-1064 nm), but this is still visible as a perceptible red light. The performance of the laser varies from 0.5 up to 7 W [9]. Studies are still underway to determine the appropriate wavelength, power, and application time, with no agreement according to which the optimal parameters that provide the most effective treatment are [10].

The aim of this study is to investigate and to compare the efficiency of conventional chemical disinfection using cleaning solutions – sodium hypochlorite (2%), citric acid (20%) – and the physical disinfection using a diode

laser (940 nm, 1 W) in vitro using extracted teeth.

Material and methods

This study was performed at the University of Medicine, Pharmacy, Science, and Technology of Târgu Mureş in collaboration with two departments – the department of Odontology and Oral Pathology, Faculty of Dentistry, and the department of Microbiology, Virusology and Parasitology, Faculty of Medicine.

For this research 23 intact single-rooted teeth were used. Teeth were extracted for periodontal reasons. The roots were separated at the enamel-cement border with a diamond bur, because only the roots were needed for the experiment. The roots were cleaned on the external surface using an ultrasonic depurator. The teeth were stored in sterile physiological saline solution during collection.

After removing the dental pulp, root canals were prepared using hand endodontic instruments-Kerr files (VDW)-up to ISO size 40 (black) using standardization technique (Figure 1). There was no need to use a step-back technique because the root canals were straight, without any curvature [11].

Figure 1. The prepared roots and the used K-files.

Sterile physiological saline solution was used for lubrication. After enlargement, each root was irrigated with 17% EDTA, applying 1 ml in each for 1 min to remove the smear layer. This was important to help the bacteria penetrate the dentin [12, 13].

After that, the root tips were closed with a composite material on the outside to prevent any subsequent leakage. The teeth were sterilized in an autoclave at 121°C for 20 min. According to the literature, autoclaving of teeth does not significantly change the hardness and other properties of dentin and can therefore be used in experiments conducted in vitro [14].

Afterwards the teeth were placed in a sterile container and kept in this during the experiment. Sterile distilled water was placed in the empty areas of the tank to maintain moisture and thus prevent the roots from drying out and the bacteria from dying.

The 23 teeth were divided into negative, positive control, and three experimental groups (NaOCl, citric acid, and laser group). The control groups contained four teeth each and the experimental groups contained five teeth each.

A negative control group was required to be possible to check for the presence or absence of contamination. In case of contamination, the experiment needed to be performed again. In the present case, there was no detectable bacterial growth in the negative control group, so there was no contamination.

In addition to the negative control group, all teeth were inoculated with Enterococcus Faecalis (Figure 2).

Figure 2. The solid medium inoculated with Enterococcus Faecalis.

10 µl of Tryptic Soy Broth (TSB) liquid medium was added to the roots, which contained the bacteria. Bacteria-free TSB was included in the members of the negative control group. This group was needed to rule out contamination of the teeth with other bacteria.

After inoculation, the teeth were placed in an incubator where they were kept for one week at 37°C. Meanwhile, the TSB was refreshed every day by using a pipette. In each case, disposable, sterile ends were placed on the pipette, which were replaced after each use.

Each root received 10 µl of TSB (as during the inoculation) every day, but it no longer contained bacteria, as the only goal here was to maintain the growth of bacteria in the teeth and prevent dehydration. When the sterile distilled water evaporated, the free spaces were refilled in the tank (Figure 3).

Figure 3. Refreshing of the TSB

After refreshing the TSB and distilled water, the teeth were placed back in the incubator and work continued for a week.

After one-week, samples were taken from each group and placed on solid media. This process consisted of several steps.

During sampling, 10 µl of sterile saline solution was placed in each root canal, and then sterile paper tips were used to absorb the solution from the canals. Paper points were manipulated using sterile tweezers. The paper tips were then placed in plastic Eppendorf tubes containing 1 ml of sterile physiological

saline solution. Using vortexing for a minute, the bacteria on the paper tips were mixed with the saline solution in the Eppendorf tubes. 100 µl of the obtained suspension was added dropping to solid medium and spread with a rod.

To evaluate the results, so that the bacterial strains on the medium could be counted, quenches were performed from 1/10 and 1/100 dilutions (Figure 4).

Figure 4. The Eppendorf tubes contain the 1/10 and 1/100 dilutions.

For the positive and negative control groups, sampling and quenching were performed as detailed above, without affecting the contents of the root canals. In the three experimental groups sodium hypochlorite, citric acid, and diode laser were applied to members of each group prior to sampling and quenching.

Sodium hypochlorite of 2% concentration and citric acid of 20% concentration were introduced in each root canal for 3 min, after which the root canals were dried with sterile paper points and then sampled and quenched as mentioned above. On the samples of the laser experimental group, a diode laser (Biolase) with a wavelength of 940 nm and a power of 1 W was used with 200 µm diameter and front emitting end only (Figure 5).

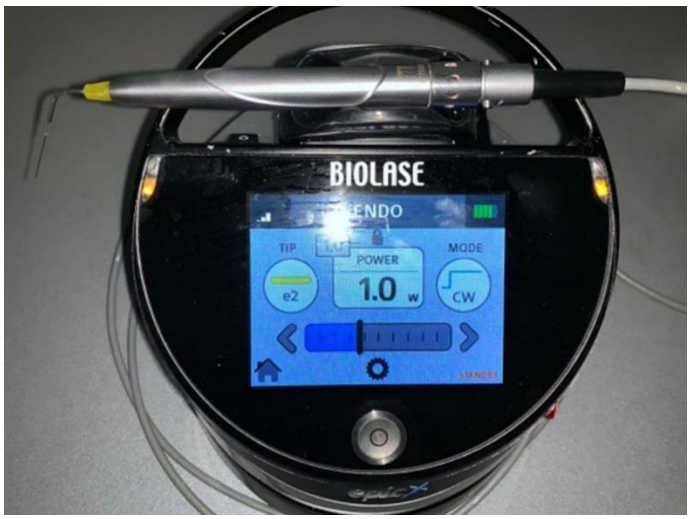


Figure 5. The used diode laser.

The laser travelled at a speed of 1 mm/ 2 seconds using circular (helical) movements from the top of each root to the top of the canal. This sequence of movements was repeated four times for each tooth (Figure 6).

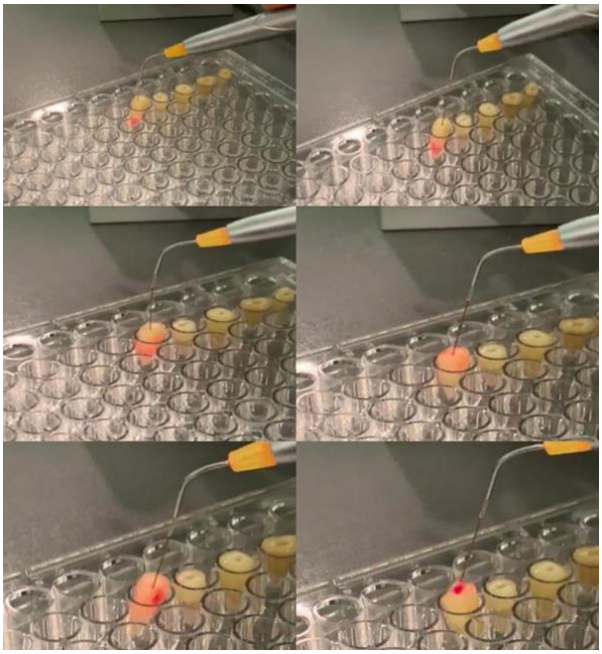


Figure 6. The usage of diode laser on the samples.

After the laser was applied, sampling and quenching were performed. After quenching the samples from the two control groups and the three experimental groups into solid media, these were placed in an incubator for 24 hours, after which the results were read, and the germ count for each tooth and group was determined.

All data were collected in Microsoft Excel work sheets (Microsoft Corporation, Washington, DC, USA, 2018). The statistical analysis was carried out in GraphPad Prism version 8.0.0 for Windows (GraphPad Software, San Diego, CA, USA). To evaluate the results, the Kruskal-Wallis and the unpaired T-test were used. The results were considered significant at a value of $p<0.05$.

Results

The obtained results after counting bacterial culture on each group substrate are shown in Figure 7.

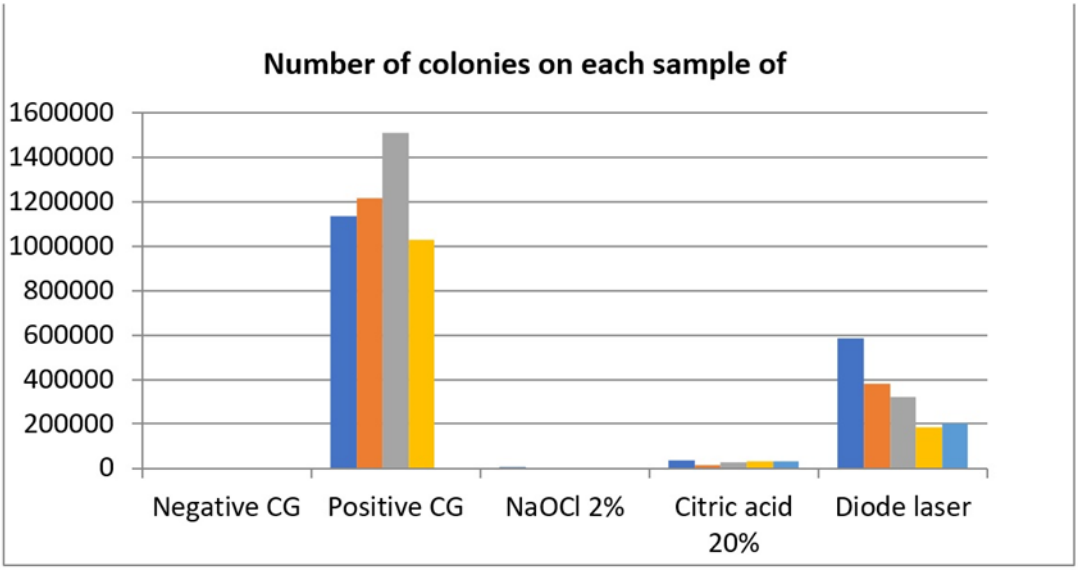


Figure 7. Number of colonies on each sample of each group

Statistical analysis of the 3 groups (NaOCl, citric acid, and diode laser) showed significant differences between the counted number of remaining colonies after disinfection performed with the mentioned solutions and method. (Figure 8)

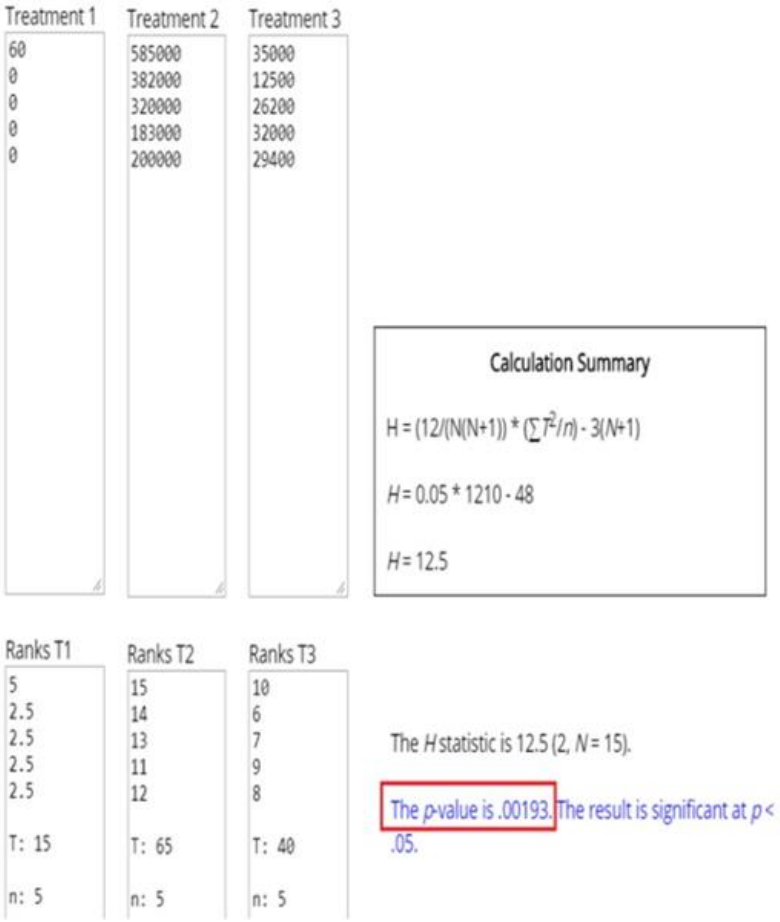
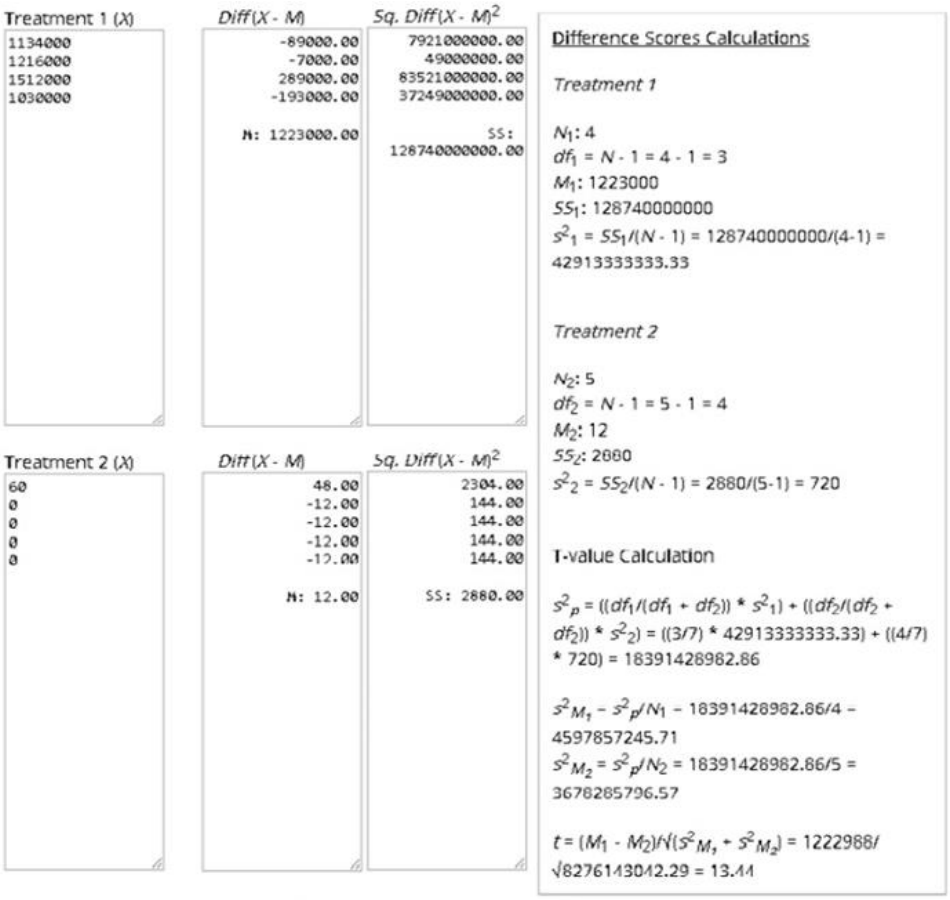


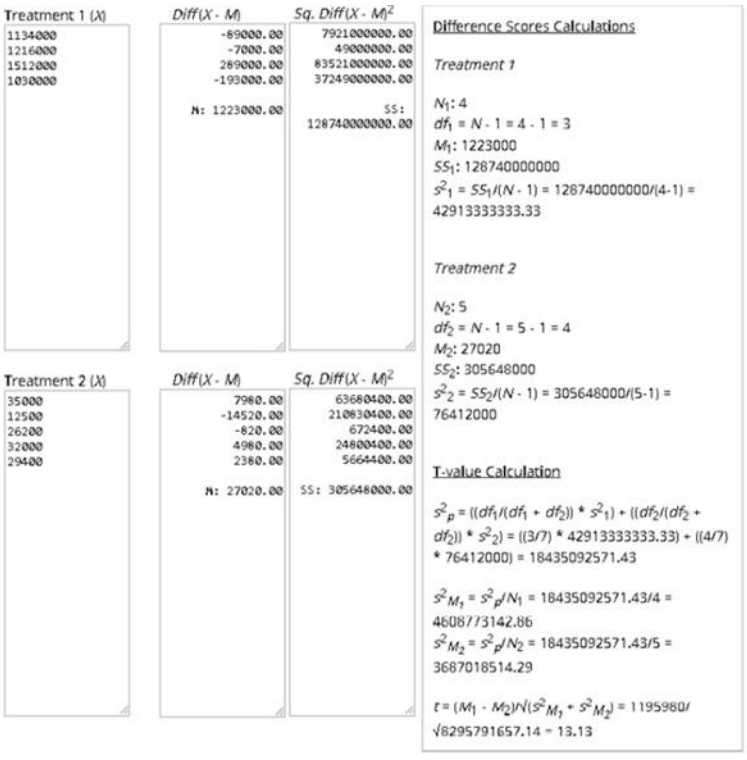
Figure 8. The performed Kruskal-Wallis test on NaOCl, citric acid, and diode laser groups

Comparing the number of colonies on the positive control group to NaOCl, citric acid, and diode laser group statistically significant results were found in every case. These results are shown in Figures 9-11.



The *p*-value is < .00001. The result is significant at *p* < .05.

Figure 9. Unpaired T-test comparing positive control group and NaOCl group.



The *p*-value is < .00001. The result is significant at *p* < .05.

Figure 10. Unpaired T-test on positive control and citric acid group

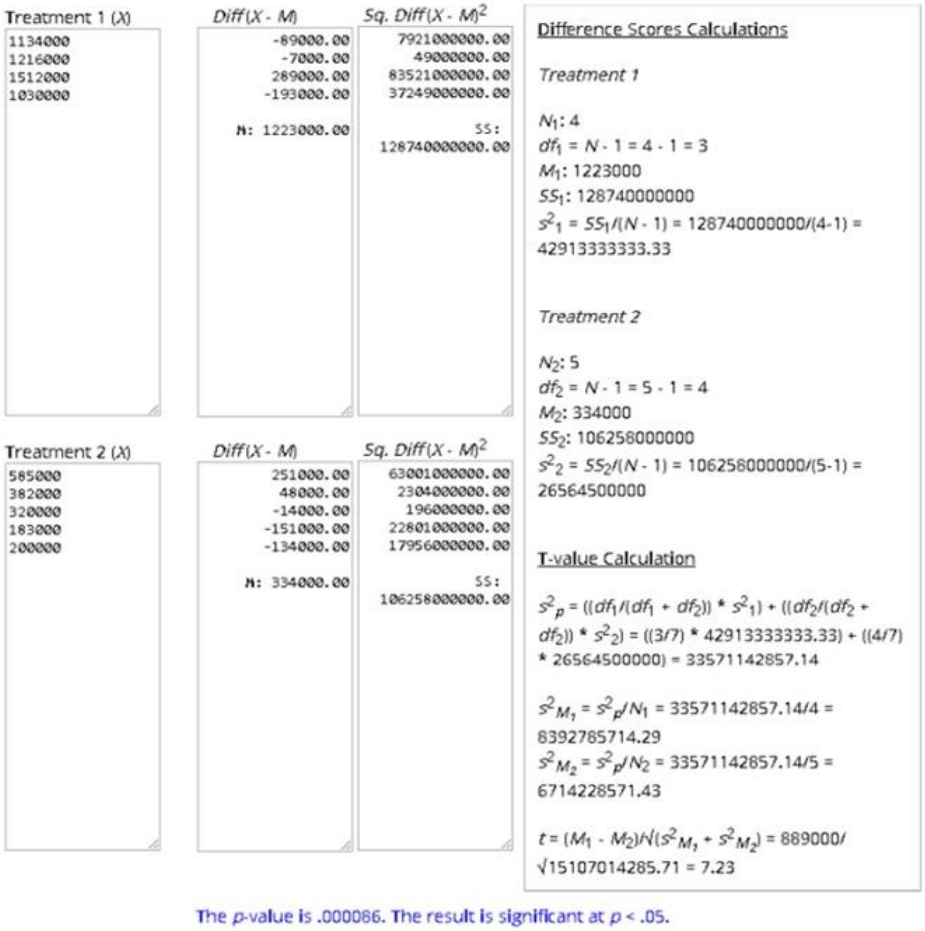


Figure 11. Unpaired T-test for positive control and diode laser group

Figure 12 shows solid media without bacterial growth on the negative control group.

Figure 13 shows bacterial growth on the solid media in case of the positive control group.

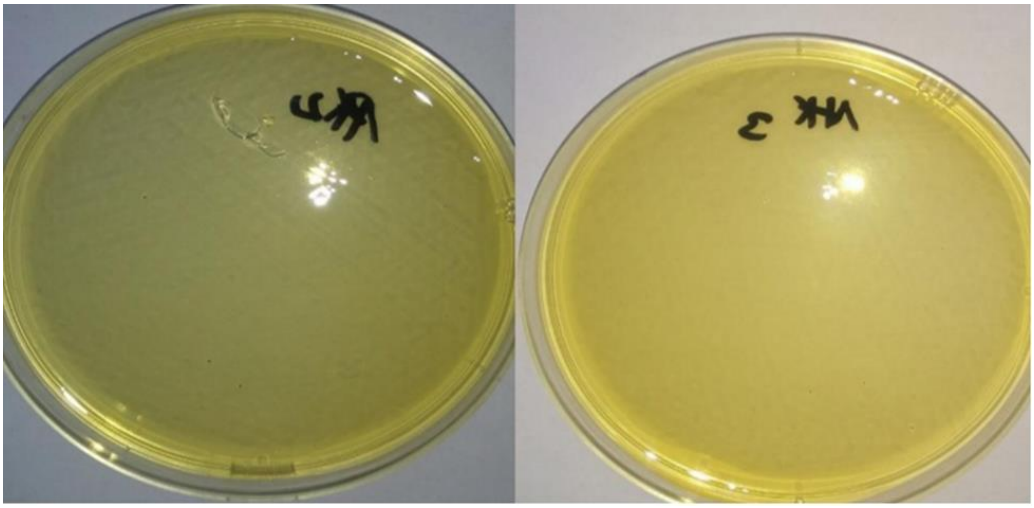


Figure 12. No bacterial growth on negative control group medium.

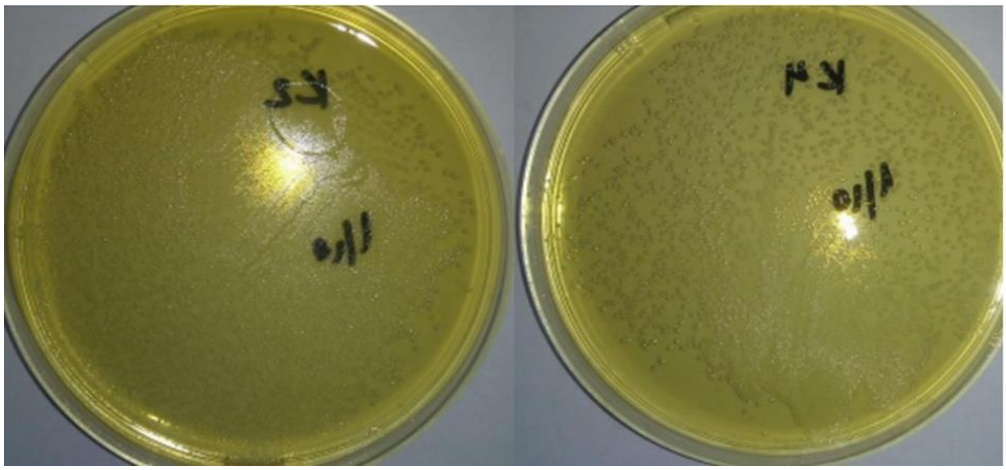


Figure 13. Bacterial growth on positive control group medium.

The number of grown bacteria on the solid media in case of NaOCl, citric acid, and diode laser group are shown in Figure 14-16.

Figure 14. Bacterial growth on NaOCl 2% medium.

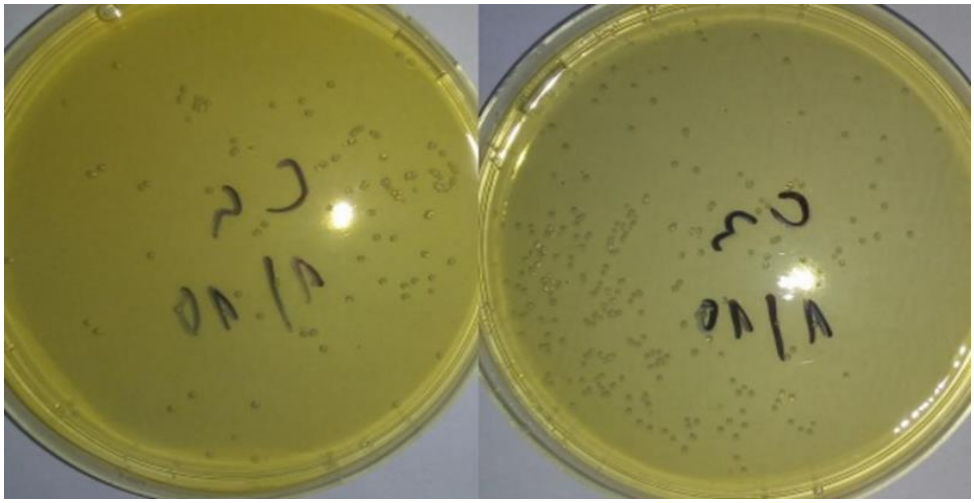


Figure 15. Bacterial growth on 20% citric acid medium.

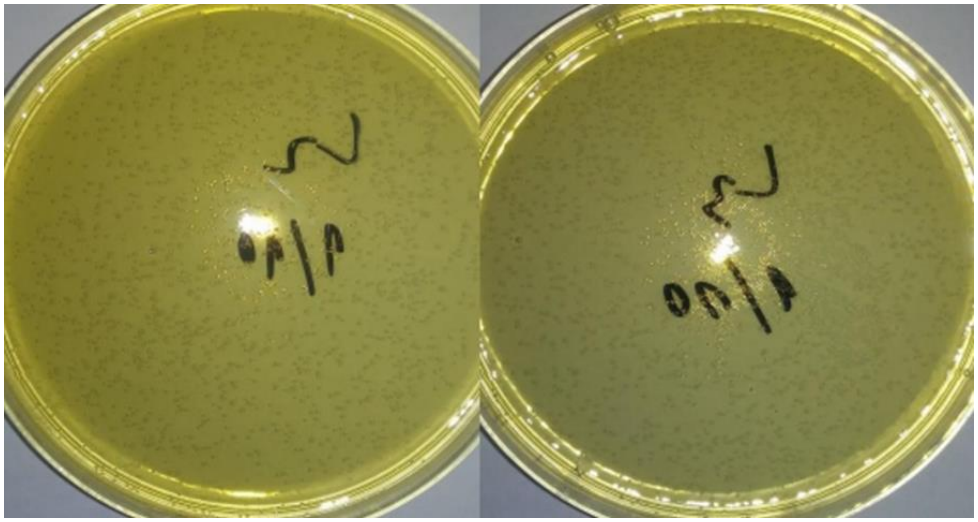


Figure 16. Bacterial growth on diode laser medium.

Discussion

During root canal treatments, the main goal is to treat or preserve the health of the periapical tissues. This can be obtained by cleaning the endodontic system. Literature data, besides the successful root canal treatments, also mention a 2-14% failure rate. In case of failure, clinical symptoms and persistent periapical or periradicular radiolucency are present [1, 2].

A common reason for failure is insufficient disinfection and proper cleaning of the root canals, due to which the remaining bacteria in the endodontic space subsequently generate inflammation. Among the pathogens that induce secondary infection, the largest number of Enterococcus Faecalis, Gram-positive, facultative anaerobic bacteria have been detected [15, 16].

To perform a successful root canal treatment, mechanical and chemical cleaning is essential. Removal of tissue debris by mechanical cleaning, a space for irrigants is created so that these can develop their effect. Therefore, various microorganisms and their endotoxins are removed from the endodontic space. For this reason, cleaning and shaping are inseparable from each other [17].

In practice, it is impossible to implement 100% cleaning of the root canal system exclusively by using irrigation, which is why many doctors use adjuvants together with the irrigants to achieve even greater disinfection. One of these methods is laser disinfection, which can be done with several types of lasers. This is a simple and effective method due to its application, so many studies recommend diode laser treatments in combination with conventional irrigation [18, 19].

According to our results found in the three experimental groups, members of the sodium hypochlorite (2%) had the highest rate of bacterial mortality, 4 out of 5 media were germ free. Thus, on one medium 6 colonies grew after treatment. The presence of these few colonies suggests that it is likely that the other 4 teeth are also not considered sterile. If it had been possible to do without dilution, to extinguish the sample taken from the teeth more concentrated, then also on the other 4 media a low number of bacteria could have been detected. Though, at such a small amount of saline solution used, this was not possible. However, despite this, NaOCl was very effective in bacterial destruction, presenting more than 99% efficiency.

The antibacterial effect of citric acid (20%) - less studied in the literature - is not proved to be quite effective compared to NaOCl, but still destroyed the bacteria in 97.8%. Higher concentrations of citric acid are likely to be even more effective from an antibacterial point of view [11].

The diode laser used in only one session destroyed 72.7% of the bacteria inside the roots. This value is similar to the results of other studies. Other studies also mention that the combined use of laser and NaOCl can also show 100% disinfection of root canals [20-22]. However, when applying only laser treatment,

it is recommended to repeat it at least 2-3 times to achieve an adequate reduction in the number of bacteria [23-25].

In other similar studies, where one-off treatment was also used, the effectiveness of the laser turned out to be much better, occasionally even producing the complete elimination of the bacterial flora. In these cases, the lasers were set to higher power (2.5 W, 4 W) and the wavelength was also different [26].

Setting the right parameters is difficult and dangerous, because the surrounding soft and hard tissues can also be damaged by the laser if it is not properly calibrated. Currently, there is still no agreement on the optimal parameters.

Conclusions

1. The diode laser used for disinfection under the mentioned settings is not effective enough, but as an adjuvant, associated with conventional irrigation effective disinfection can be obtained.

2. Citric acid irrigation is recommended for smear layer removal, but its antibacterial effect prevails also during treatment.

3. When used alone, sodium hypochlorite irrigation still has the highest antibacterial effect.

Conflict of interest: None declared.

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ORIGINAL RESEARCH

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Comparative study on the degree of dental anxiety among adolescents/young adults versus middle-aged/senior adults.

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Abstract

Introduction: Dental anxiety is one of the most common diseases present in the global population. It induces aversion to dental procedures by causing a psychological response which misinterprets a dental stimulus as imminent danger. The purpose of this study was to analyze the degree of dental anxiety based on age groups, gender, background, but also on previous experiences, through a questionnaire distributed in different areas of Romania.

Materials and methods: A series of 14 questions relevant to the subjects was compiled in a questionnaire which was distributed to subjects of varying backgrounds. The questionnaire was formatted to allow the relevant drawing of conclusions from the collected data.

Results: 413 people responded to the questionnaire, of which 126 were women, 287 were men, 165 were from rural areas, and 248 were from urban areas. The age groups were divided in the following way: <35years, included adolescents/young adults, and >=35 years, included middle-aged adults/seniors.

Conclusions: It has been found that adolescents and young adults are more anxious than middle-aged adults and seniors, and that previous unpleasant experiences have left their mark on the patients' anxiety levels before the visit to the dentist.

Keywords: dental anxiety, dental fear, young adults.

Introduction

Dental anxiety can be defined as a general reaction on the part of the patient who feels a hold on the visit to the dentist or dental treatment, with the projection of negative events that might happen. This behavior may lead to the avoidance of presentation to the dental office, even if the patient is in pain [1,2].

Since it is such a common condition, it is considered imperative that dentists place more emphasis on this problem. It is estimated that about 20% of people have high levels of dental anxiety, and prior to appointments, about 40% patients experience anxiety [3,4].

Some authors suggest that dental anxiety may have both exogenous and endogenous origins. Exogenous types of anxiety are conditioned by the negative dental experiences of the past that the individual has had, and endogenous types of anxiety may be explained by the vulnerability and reactions a person has in relation to situations they perceive as dangerous [5].

The most common cause is considered to be the trauma resulting from experiences from the past, usually from childhood. A traumatic experience or a traumatized parent who induces fear in the child may initiate dental anxiety early in life [6,7].

Material and methods

A questionnaire containing 14 questions was designed to achieve the goal of the study. The questions were short, concise, easy to understand. The questionnaire was distributed in 3 counties of Romania. The responses were collected between November 1, 2021 and March 1, 2022. Anonymity and confidentiality were respected.

The first 4 questions were designed to provide information about age, gender, background, and the existence of a dentist they consult regularly. The following questions focused on the reasons for the presentation to the dentist and on how the patients feel in the dental office. The following questions focused on the previous complicated/painful experiences and their examples, on knowing the stages of treatment and how their mood was influenced after they were informed. The last 3 questions focused on improving patient-dentist relationships and influencing those

around them regarding the perception of the visit to the dentist.

Over 4 months, 413 responses were obtained that were analyzed to achieve the objective of the study.

Results

After collecting the results, 59.3% of the responses were those of people under the age of 35, in the adolescent/young adult category, and 40.7% were from people over the age of 35, in the middle-aged/senior adult category. (figure 1)

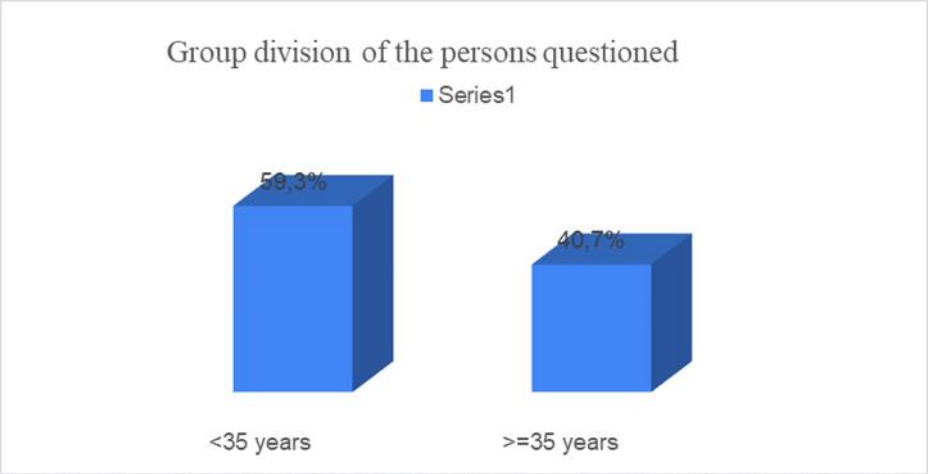

Figure 1. Group division of the persons questioned.

In terms of gender distribution, 69% women and 31% men answered, and depending on their background, 60% of the answers came from urban, and 40% from rural areas. Of all those surveyed, 61% stated they had a dentist they visited regularly, and 39% said they did not.

As for the reasons for the presentation to the dentist, 127 of those surveyed said that they presented when they noticed a cavity in one of the teeth, 106 said that they had regular check ups once a year, 70 at every 6 months. Of the respondents, 62 presented when analgesic medication was no longer effective, and 48 when a tooth was broken.

When asked about their feelings before entering the dentist's office, 17% said they felt anxious, 22% felt nervous, 18% experienced fear, 17% felt apprehensive, and 26% felt relaxed. (figure 2) Related to complicated or painful experiences in the past, 28% of those surveyed said they had experinced them, and 72% denied having had unpleasant experiences. (figure 3) The most common complications after dental treatment were: pain 34%, inflammation of the area 26.4%, local bleeding 12%, and 27.6% said they had no complications. Regarding the knowledge of the treatment stages, 373 stated that they were explained the steps of the treatment, and 40 others were not informed of the treatment plan. Of those who confirmed their knowledge of the treatment stages 293 said they felt calmer, 70 said they did not change their condition, and 10 said their fear increased.

Figure 2. The feelings patinets have before visiting the dental office.

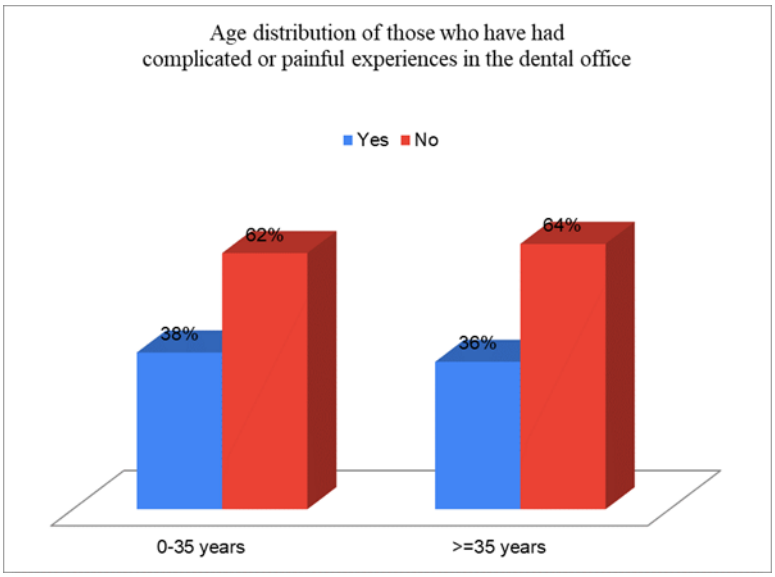

Figure 3. Age distribution of those who have had complicated or painful experiences.

From the point of view of the dentist-patient relationship, all the respondents stated that empathy and communication were factors that could positively influence the patient's condition and help them calm down.

It was observed that 67.3% of those surveyed were not influenced in any way by those around them before the visit to the dentist, 17.9% were reassured by encouragement, and 14.8% became more anxious.

Discussions

For this study, a total of 413 people, 245 adolescents/young adults and 168 middle-aged adults/seniors responded, including 287 women and 126 men.

Differences were observed among those who had a dentist they visited regularly according to the age category, namely 154 of adolescents and young adults regularly saw a physician, and 92 of middle-aged/senior adults confirmed that they had one. Of those who responded affirmatively, 52% belonged to the rural environment and 46% to the urban environment. Other studies have found no difference depending on the environment of origin regarding adherence to regular dentist appointments [4].

A total of 215 participants in the first age group responded that they had anxiety, nervousness, and fear prior to the visit to the dentist, while only 90 of those in the second age group reported such conditions associated

with the visit to the dentist. It was observed that 38% of adolescents and young adults surveyed had unpleasant or complicated dental practice experiences, and 36% of middle-aged adults/seniors experienced such situations. There are studies that show greater interest in oral health among people over 35, which may indicate lower levels of dental anxiety, while other studies have identified a correlation between age and dental anxiety. Moreover, in another study, it was observed that adolescents had higher anxiety levels than older people, and a different study of adolescents found that girls were more anxious than boys [4,8,9,10,11].

Another study supported the idea that people with high anxiety levels experienced painful or unpleasant experiences in their history, changing their expectations about future dental treatments, associating the visit to the dentist with an unpleasant, painful, and stressful event. Additionally, it has been shown that dental anxiety is not linked to the type of dental treatment performed be it either surgical, prosthetic, or endodontic [12,13].

A different study emphasizes the positive impact of knowing the stages of treatment on the patient's anxiety, helping them feel safe and calm, without any differences in age groups. In this study, much of the adolescents/young adults and middle-aged adults/seniors who were surveyed confirmed that after knowing the treatment stages they felt more peaceful and their anxiety reduced, however, some patients reported that their anxiety increased. The few people who claimed that dental anxiety intensified after talking with the dentist belonged to the adolescents/young adults' category [14].

The study showed that the level of dental anxiety is higher in women compared to men, and there are other studies that support the same. Moreover, it is known that women express their feelings much more easily, and men face social norms that do not allow such free expression [1,15,16].

Thus, we can say that regardless of age, it is important to inform the patient at every stage of work, and to express empathy and patience. Other studies have argued the same thing, namely that communication can reduce the level of dental anxiety and thus create an effective dentist-patient relationship. There are studies that have focused on other methods of reducing dental anxiety, such as: background music, breathing breaks, distracting discussions, freedom of free expression of emotions [17,18].

Conclusions

Adolescents/young adults have a higher level of dental anxiety than middle-aged adults/seniors, the first category being easier to influence by those around them, the state of fear and anxiety being more easily induced.

Dental anxiety causes most people to see their dentist only when they have a problem, avoiding regular visits that could prevent cavities, gingivitis or periodontitis.

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CASE REPORT

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Digital workflow in pediatric dentistry. A case report.

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Abstract
Introduction. This study aims to discuss the diagnosis, treatment plan, and results from the esthetic point of view and the patient's adaptability and acceptability of prosthetic and orthodontic restorations performed using CAD-CAM technology on the mandibular arch of a child patient.
Case presentation. A 6-year-old patient presented to our dental clinic, subjectively asymptomatic but desiring to improve her esthetic appearance and achieve oral health. She was diagnosed with caries of various sizes, simple as well as complicated, some teeth being therapeutically irrecoverable, others requiring endodontic treatments and extensive crown restorations. Thus, treating the mandibular arch teeth using esthetic materials and CAD-CAM technology was decided.
Conclusions. At the 6 months evaluation after cementing the prosthetic crown on tooth number 7.4 and 3 months after cementing the space maintainer on tooth number 8.5, the digitized fabricated pieces have increased esthetics, no cracks or other physical/mechanical damage appeared, and the patient, accepting them from the first day, is happy with their presence in the oral cavity.
Keywords: digital workflow, digitalization in pediatric dentistry, pedodontic crowns, individualized crowns.

Introduction

This study aims to discuss the diagnosis, treatment plan and results from an esthetic point of view and the patient's adaptability and acceptability of prosthetic and orthodontic restorations performed using CAD-CAM technology on the mandibular arch of a child patient.

Primary teeth are small and require retentive, esthetic restorations that are resistant to fracture and wear, making them difficult to treat. The main reasons for caries treatment failure in primary teeth are relapses, crown fractures, endodontic complications, and lack of restorations [1]. It is well known that restoring primary teeth with different dental materials is difficult, with quite high failure rates - up to 29.9% (for RMGIC) - at one year [1]. However, more and more effective treatment options are emerging to ensure adequate esthetics and retention of restorations in such cases [2]. It has been shown that the best method of restoration is a crown [1].

As digital technologies rapidly advance, there is always something new to learn from while redefining current trends in dentistry. Although digitalization is not a new concept in dentistry, it is only starting to be used in pediatric dentistry. The curiosity to explore and improve has led to the development of digitalization, which seems to have potential in pediatric dentistry due to the advantages of accuracy, convenience, and shortening of the time spent in the dental office. This workflow helps reduce fear and improve children's cooperation and enthusiasm for dental treatments [3].

Premature loss of a primary tooth is one of the causes of loss of space or dental arch length. When a primary tooth is lost prematurely, adjacent teeth migrate into the edentulous space, leading to dental crowding and other dental malocclusions. Various researchers have developed several devices to manage the space in case of early loss of a deciduous tooth [4]. Space maintenance concepts have been developed, and more recently, these are being produced digitally. These devices, known as "Digital Space Maintainers", use CAD-CAM or 3D printing technology together with modern, biocompatible materials to solve the challenges and drawbacks encountered in traditional manufacturing [5]. The CAD-CAM method

can virtually design and machinate restorations on an automated milling machine [6].

Typically, prosthetic/orthodontic parts are produced in a dental laboratory. The CAD-CAM process starts with a traditional impression made by the dentist, which is then converted to digital format in the lab [7]. Sirona introduced the first chairside CAD-CAM technology, the CEREC system, which allows the dentist to scan, design, and fabricate restorations directly in the dental office [8].

Case presentation

The current study presents the case of a 6-year-old patient who presented to the dental clinic with multiple carious lesions on her primary teeth. She had no dental pain, but after clinical and radiographic examination, teeth number 5.4, 5.5, 6.4, 6.5, and 8.4 were found to be therapeutically unrecoverable, with pathological root resorption and/or untreatable coronal destruction, the dental diagnosis being deep acute occlusal-proximal caries complicated with apical periodontitis. Also, 7.4 shows a deep acute disto-occlusal decay complicated with total chronic pulpitis with a closed pulp chamber. Endodontic and prosthetic treatment of the tooth was decided. Teeth 7.5 and 8.5, on examination, were diagnosed with deep, simple, occluso-proximal caries and incipient cervical caries.

Behaviorally, the patient met the specific cooperation criteria 3+ on the Frankl scale.

Prior to the implementation of treatment, the patient was instructed regarding hygiene and diet, the use of toothpaste with 1450 particles per million of Fluoride, and regular professional fluoridations for remineralization of the affected teeth (especially superficial caries at the cervical level of the 2nd primary molars) was recommended.

The following treatment plan was decided, in this order, taking into account the patient's adaptability to the evolution of the treatment difficulty, the order of exfoliation of the primary teeth (prioritizing the symptomatic teeth, which will be exfoliated last, then those with the possibility and indication of treatment, the last being the teeth that are irrecoverable from a therapeutic point of view): obturation of the mandibular 2nd molars, endodontic treatment of teeth with pulp involvement and their coronal restoration, extraction of irrecoverable teeth and ortho-prosthetic treatment of the edentulous space. Permanent 1st molars erupted during treatment and it was recommended to have them sealed for carious preventive purposes.

1. Digitized prosthetic restoration of a primary tooth

As mentioned above, tooth 7.4 is affected by deep, acute disto-occlusal caries. The tooth is in developmental stage II, a mature tooth with no visible root resorption. Differential diagnosis of caries of the first primary molar was made with deep, simple caries and deep caries complicated with apical periodontitis. Since vitality tests in children are irrelevant due to their subjectivity and non-differentiation of pain complaints, it was decided to diagnose the tooth positively during treatment. Cleaning the carious process, the pulp chamber was reached, where the vital and inflamed pulp was observed. Due to the lack of symptomatology at the time of the patient's presentation to the office or history and the signs observed in the tooth, the diagnosis of acute, deep disto-occlusal caries complicated with chronic pulpitis with closed pulp chamber was made. Endodontic and prosthetic treatment of the tooth was decided.

Endodontic treatment was performed using dam isolation, mechanical-antiseptic treatment with 21mm manual Kerr and Hedstrom files, 2% taper and 16mm rotary Kerr files (AF Baby rotary, FANTA), 4% taper, sodium hypochlorite 2%, EDTA 17% gel and saline. Root canals were filled with calcium iodoform in the commercial form of Forendo Paste, and Equia Forte HT was used for the coronal filling (figure 1).

In a separate session, tooth 7.4 was prepared with a 1.5 mm tangential shoulderless preparation, and a digital impression using the CEREC Primescan AC with CEREC Software Sirona intraoral scanner was performed. The crown was milled from Cerasmart to CAD-CAM (figure 2). Due to the isolation conditions and the need to limit the cementing time to preserve the patient's cooperation, it

was decided to cement the pedodontics crown using the glassionomer Fuji Plus (figure 3).

Figure 1. Appearance of tooth 7.4 following endodontic treatment and tangential tooth preparation.

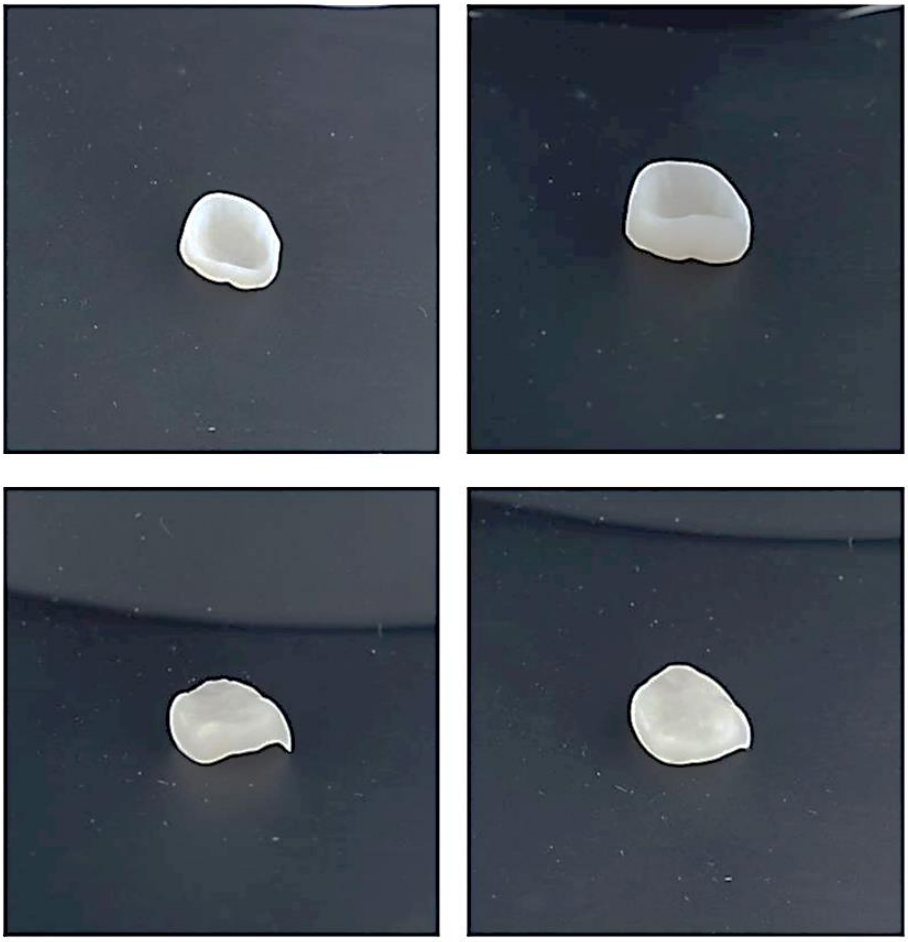

Figure 2. Esthetic appearance and crown thickness before cementation, different angles.

Figure 3. Crown appearance immediately after cementing.

The treatment was evaluated for symptoms and signs 3 and 6 months after the procedure. The patient experienced no painful symptoms at 7.4 following treatment and during the 6 months (figure 4). No fistula, abscess, or other sign indicating pathological tooth relapse was observed. The dental crown does not present cracks or fractures. As for the appearance and outcome of the treatment, both the patient and we, the authors of the study, consider the treatment a success so far. Thus, the current individualized pedodontics crown is at least as effective as a preformed one, but its individuality gives it a more esthetic and natural appearance than a preformed zirconia crown. However, from a hygiene maintenance point of view, the patient shows plaque-induced gingivitis at the time of the check-up, dental hygiene improvement did not occur during or after the treatment, and the material, although hybrid ceramic, retains plaque.

Figure 4. Appearance of the cemented crown on tooth number 7.4, 3-6 months after cementation. A and B - smile appearance, 3 months after crown cementation.
C and D – appearance of the crown on tooth 7.5, 6 months after crown cementation.

2. Preservation of esthetics and space by fixed, esthetic, digitized space maintainer

The diagnosis for tooth number 8.5 was deep D-O caries complicated with apical periodontitis. The tooth was in stage 3, showing pathological resorption predominantly in the distal root. The differential diagnosis was made with simple caries and complicated caries with chronic pulpitis, but the radiological appearance, the presence of the gingival lesion, the absence of vitality in the pulp chamber, and the discharge of secretion specific to purulent infection during endodontic drainage led to the conclusion of the above positive diagnosis.

Initially, stabilization of the condition was attempted by endodontic drainage with hydrogen peroxide, then saline. Following drainage, a mixture of antibiotics (ciprofloxacin, metronidazole, and doxycycline in a ratio of 1:3:3) was applied to the pulp chamber as local antibiotic therapy, filled with glassionomer (Equia Forte HT), treatment was maintained for 1 month. Following treatment, the dental abscess disappeared, and extraction could be performed (figure 5).

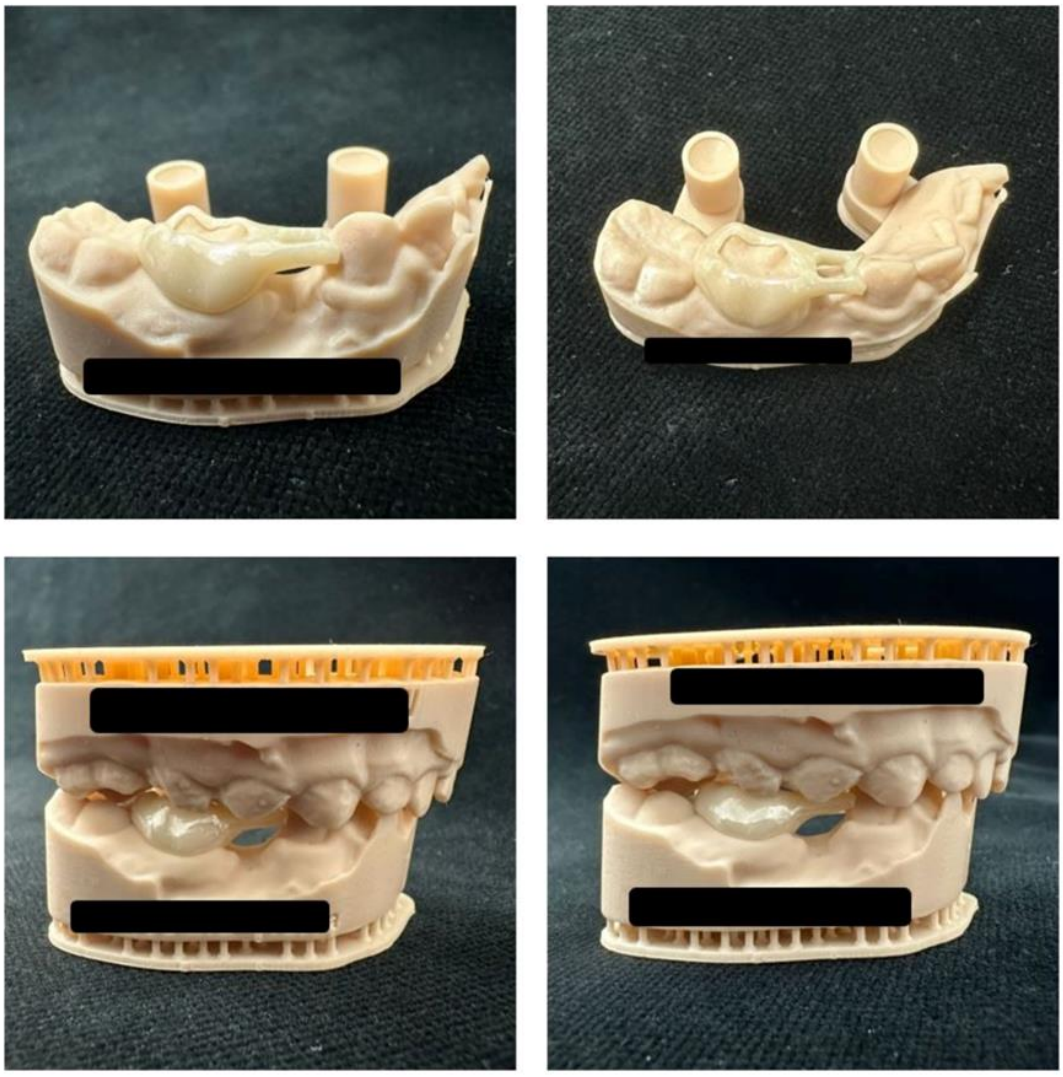

Figure 5. The appearance of the space maintainer on the digitally printed model.

For the same reasons listed above for the cementing of the crown on tooth number 7.4, but also because the space maintainer will require debonding at the time of the eruption of premolar 4.4, it was decided to cement the maintainer with glassionomer (Fuji Plus) (figure 6).

Figure 6. Clinical appearance of the space maintainer immediately after cementing.

The space maintainer was inspected 3 months after cementing (figure 7). The patient adapted to the situation very easily, and the space maintainer was unaffected esthetically or functionally. However, although the permanent 1st molar is still erupting, it requires follow-up so that the thickness of the space maintainer does not affect/block its eruption.

Figure 7. Clinical appearance of the space maintainer 3 months after cementing.

Discussions

Applying prefabricated metal crowns (SSC) is the preferred method of treatment of primary molars, with a success rate of about 96% [3]. Prefabricated zirconium oxide crowns are also used, which, although esthetically pleasing, have some important disadvantages: they require a greater sacrifice of hard substance, and according to the VICKERS classification, their hardness is 3 times higher than that of the enamel of primary teeth (900mpa vs 350 mpa), thus abbrazing the antagonists, and their adaptation in the patient's oral cavity is often difficult [3]. We fabricated a Cerasmart (hybrid ceramic) crown and a Zirconium Oxide space maintainer, taking into consideration that the patient's antagonistic natural teeth were therapeutically unrecoverable. Thus, although digital impressions were also made at the level of the

antagonist arch and occlusion, due to maxillary coronal destruction, no occlusion/occlusal adaptation problems of the prosthetic devices occurred. However, it is intended to perform the treatment of the maxillary teeth as well, and this treatment plan will be made and implemented together with the orthodontic department of the dental clinic. In this respect, it will be necessary to consider the hardness of the materials used at the mandibular level.

Kist S. et al. simulated masticatory forces in several pedodontic, preformed, individualized CAD-CAM crowns made of different materials and concluded that the aging of materials had a significant influence on preformed crowns, and except for the Kinder Krowns, preformed zirconium oxide crowns and those produced at CAD-CAM were not affected in this respect. The reasons for failure were fatigue cracks or holes on the occlusal surface. However, their study proved that the differences in resistance to masticatory forces between the materials were insignificant and of no clinical importance [9].

Despite the technological ease, survivability and successful outcomes of CAD-CAM technology, it requires long-term study, with current studies not yet reaching a common agreement on these issues. Rodrigues et al., through a meta-analysis, concluded that the longevity of a ceramic prosthesis fabricated by CAD-CAM may be less than that of conventional crown fabrication [10]. Almukhlis et al., through their retrospective study, observed that the success rates of CAD-CAM versus conventionally fabricated restorations may not be significantly different [11]. Papadiochou S. et al state that the existing scientific evidence does not allow concluding on the superiority of CAD-CAM over conventional crown fabrication technique in relation to marginal fit. They consider that the restorative material influences the marginal fit and the performance of the CAD-CAM system [12].

Compared to metal, preformed, or conventionally fabricated space maintainers in the dental laboratory, ceramic ones produced by CAD-CAM technology have several advantages: increased esthetics, reduced deformations, decreased errors produced by the human hand, low risk of fracture and disintegration (being produced in one piece), fast fabrication time, has a low bacterial and plaque retentivity, thus being suitable for young patients, who have poorer hygiene than adults and increased susceptibility to caries, the proof being the need for extraction of the primary tooth replaced by the space maintainer. Also, the lack of metal in the oral cavity means fewer allergic reactions, less weight, and less gum trauma [13,14,15].

However, CAD-CAM fabricated space maintainers also have disadvantages: they are financially expensive for both professionals and patients and require laboratory assistance and dental technician involvement and expertise in their fabrication [16].

Conclusions

Early loss of a deciduous tooth can lead to displacement of adjacent teeth, resulting in loss of space, dental crowding, and malocclusion.

The digital workflow in dentistry is continually evolving and revealing new techniques. Digitally fabricated devices are considered reliable and durable but comparable in physical and mechanical properties to conventionally produced devices. CAD-CAM technology eliminates time-consuming manual manufacturing steps, making it more suitable and interesting for children.

So far, we consider the treatment through a digitized workflow appropriate, effective, and successful for our patient. The patient is to be treated at the maxillary level as well and followed up by inviting her for regular check-ups, hygiene, and fluoridation every 3 months, having very high carioreceptivity.

Conflict of interest: None to declare.

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CASE REPORT

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Rehabilitation of anterior esthetics using CAD-CAM fabricated zirconia Maryland bridge. A case report.

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Abstract

Introduction: Missing anterior teeth have a great impact on the psychological status of an individual due to the unesthetic appearance. These can be restored using removable prostheses, conventional bridges, resin-bonded prostheses, or implants. A resin-bonded fixed prosthesis is a minimally invasive treatment option in such cases to restore function and esthetics.

Case Presentation: This case report describes the CAD-CAM zirconia Maryland bridge as a treatment modality for effective restoration of the missing maxillary central incisor in a 32-year-old female patient who reported the chief complaint of unesthetic appearance. The patient had a history of extraction due to trauma 6 months ago with normal overjet and overbite.

Discussion: One of the types of resin-bonded prosthesis is a Maryland bridge which involves minimal tooth preparation with supragingival margins, thus maintaining periodontal health. Maryland bridges enhance dental esthetics with minimal loss of tooth structure.

Conclusion: CAD-CAM fabricated all-ceramic resin-bonded prosthesis is an efficacious way of replacing missing anterior teeth, restoring function, providing excellent esthetics, and thus boosting patient's confidence.

Keywords: CAD-CAM zirconia, Maryland bridge, missing anterior tooth, resin-bonded fixed prosthesis, resin-bonded restoration.

Introduction

A missing anterior tooth does not only limit function, but also has a huge psychological impact on an individual, thus affecting his/her social life [1]. Various treatment options are available for restoring the missing anterior teeth including removable partial dentures, conventional fixed partial dentures, and implants. Implants are a better treatment option, but their placement depends on various factors including the amount of bone available, medical conditions, financial factors, and patient acceptance [2]. The long-term use of removable partial leads to bone resorption and conventional fixed partial dentures cause increased loss of tooth structure. In such cases, a resin-bonded fixed prosthesis provides a minimally invasive treatment option with excellent esthetics [3,4]. This case report describes the restoration of a missing maxillary central incisor with an all-ceramic Maryland bridge fabricated using CAD-CAM technology.

Clinical report

A 32-year-old female patient presented to the Department of Prosthodontics with the chief complaint of a missing upper central incisor and an unesthetic appearance due to the missing tooth. The patient gave a history of extraction due to the trauma 6 months ago and wanted replacement of the same. Intraoral examination revealed a missing right maxillary central incisor (figure 1) with normal overjet and overbite. The patient had a Class I molar relation. All the treatment options including implant, conventional fixed dental prosthesis, removable partial denture, and resin-bonded bridges were given to the patient. The patient wanted a minimally invasive fixed treatment option hence, resin bonded prosthesis was planned.

Figure 1. Pre-rehabilitative intra-oral view.

Procedure

Diagnostic impressions of the maxillary and the mandibular arch were made. Diagnostic casts were obtained and the wax-up for the missing tooth was done. The lingual surfaces of the right lateral incisor (12) and left central incisor (21) were prepared with a supragingival chamfer finish line (figure 2a). The incisal end of the tooth preparation was kept 1mm cervical to the incisal edge. Gingiva retraction was done followed by the final impression made using single-step putty wash impression technique using addition silicone impression material (figure 2b). The prosthesis was designed using the Exocad software and milled in zirconia (figure 2c). The prosthesis was finished and polished (figure 2d).

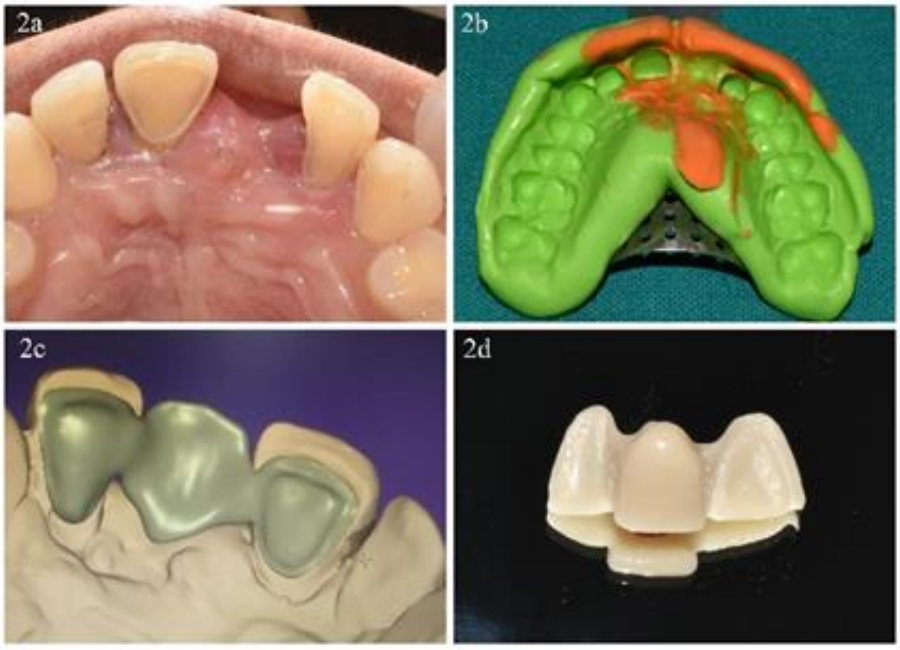

Figure 2. (a) Tooth preparation (12 and 21) (b) impression (c) digital designing of prosthesis (d) finished and polished prosthesis.

The prosthesis was etched with hydrofluoric acid (figure 3a) followed by rinsing with water and air drying. The teeth were simultaneously etched with 37% phosphoric acid (figure 3b). A silane coupling agent (figure 3c) was applied to the prosthesis followed by the application of a bonding agent (figure 3d) on both the prosthesis as well as teeth. The prosthesis was looted using resin cement (figures 3e and f), the occlusion was assessed, and post-cementation instructions were given to the patient.

The patient was kept on follow-up at regular intervals and she was satisfied with the result (figures 4a and b).

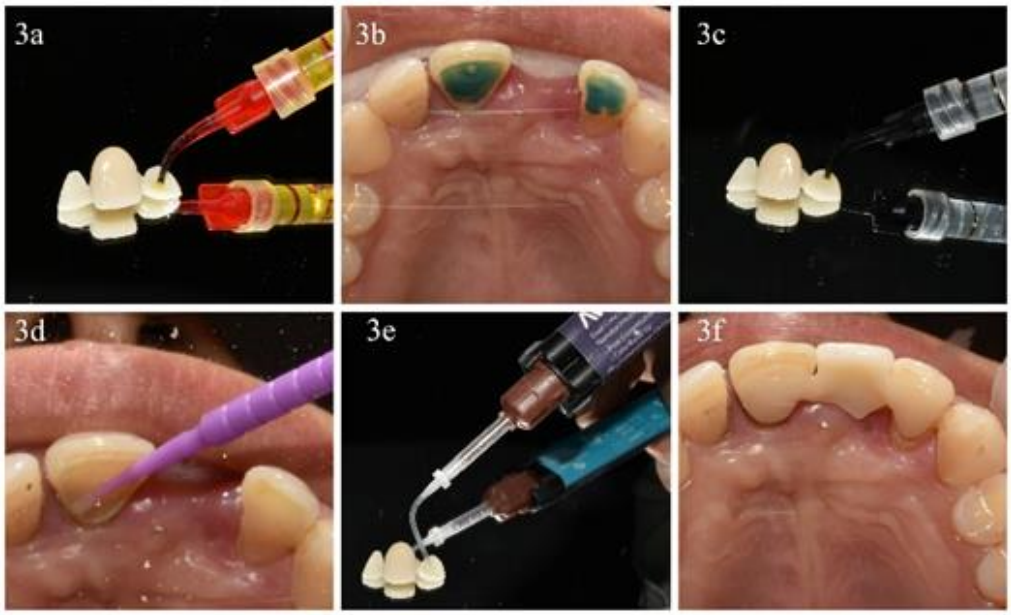

Figure 3. (a) Etching of Maryland bridge with hydrofluoric acid (b) etching of teeth with phosphoric acid (c) application of silane coupling agent (d) application of bonding agent (e) resin cement application (f) final prosthesis in situ.

Figure 4. (a) Pre-rehabilitative view (b) post-rehabilitative view.

Discussion

A number of conservative tooth replacement schemes have been developed to fulfill patients' esthetic needs. Two early prosthetic solutions for replacing missing incisors are the removable partial denture and the three-unit conventional bridge. Although the former can provide adequate esthetics and function, many patients dislike the bulkiness and maintenance of a removable appliance and the discomfort experienced in wearing it. Three-unit bridges avoid these problems. However, they cause increased loss of tooth structure [5].

Resin bonded prosthesis is a minimally invasive treatment modality and a substitute for conventional fixed partial prosthesis requiring minimal tooth preparation used

mainly for missing single anterior teeth [3]. The Maryland bridge is a type of resin-bonded prosthesis developed at the University of Maryland, that requires a minimal amount of tooth preparation restricted to the enamel only and is bonded directly to the tooth structure with the help of resin cement [3]. Maryland bridges have various advantages including minimal tooth preparation conserving the enamel, minimal pulpal trauma, decreased potential for gingival irritation, a single path of insertion preventing displacement, enhanced esthetics, patient satisfaction, and precludes the use of local anesthetic [6,7]. However, it also has certain disadvantages including its technique-sensitive application, debonding, caries, and discoloration [3,8-9]. The factors to be considered while case selection for Maryland bridge include: (a) adequate enamel thickness, (b) no severe rotation or mispositioning of abutment teeth, (c) periodontal conditions, (d) adequate occlusal clearance, and (e) parafunctional habits [1]. The all-ceramic veneer bridge consists of an all-ceramic pontic flanked by two veneer retainers that are attached to the abutment teeth. The all-ceramic bridge provides excellent esthetics, thus boosting the self-confidence of the patient [5].

The indications for Maryland bridge prosthesis include large pulp chambers in the abutments, expected transition in the position of the gingiva, and the age of the patient. However, the Maryland bridge is contraindicated in certain situations including more than one missing tooth in a row, the presence of parafunctional habits, deep bite, cavities in the abutment tooth, and crowded or proclined teeth [3].

Conclusions

CAD-CAM fabricated all-ceramic resin-bonded bridges are an efficacious way of replacing missing anterior teeth, restoring function, providing excellent esthetics, and boosting patient's confidence. Careful case selection, meticulous design planning, precise tooth preparation, and cementation can all lead to the long-term success of Maryland bridges. Hence, the Maryland bridge is an effective treatment modality to restore missing teeth in young patients.

Conflict of interest: None to declare.

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Definitive reports on a full study, describing original preclinical or clinical study (which is not a case presentation or a case series report) represent research of high scientific level and timeliness. A concise abstract of no more than 300 words is required. The abstract should briefly state the purpose of the research, the main results and major conclusions. An abstract is often presented separate from the article, so it must be able to stand alone. The manuscript should be written clearly and concisely. The authors are responsible for providing the correct nomenclature, which must be consistent and unambiguous. The text should be arranged in the following order: Introduction, Materials and Methods, Results, Discussion and Conclusions.

The length of the manuscript should be limited to 5000 words (including references, tables and figures).

Brief reports

Brief reports refer to articles presenting a short communication related to an original preclinical or clinical study which is not a case presentation or a case series report. While the structure of the abstract and of the full text should be detailed similar to that for full original articles, the length of the manuscript should be shorter, the abstract limited to 200 words and the full text (including references, tables and figures) to 2.000 words.

Letter to editor

A letter to the editor may refer to an article recently published by the journal, commenting on the article in a constructive professional manner the content of which, in the opinion of the author(s) would add the current status of knowledge in the field. If accepted, the letter will be sent to the authors of the original article who will have the opportunity to respond and to have their response published in the same journal issue as the letter to the editor. The letters should be limited to 500 words, 5 references and 3 authors. No abstract is required.

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Editorials should be limited to 3000 words (including references) and should be related to an article published in the current number or to a specific topic that is current and of high interest to the readers.

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The journal publishes state-of-the-art articles that aim to provide an update on the current status of areas of high interest to dental medical specialists. The main aim of such articles is to offer the specialist and other practitioners a source of continuous

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Peer review process

Submitted manuscripts are first checked to ensure that they comply with instructions to authors and are in accordance with the "Uniform Requirements for Manuscripts Submitted to Biomedical Journals", Annals of Internal Medicine, 1997,126, 36-47, and that all references, figures and tables meet the journal's requirements.

All manuscripts sent to the journal are routinely screened using specialized anti-plagiarism soft-wares. In all cases where any possible irregularity exists, the editorial office will follow the principles stated in COPE (Committee on publication ethics) guidelines.

Only manuscripts complying with the above requirements and free of possible irregularities, will be entered into the review process. The author(s) will be informed that the manuscript has been accepted for review.

Authors may suggest the names of potential reviewers and the Editor may choose, without obligation or explanation, to use one or more of these. Authors may also specify the names of a person(s) which they do not wish to review their manuscript, in which case a brief explanation should be given.

All articles will be reviewed by at least two peers with expertise in the manuscript's subject matter. The identities of the reviewers, chosen by the editor, will not be disclosed to the authors.

The average time from submission to a decision following the first review is approximately 4-6 weeks. Based on the reviewers' opinion, the Editor will choose one of the following alternatives:

- Accepted;
- Minor revisions required;
- Major revisions required;

In cases where revision is required, the author(s) will be invited to amend their manuscript, which should be resubmitted as soon as possible, but not later than 6 weeks. The revised manuscript will be reappraised by the initial reviewers and notification of a final decision will be sent to the author in approximately three weeks.

After acceptance and prior to publication, authors will receive a pdf file with the edited version of their manuscript for final proofreading and will be asked to carefully check the completeness and accuracy of the text, tables and figures.

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