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EDITORIAL

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Light technology potential in reducing secondary infections in the dental office.

Edwin Sever Bechir[1]

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In the current context of the exponential spread of the new coronavirus (SARS-CoV-2) and its associated disease globally, and also in Romania, we are faced with a growing concern in the way it affects us both in terms of public health as well as personally in the activity we carry out every day in our field of work.

Unfortunately, it seems that this pandemic will not end shortly, implicating that we will have to adapt to the new conditions and consider the current protocols as rules that will need to be applied from now on for an extended period of time. During this timeframe, a significant number of people will probably avoid dental treatments (excepting dental emergencies) both because of the way this pandemic affects us financially, but before all else for psychological reasons: it will be difficult for the patients to overcome their fear of falling victim to this novel virus. For many of these, the dental office is a potential source of infection, primarily considering that the person most exposed to this risk is the dentist himself [1].

Studies showed abundant presence of SARS-CoV-2 in the nasopharyngeal and salivary secretions of affected patients, and that it predominantly spreads through respiratory droplets [2]. The risk of transmission amongst medical workers has been documented and the risk of infection is higher in the case of dentists, dental assistants, oral and maxillofacial surgeons (with a risk of exposure within 95% to 100%) because of their constant work in close vicinity of aerosols and saliva droplets generated by the various procedures performed on patients.

This is the reason why dental office managers and especially doctors must constantly adjust and improve operating protocols to protect both the team members as well as the patients [3,4]. After performing dental procedures, the doctor often removes his mask to talk to the patient. Removing this protective barrier may prove to be a mistake because aerosols can remain in the air for up to 30 minutes thus increasing the potential of contact with contaminated material [5].

The current guidelines for dental practice are constantly evolving and mainly target a specific purpose, namely the diminution of the transmission risk of viruses and bacteria both amidst medical staff and patients as well as from one patient to another.

In addition to the use of standard precautions such as the use of protective barriers (masks, caps, gowns, visors, gloves, etc.), the disinfection of instruments and equipment, the use of substances that can reduce coronavirus infectivity (e.g. hydrogen peroxide in a concentration of 0.5% has proven effective when used in oral rinses for 1 minute), which represent the fundamental actions to minimize cross infections in the dental office, the use of lasers can play a major role in diminishing the risk of SARS-CoV-2 transmission by the very fact that they are not included in the list of sources that create aerosols [6,7].

The Centers for Disease Control and Prevention concluded that when practicing dentistry the risk of SARS-CoV-2 transmission during aerosol generating dental procedures cannot be eliminated, and recommended avoiding these procedures whenever possible [8].

According to Zemouri C, de Soet H, Crielaard W, Laheij A the aerosol sources in dental clinics are represented by: ultrasonic scalers, high speed hand pieces and the air and

water syringe from the dental unit [9].The water spray is an important factor in creating aerosols in the dental office, aerosols that can cause the transmission of pathogenic viruses.

The evolution of dental lasers currently allows us to perform a large number of procedures, including cavity preparation, periodontal procedures, restorations, crown lengthenings, frenectomies and many others while reducing the aerosols produced by conventional instruments.

Lasers have the advantage that they can be used for both soft and hard tissues either by using water and air spray or by stopping the water and air spray altogether. When working without water and air spray, the risks caused by aerosols in the spread of bacteria and viruses, including SARS-CoV-2, are considerably reduced while using lasers compared to conventional rotary instruments.

The mechanical way of cutting with the high speed drills causes a spread of dental tissue residue outside the oral cavity that can contain bacteria and viruses with harmful potential. Lasers, on the other hand, perform the ablation of small areas of dental tissue, causing a reduced spread of tissue debris outside the oral cavity. At the same time, these lasers have an antimicrobial capacity, thus significantly reducing the risk of infection. In this context, lasers should become an essential tool in our daily practice considering they allow a way to minimize the production of aerosols and water and saliva droplets therefore reducing the risk of SARS-CoV-2 infection [7].

The constant evolution in light technology proved the therapeutic effects of different light spectra, particularly violet/blue, red and near infrared light. Studies have shown that light in the range of 400–470 nm (blue light) has an antimicrobial effect against a number of bacteria and it can potentially reduce bacterial suprainfections associated with SARS-CoV-2 and other coronavirus infections. Additionally, wavelengths in the approximate range of 600–700 nm and 700–1000 nm (red and near infrared light respectively), have the ability to reduce pulmonary inflammation and fibrosis, and therefore acute respiratory distress syndrome, which represents a leading cause of death in the existing SARS-CoV-2 pandemic. Also, studies provide convincing grounds to investigate the promising effects of several spectra of light in decreasing opportunistic bacterial infections associated with this condition, and their potential use in suppressing SARS-CoV-2 and other viral infections [10].

Lastly, given the existing context, lasers should be considered an option that is safer than the high speed handpieces for both dentists and their patients, offering them state-of-the-art treatments, in a considerably safer setting, with fewer risks and a greater peace of mind.

Conflict of interest: None to declare.

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REVIEW

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Endo-perio lesions: diagnosis and interdisciplinary treatment options.

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Abstract

About 50% of tooth loss is caused by either endodontic infection, periodontal disease or the combination of the two in the form on endo-perio lesions (EPL). Combined EPL develop due to the intimate anatomic and functional relation between endodontic and periodontal tissues. Both the pulp and periodontium share the same embryologic and anatomic origin. The various pathways connecting the two, added up to the extremely alike microorganisms in both illnesses' etiology, create a complex condition in which interdisciplinary approach is required. Despite numerous decades of literature describing these lesions, they remain a continuous challenge for practitioners in both diagnosing and managing. The purpose of this article is to present a comprehensive review of various aspects of the combined EPL and to emphasize the importance of making a correct diagnosis and adopting the appropriate treatment method in the management of these challenging situations.

Keywords:endo-perio lesions, periodontal disease, diagnosis, treatment.

Introduction

The complexity of endo-perio lesions (EPL) reflects the close interrelationship between the periodontium and the endodontic system. A review of current literature was commenced in order to debate the intricacy of the endo-periodontal anatomic and pathologic communication avenues. PubMed online research was conducted in order to identify articles regarding this subject using the keywords "endo-perio lesion", "endodontic infection" and "periodontal disease". Manual searches of published articles and related reviews were performed as well for completing the research necessary in writing this paper.

The „EPL" term was first introduced in the American Association of Endodontics' Glossary of Endodontic Terms in 1998, followed closely by the American Academy of Periodontology, which defined the lesion to be a localized infection original from the periodontal or pulp tissue [1]. Both endodontic and periodontal lesions are polymicrobial anaerobic infections. The combined EPL disease is caused by simultaneous inflammation in varying degrees of the endodontic system and periodontium. Etiologic components of predominantly bacterial origin, as well as other factors such as dental malformations, history of trauma, iatrogenic perforations, and external or internal root resorptions have their part in the progression of EPL [2]. The presence of active carious lesions, furcation involvement, anatomical grooves, and porcelain fused to metal crowns are considered risk factors in the occurrence of EPL. In patients presenting with periodontitis, EPL usually shows no evident symptoms and has slow, chronic progression [3].

Pathways

The strong connection between the endodontic system and the periodontium has always been known to be the main cause of combined EPL. There are many pathways that benefit the exchange of infectious elements from the pulp to the periodontium and vice versa. These, combined with the existence of mixed anaerobic microbiota, lead to the development of EPL [4]. The anatomic, embryologic and functional relation amongst the two distinct anatomical areas has been widely researched as it is difficult to make a differential diagnosis between periodontal and endodontic diseases more so when the lesion combines both etiologies [5].

Anatomically, the periodontal tissue and the endodontic system are connected by the apical foramina and lateral canals. These two types of tissues can connect through the

apical foramen particularly if the periodontal socket is so deep that it reaches beyond the apical third of the tooth. Lateral canals, on the other hand, serve as a more accessible path for microorganism to migrate from one tissue to another, as they can be found all along the root surface, unlike the apical foramina. Their presence ensures a better vascular exchange than the blood vessels passing through the apical foramina. Therefore, exchange of nutrients, inflammation byproducts and bacteria are possible through these small accessory canals. The mesodermal origin of both pulpal and periodontal tissues ensures the anatomical bond between the two [6, 7].

As far as the functional relation of the two systems is concerned, an endodontic infection can discharge through the periodontal ligament and worsen the periodontal disease by raising the pocket's depth. An endodontic infection can also cause periodontal tissue destruction in the apical region which can likely migrate upwards reaching the gingival margin [8]. This lesion was termed as a retrograde periodontitis which is different from marginal periodontitis as the last-mentioned proceeds from the gingival margin towards the apical region. Reversely, microorganisms and other toxic irritants can enter the endodontic system through dentinal tubules after the gradual loss of the periodontal attachment. Given that in both endodontic and periodontal disease, the live pathogens encountered are similar (Campylobacter rectus, Actinobaccillus actinomycetemcomitans, Tanerella forsythensia, Eikenella corodens, Fusobacterium nucleatum, Porphyromonas gingivalis, Prevotella intermedia and Treponema denticola), the common etiology of endo-periodontal lesions in explained [9, 10].

Iatrogenic pathways which can cause combined EPL include accidental perforations of the root during endodontic treatment, root cracks as a result of extreme forces applied when cleaning and shaping the root canals, carious lesions affecting the external root surface below the cementoenamel junction, and incorrectly adapted coronal restorations [11].

Classification system

According the latest classification of periodontal conditions, combined EPL are included in the "periodontal manifestations of systemic diseases and developmental and acquired conditions" section and "other periodontal conditions" subsection [12]. EPL are classified after their etiology and diagnosis. Simon et al introduced the first classification which describes five types of existing EPLs:

1. Primary endodontic lesions
2. Primary endodontic lesions with secondary periodontal involvement
3. Primary periodontal lesions
4. Primary periodontal lesions with secondary endodontic involvement
5. True combined lesions [13]

Primary endodontic lesions are described as acute exacerbation of chronic apical lesions with continuous necrotic discharge into the gingival sulcus through the periodontal ligament [14]. These teeth usually present some sort of restorative fillings, caries or trauma in their history. They do not respond to vitality tests and radiolucency can be observed in the apical region. Also, the symptoms such as pain, swelling, tenderness to percussion, and tooth mobility indicate a pulpal illness rather than a periodontal abscess, especially when a sinus tract appears. For the differential diagnosis, a gutta-percha point introduced in the opening of the sinus tract can be helpful [15]. Furthermore, primary endodontic lesions usually heal after a thorough endodontic treatment unlike EPL which require both endodontic and periodontal therapy.

Primary periodontal lesions are the result of progressive marginal periodontitis. The periodontal disease initiates at the marginal gingiva and may advance to the supportive periodontal tissue when its management is delayed. In severe cases, when both soft and hard supportive tissues are destroyed, periodontal abscess can occur, resembling the symptoms of a pulpal disease. Occlusal trauma can worsen the clinical picture by increasing the probing depth around the damaged tooth. Primary periodontal lesions only require periodontal treatment as in most cases, the tooth still responds to vitality tests. The positive outcome of the treatment is

lower than the success rate of endodontic treatment on primary endodontic lesions, revolving around several factors such as the severity of the periodontal disease, the efficiency of the treatment, and the patient's response to the therapy [16].

True combined lesions are the concomitance of a pulpal necrosis and periodontal disease which begin independently on the same tooth. According to current knowledge, these kinds of lesions occur less frequently than other endodontic or periodontal illnesses. The necrotic pulp which causes an apical periodontitis is slowly progressing apically where it joins the existing bone resorption caused by the existence of a periodontal pocket [17]. The radiographic aspect of these lesions can simulate a root fracture in which cases differential diagnosis is important so the management method can be chosen correctly.

Diagnosis

As far as primary endodontic and periodontal lesions are concerned, the diagnosis is simple. In primary endodontic diseases, the tooth does not respond to vitality tests as it is infected and nonvital while in primary periodontal lesions, the pulp is responsive to thermal and electric tests. Nonetheless, true combined lesions or primary endodontic lesions with secondary periodontal involvement, or primary periodontal lesions with secondary endodontic involvement are similar both clinically and radiographically. A proper diagnosis can be made by meticulous clinical examination followed by tests such as radiographs, pulp vitality testing, pocket probing, fistula tracking, and cracked tooth testing as described in Table 1 [18, 19].

Table 1. Diagnostic examinations used to classify EPL adapted from Parolia et al 2013

Test	Primary endodontic lesion	Primary periodontal lesion	Primary endodontic secondary periodontal	Primary periodontal secondary endodontic	True combined lesions
Visual	Presence of decay/ incorrect restorations/ erosion/ abrasion	Inflammation/ recession of gingiva Presence of plaque/ calculus Intact teeth	Plaque/ calculus at the gingival margin Root perforation/ fracture	Plaque/ calculus And swelling around multiple teeth Puss + exudate	Periodontitis around single or multiple teeth Puss + exudate
Pain	Sharp	Usually dull ache	Usually sharp	Usually dull ache	Usually dull ache, sharp only in acute condition
Palpation	Not conclusive	Pain on palpation	Pain on palpation	Pain on palpation	Pain on palpation
Percussion	Normally tender	Tender on percussion	Tender on percussion	Tender on percussion	Tender on percussion
Mobility	Present only in fractured or traumatized teeth	Localized/ generalized mobility	Localized mobility	Generalized mobility	Generalized Higher grade mobility on involved tooth
Pulp vitality	Lingering or no response	Positive	Negative	Positive	Usually negative
Pocket probing	Solitary narrow pocket	Multiple wide and deep pockets	Solitary wide pocket	Multiple wide and deep pockets	Typical conic periodontal type of probing
Sinus tracing	Radiograph with gutta-percha points to	At lateral aspect of the root	Mainly at the apex/ furcation area	At lateral aspect of the root	Difficult to trace

	apex/furcation				
X-rays	Periapical radiolucency	Vertical bone loss Wider bone loss coronally	Wide based apical radiolucency	Angular bone loss in multiple teeth	Similar to a vertically fractured tooth
Cracked tooth testing	Painful when chewing	No symptoms	Painful when chewing	No symptoms	Painful when chewing

Treatment options

The chosen management method and prognostic of EPL are based upon correct diagnosis. The most important factors which should be taken into consideration when selecting a treatment technique are the vitality of the pulp and extent of the periodontal defect.

Primary endodontic lesions usually heal after a correct endodontic treatment. The prognosis is generally a good one especially if during cleaning and shaping of the root canals, the irrigation protocol was thoroughly performed [20]. The sinus tract will retract in the early stages of the root canal treatment, after the infected pulp is removed. Intracanal medicaments based on calcium-hydroxide are a crucial step of the endodontic treatment, especially in case of large periapical lesions due to its bactericidal and disinfecting properties.

Primary periodontal lesions only require periodontal therapy. Treatment options include etiologic therapy by eliminating all factors which can induce or promote epithelial downgrowth followed by surgical periodontics [21].

True combined lesions demand both endodontic and periodontal regenerative procedures. Without this interdisciplinary treatment method, there will be no satisfactory prognosis, with the success rate dropping to 27-37% as the study conducted by Oh et al reported [22]. As a first step, true combined lesions should be addressed with an endodontic treatment. Before any periodontal surgical procedure, etiologic therapy should be initiated as the prognostic of these combined lesions is closely related to the efficiency of the periodontal management [23]. However, apical resection, root amputation or even hemisection of the molar teeth may allow enough change in the configuration of the roots in order for part of the root structure to be saved. The clinician must contemplate on multiple factors such as dental restorability, recovery of bone support around the remaining, healthy root, and last but not least, the patient's consent. Prognosis of an affected tooth can also be improved by increasing bone support around the denuded cement surface, achieved through bone grafting and guided tissue regeneration (GTR). These regenerative treatment techniques, performed by using the operating microscope, have reported a success rate of 77.5% as Kim et al established [24, 25].

Conclusions

EPL can be a challenge to doctors as interdisciplinary collaboration is needed in order to obtain a favourable outcome. Due to the lack of current literature documenting these multi-factorial illnesses, the first step of diagnosis can be challenging. Thus, this review's purpose is to highlight the current diagnostic and treatment planning strategies. As this paper shows, the diagnostic should be conducted by conscientiously following all clinical examination tests in order to correctly classify the lesion. Only by careful diagnosis can the most effective therapy method be selected and the succes rate increased. The guidelines to a precise treatment method are straightforward once the lesion is cathegorized properly.

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ORIGINAL RESEARCH

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Self-reported tooth and implant prognosis evaluation based on radiographic bone loss: a cross sectional study.

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Abstract

Introduction: Tooth prognosis evaluation involves continual assessments to guide patient-centered treatment plans. This means that the tooth prognosis may dictate whether a tooth is restored, extracted, or maintained.

Aim of study: The aim of this work was to evaluate current trends in tooth prognosis evaluation based on radiographic bone loss amongst dental practitioners.

Material and Methods: A survey including demographic questions and ten radiographs (vertical bitewings or peri-apical) showing bone loss around teeth and implants were distributed to dental practitioners. Practitioners were asked to determine the prognosis of the tooth or implant and suggest a percentage describing the likelihood of the tooth or implant surviving for ten years.

Results: One of the ten radiographs provided for assessment was given good to fair prognosis by 100% of the participants. Only three out of the ten radiographs presented had strong suggestions for tooth retention. Recommendation for extraction by dental practitioners varied from 1-66% across the radiographs. Furthermore, practitioners predicted a 0% chance of ten-year survival for many of the teeth.

Conclusions: Assessing prognosis based on radiographs only, is insufficient and clinical data provides invaluable information to establishing tooth prognosis. Dental professionals should understand that compromised teeth can outlive dental implants and our role as dental professionals is to prevent and treat oral diseases to preserve the dentition as long as possible.

Keywords: periodontitis, plaque, prevention, peri-implantitis.

Introduction

Tooth prognosis is arguably one of the most important evaluations in dentistry. Tooth prognosis uses assessments to predict the longevity of a tooth [1,2]. The purpose of this evaluation is to guide treatment planning such as extractions, restorations, and periodontal therapy. Unfortunately, incorrectly evaluating tooth prognosis can lead to several downstream consequences. Such consequences include increased cost for the patient as treatment plans change and oral hygiene is challenged when plaque retentive restorations are suggested, such as bridges or partial dentures. Therefore, it is important that tooth prognosis is accurately evaluated on a continuous basis to limit these downstream consequences as some patient risk factors can be modified and preventative maintenance can have a strong influence [3, 4].

In regard to periodontal disease, several prognostic tools have been suggested in the literature [5,6]. A commonly used one is the McGuire and Nunn Classification [6]. This specific tool guides practitioners to classify each tooth as good, fair, poor, questionable, or hopeless [6]. These classifications are based on assessments such as furcation involvement, crown to root ratios, mobility, clinical attachment loss and bone loss [6]. Such tools are developed to guide the practitioner to provide evidence-based treatment plans for the patient. However, although teeth may be labelled with hopeless prognosis based on existing prognostic tools, this does not always mean the tooth cannot survive any longer and needs to be extracted immediately. The success of proper periodontal treatment followed by supportive periodontal therapy should not be overlooked. Patients with poor tooth prognosis are shown to maintain their teeth for long periods of time if they are compliant with supportive periodontal therapy [7-10]. This finding highlights the lack of fully validated methods for tooth prognosis. This lack of accurate prognostic tools may be related to the

growing concern that practitioners are too focussed on "fixing" problems caused by dental diseases instead of concentrating on preventing them [11]. This has been evidenced by patient complaints of over-servicing by dental practitioners [12-16]. The emphasis on teaching technical skills versus an in depth understanding of dental disease during dental training may be the underlying cause of practitioners' tendency to "fix" instead of "cure" or manage the disease [12, 17]. Furthermore, the rapid development of the dental implant industry may be making the decision to extract teeth easier [12]. Therefore, it is important to assess how practitioners are establishing prognosis in order to eventually improve treatment planning and dental education in the future.

Despite the popularity of dental implants, there is increasing literature developing around the prevalence of peri-implantitis and dental implant failure [18]. As a logical follow-up to this, ethical dilemmas in dental implant treatment are rising [12,17]. Gross et al. highlight ethical parameters that should be considered in dental implantology to ensure responsible treatment of diseased implants and the prevention of dental implant failure [12]. Such parameters include a critical self-assessment of the dental practitioner's skills and knowledge as well as a thorough evaluation of the indications for dental implants in order to ensure all other treatment options are exhausted first [12]. Gross et al. also discussed the importance of patient compliance and responsibility in dental implant treatment as well as emphasizing after care for dental implant patients [12]. Not only are these important evaluations for dental implant planning, but for establishing prognosis of natural teeth as well.

Dental implants are not risk-free options, yet, tooth retention seems to be a decreasing priority among dental practitioners [7, 19, 20]. Tooth prognoses is sometimes undervalued and as a result, tooth extractions can happen early, and implants might be placed too soon. This trend has lead to a call to action to preserve teeth instead of rushing to replace them [9]. However, in order to preserve teeth, practitioners must first be successful in establishing accurate tooth prognosis evaluation. Furthermore, practitioners must also be educated about how to maintain teeth with poor prognosis. Therefore, the aim of the present study was to assess the accuracy of tooth prognosis evaluation amongst dental practitioners.

Material and methods

A 15-item questionnaire was developed and validated with a group comprised of dental practitioners who reviewed the questionnaire and modified the questions for clarity until consensus was achieved. The questionnaires were distributed to graduated dental professionals prior to the start of continuing education courses at the University of Alberta. All of the course attendees were invited to participate in the study. An explanation of the questionnaire's format was provided to respondents and questions related to filling out the questionnaire itself were answered. No assistance was given in interpreting the radiographs and a specific prognostic tool was not suggested. Questionnaires were answered individually by participants and returned at the end of the course. The questionnaire included demographic information such as the age, gender, place of graduation, years practicing, type of office at which they are employed (general, periodontal, etc), and their dental profession title. Bitewing and peri-apical radiographs with varying levels of bone loss around teeth and implants were included in the questionnaire (Figure 1). No clinical information was provided to the practitioners.

For each radiograph, the participants were asked to determine if the prognosis was good, fair, questionable, or poor based solely on the radiograph. After choosing a prognosis for the teeth in question, the participants were asked to give a percentage value that described the likelihood that the tooth would be maintained for 10 years after acquiring the radiograph. Finally, the participants were asked to choose whether the tooth should be extracted or maintained. Ethics approval was obtained by the University of Alberta Ethics Board.

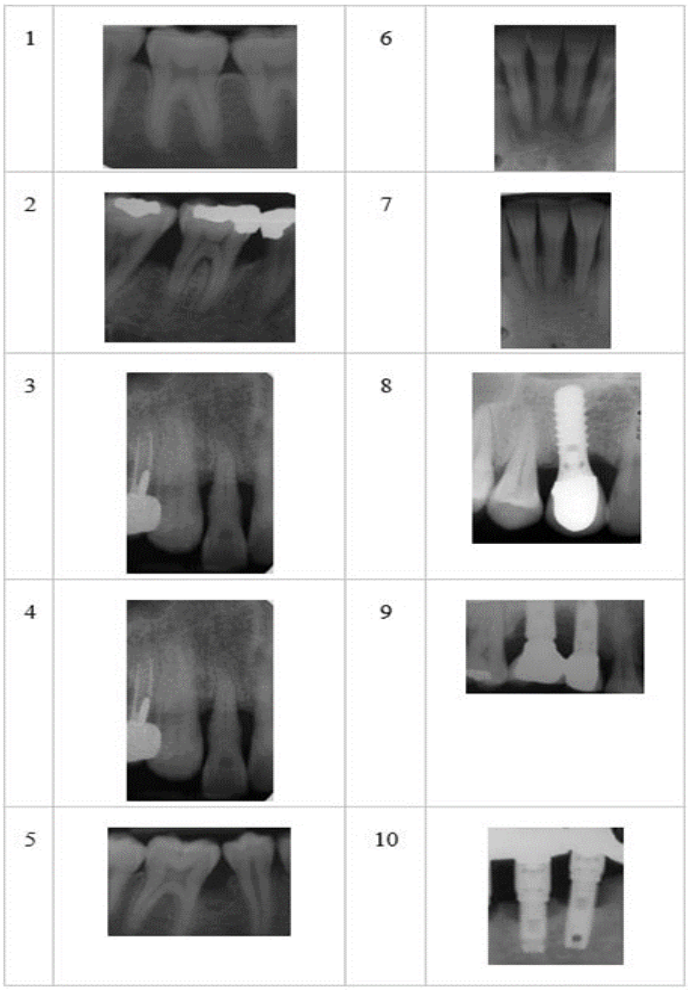

Figure 1. Radiographs presented to dental practitioners

Results

A total of 100 questionnaires were collected and analyzed in this study. The age of practitioners averaged 35.26 (SD=12.21) years and the average number of years practiced was 11.67 (SD=11.99) years. Regarding prognosis, 100% of participants agreed that only one tooth (radiograph 1) had good to fair prognosis (Figure 2). Only three out of the ten radiographs presented had strong suggestions for tooth retention (Figure 2).

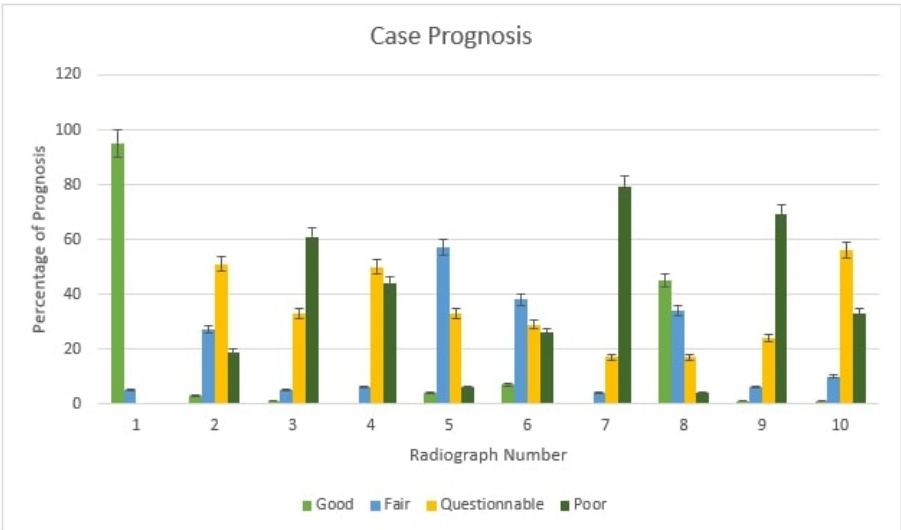

Figure 2. Prognosis of each radiograph assigned by the participants

However, for every other radiograph, suggestions to extract ranged from 1-66% (Figure 3). Radiographs 3, 7, and 9 had strong suggestions for extraction: 44%, 66%, and 52% respectively. Interestingly, 6/10 of the radiographs were estimated to have less than a 50% chance of survival for ten years (Figure 4). Based on Figure 4, the average ten-year survival fluctuated between 80% and 20%. A 0% chance of ten-year survival was the lowest recorded value for 6/10 of the radiographs presented (Figure 4). Pearson correlation tests showed no correlations between extraction, survival rates or prognosis with the descriptive factors of the sample such as the years of experience or type of dental specialist.

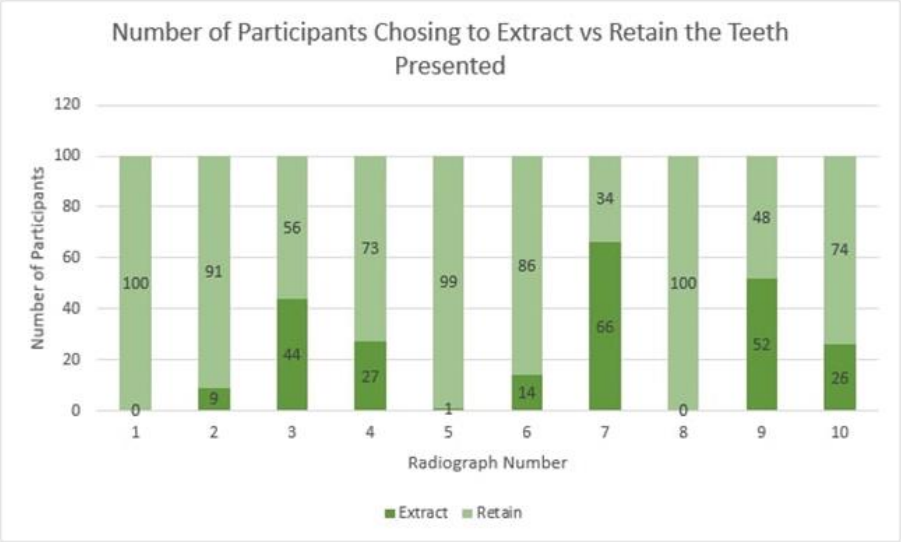

Figure 3. Distribution of participant's suggestions to extract or retain the teeth/implant in the radiographs

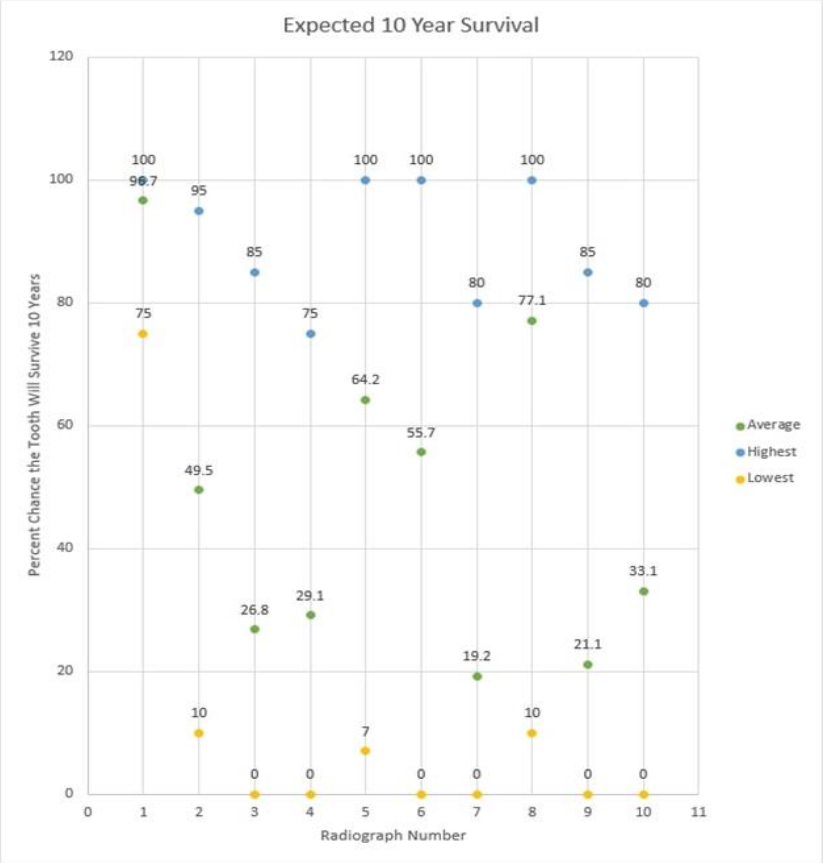

Figure 4. Expectation of tooth survival for 10 years

Discussions

The results of this study suggest many of the teeth presented in the radiographs had a relatively poor prognosis according to the surveyed practitioners. This is evidenced by the choice of extraction varying from 1-66% across the radiographs. This variation is likely attributed to the different levels of bone loss across the different radiographs. Furthermore, practitioners predicted a 0% chance of ten-year survival for many of the teeth. In reality though, 7/10 radiographs which were of natural teeth, are currently still functioning in the patient's mouths at least 5 years since the radiographs were taken. Unfortunately, the authors do not have data on the dental implant cases that were presented. Regardless, the five-year retention of natural teeth labelled questionable or even hopeless by some practitioners suggests that how prognosis is established should be reviewed. In the event these teeth were extracted, the treatment plan can become extensive. Any invasive treatment involves risk to the patient as well as cost. These are factors that need to be considered carefully before teeth are extracted by the dental practitioner [9,12].

Treating periodontal disease is not impossible and periodontally involved teeth can function and be maintained for years [1,21]. Dental practitioners must understand that treating and maintaining teeth is a viable option but more importantly, communicate this to the patient. Dental implants are revolutionary in the field of dentistry however the decision to extract a tooth and replace it with an implant needs to be made carefully [22]. Previous studies suggest that diseased teeth still have a longer lifespan than a dental implant [19, 21, 23-26]. Dental implants are susceptible to dental disease and peri-implantitis is quite prevalent amongst implant patients [27]. Fortunately, there is encouraging evidence for compromised teeth. Even in the case of severe (formerly aggressive) periodontal disease, teeth labelled hopeless have survived for many years with supportive periodontal therapy [10]. The results of this study suggest that practitioners need to be reminded that "We have been trained to preserve teeth. Let us face the challenge." [9].

The authors acknowledge that a small sample size of 100 participants is a limitation to this study. The small sample size may have limited the ability to correlate the prognosis evaluation provided by the dental practitioners with their dental education, specialty and years of experience. The sample was also a convenience sample as the practitioners were attending continuing education seminars. This specific cohort may be biased in that they are practitioners seeking current evidence to implement in their practices. Therefore, the reality may involve even more practitioners performing extractions too early. Interpretation bias may have also occurred when practitioners assessed the radiographs only with no clinical information provided.

Clinical information is critical in establishing tooth prognosis. Another limitation to the study is the limited information (radiographs only) provided to the practitioners to determine prognosis which is different from the real-life situation when examining a patient. Clinical data, such as oral hygiene, clinical attachment levels, medical history etc, are very important factors in evaluating prognosis. However, it is important to note that radiographic bone loss is heavily weighted on the McGuire and Nunn Classification as well as a modified McGuire and Nunn Classification used by Checchi et al. [7, 6]. Again, despite the heavy weighting on radiographic bone loss, patient parameters such as compliance and oral hygiene should also be involved in the evaluations of prognosis. Oral hygiene plays an astounding role in periodontal disease and this should be emphasized to both practitioners and patients [28]. Assessing radiographic bone loss alone is subject to bias, and the use of the current prognostic tools should be implemented with caution.

Overall, this study gives insight to practitioner's interpretation of radiographs for prognosis. Compromised teeth might be extracted too soon, and the number of replacement options are probably contributing to practitioner's bias when establishing prognosis. Therefore, there is a need to improve this situation which may involve reviewing the role of the dental practitioner and placing more emphasis on preserving the

dentition. Emphasizing this as the role of the dental professional needs to be engrained during dental school and reiterated in continuing dental education.

Conclusions

Correctly establishing tooth prognosis is a critical assessment in the field of dentistry. This study suggests dental practitioners are unable to accurately determine tooth prognosis based on radiographic bone loss alone which is a heavily weighted factor in many prognostic tools. Assessing prognosis based on radiographs only, is insufficient and clinical data provides invaluable information to establishing tooth prognosis. Therefore, it is important to recognize the importance of clinical data when establishing tooth prognosis, the limitations of prognostic tools, as well as the evidence for the success of long-term periodontal treatment and supportive periodontal therapy. Even compromised teeth stand a chance and it is the dental practitioner's duty to preserve the dentition as long as possible.

Conflict of interest: None declared.

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ORIGINAL RESEARCH

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In vitro study about the abutment axial wall's convergence.

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Abstract

Introduction: The total convergence of the axial walls is the angle made between the opposing axial walls of an abutment. The lower the taper value, the better the retention of the crowns is. Obtaining a proper convergence of the axial wall is a challenge for dental practitioners due to limited access and low visibility, but it also greatly depends on the clinician's practical skills.

This study aims to compare the total convergence of axial walls obtained after tooth preparation done by different experience practitioners in various positions of the patient and different working time (different days of the week, various parts of the day).

Materials and methods: To perform this study, 40 acrylate model teeth have been prepared by two last year dental students and two prosthetists. All of them performed two teeth preparations per day in every working day of a week. All the prepared teeth have been photographed, and digitally measured.

Results: The extremely statistically significant difference was found in the two beginners' case, the values of the second beginner being much higher, as in the two experienced operators, where the values are higher for the second prosthetist.

Conclusion: The total convergence of the axial wall did not depend on the operators' experience or education level.

Keywords: convergence, taper, tooth preparation

Introduction

Optimal prosthetic oral rehabilitation is the result of complex and consistent clinical treatment steps. The abutment preparation is vital in order to achieve proper prosthetic reconstruction from an aesthetic and functional point of view.

In fixed prosthodontics, the therapeutic success depends on retention and durability of the prosthetic reconstruction, which is an intensely researched topic in literature [1].

Jorgensen and Rosenstiel defined the total convergence of the axial walls as the angle made between the opposing axial walls of an abutment [2, 3].

The total convergence is a popular study topic in prosthodontics [4, 5, 6, 7]. The recommended value, by many studies, is by 4 – 14 degrees [8, 9]. Shillimburg and al., as well as Rosenstiel, defined the ideal value as 6 degrees [10, 11]. To obtain this value is a challenge for dental practitioners due to limited access and low visibility, but it also greatly depends on the clinician's practical skills [12, 13]. The lower the taper value, the better the retention of the crowns is [3, 4, 14, 15].

Clinical research performed on teeth prepared by students, dentists, and prosthetists has shown a mean convergence value of 10-24°, much higher than theoretically established [6, 15, 16, 17, 18, 19, 20].

This study aims to compare the total convergence of axial walls obtained after tooth preparation done by different experience practitioners in various positions of the patient and different working time (different days of the week, various parts of the day).

Materials and methods

To perform this study, 40 acrylate model teeth (second molar) were used, mounted on intact dental arches, assembled in a simulator unit used for practical teaching.

The teeth preparation was done by two last year dental students and two Fixed Prosthodontics Department (George Emil Palade University of Medicine, Pharmacy, Science, and Technology of Târgu-Mureș, Faculty of Dental Medicine) prosthetists. All of them performed two teeth preparation per day in every working day of a week.

For tooth preparation, a round-end diamond size 016 with a standard 3° taper has

been used, maintained as much as possible parallel with the tooth's long axis to achieve an ideal taper. In ideal conditions, using this diamond, a total convergence by 6° and 0,5 mm wide can be achieved to obtain a deep chamfer finish line.

Each tooth was prepared with a new diamond. In the end, each operator prepared two acrylate teeth every day, during five days, with the same finishing area.

The prepared teeth were repositioned on the same simulator model; adjacent teeth have been removed. A proper position for picture was chosen by a survey; pictures have been taken with a Canon D5300 camera mounted on a tripod.

The survey's table, on which the models were positioned, was tilted until it was found an appropriate position of the prepared tooth so that it could be photographed with the Macro lens perpendicularly positioned on the vestibular surface.

A ruler has been placed parallel with the table of the survey, at the cervical area of the prepared tooth, close to the finish line to calibrate the digital measurements, with the Image-Pro Insight software (figure 1).

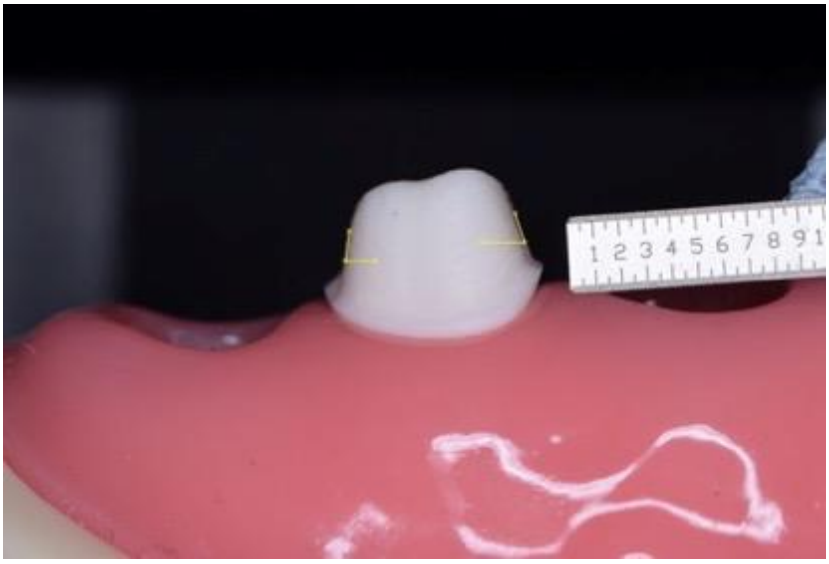

Figure 2. Graphic representation of axial walls taper measurements for all operators

For the evaluation of the measurements, an ideal convergence established by Shillingburg or Rosenstiel of 6° [10, 11] was established as a reference value, respectively, a clinically accepted convergence of 22°.

The inclination of the axial walls of 3° and 11°, respectively, have been taken into account for measurements.

For each tooth, three measurements were performed, calculating their average.

The statistical analysis was performed by using GraphPad Prism 8 for macOS version 8.4.3. software. The statistical significance was set at $p < 0,05$. The mean (M), median (Me) and standard deviation (SD) were calculated. The used test: Wilcoxon Signed Rank and Mann-Whitney test (non-Gaussian distribution).

Null hypothesis: Experienced practitioners with a higher level of education are able to obtain a value of axial wall taper closer to the ideal (6°) and clinically accepted (22°) than beginners.

Results

The results of the descriptive statistic obtained by the four practitioners are shown in table 1 and figure 2.

Table 1. Descriptive statistics

	S1d	S1m	T1d	T1m	T2d	T2m	S2d	S2m
Number of values	10	10	10	10	10	10	10	10
Minimum	-5,290	3,945	0,000	3,342	-4,399	6,357	0,000	10,13
Median	1,614	6,376	5,335	13,21	8,294	18,14	2,633	15,41
Maximum	5,711	12,80	12,68	19,65	18,44	26,57	15,59	21,32
Range	11,00	8,859	12,68	16,31	22,83	20,21	15,59	11,19
Mean	1,220	6,882	6,044	12,62	7,564	18,10	4,464	15,55
Std. Deviation	2,945	2,665	4,428	5,607	5,969	6,078	4,906	4,011
Std. Error of Mean	0,9312	0,8426	1,400	1,773	1,887	1,922	1,551	1,268
Lower 95% CI of mean	-0,887	4,976	2,877	8,611	3,294	13,75	0,9541	12,68
Upper 95% CI of mean	3,326	8,788	9,211	16,63	11,83	22,44	7,974	18,42

Note: S1d – first student distal wall; S1m – first student mesial wall; S2d – second student distal wall; S2m – second student mesial wall; T1d – first prosthetist distal wall; T1m – first prosthetist mesial wall; T2d – second prosthetist distal wall; T2m – second prosthetist - mesial wall

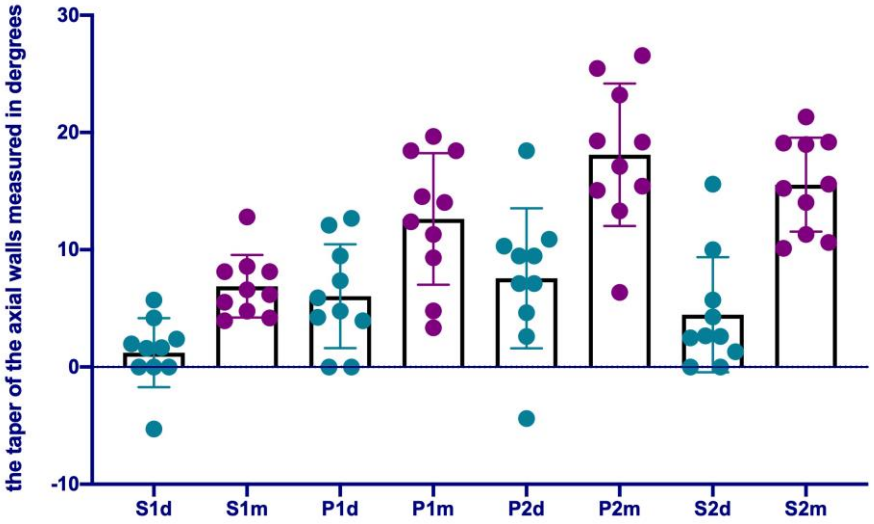

Figure 2. Graphic representation of axial walls taper measurements for all operators

For comparing the four study participants' recorded values with the standard (3°) and clinically accepted (11°) values, the Wilcoxon Signed-Rank test was used. The results are presented in tables 2 and 3.

Table 2 Wilcoxon Signed-Rank test results - participants' recorded values vs. standard (3°)

	S1d	S1m	T1d	T1m	T2d	T2m	S2d	S2d
Theoretical median	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Actual median	1,614	6,376	5,335	13,21	8,294	18,14	2,633	2,633
Number of values	10	10	10	10	10	10	10	10
Sum of signed ranks (W)	-37,00	55,00	33,00	55,00	37,00	55,00	3,000	3,000
Sum of positive ranks	9,000	55,00	44,00	55,00	46,00	55,00	29,00	29,00
Sum of negative ranks	-46,00	0,000	-11,00	0,000	-9,000	0,000	-26,00	-26,00
P value (two tailed)	0,0645	0,0020	0,1016	0,0020	0,0645	0,0020	0,8984	0,8984
P value summary	ns	**	ns	**	ns	**	ns	ns

Note: S1d – first student distal wall; S1m – first student mesial wall; S2d – second student distal wall; S2m – second student mesial wall; T1d – first prosthetist distal wall; T1m – first prosthetist mesial wall; T2d – second prosthetist distal wall; T2m – second prosthetist mesial wall; ns -not significant; ** - very significant p ≤ 0,01

Table 3 Wilcoxon Signed-Rank test results - participants' recorded values vs. clinically accepted (11°)

	S1d	S1m	T1d	T1m	T2d	T2m	S2d	S2d
Theoretical median	11,00	11,00	11,00	11,00	11,00	11,00	11,00	11,00
Actual median	1,614	6,376	5,335	13,21	8,294	18,14	2,633	15,41
Number of values	10	10	10	10	10	10	10	10
Sum of signed ranks (W)	-55,00	-53,00	-47,00	19,00	-39,00	47,00	-51,00	45,00
Sum of positive ranks	0,000	1,000	4,000	37,00	8,000	51,00	2,000	50,00
Sum of negative ranks	-55,00	-54,00	-51,00	-18,00	-47,00	-4,000	-53,00	-5,000
P value (two tailed)	0,002	0,0039	0,0137	0,3613	0,0449	0,0137	0,0059	0,0195
P value summary	**	**	*	ns	*	*	**	*

Note: S1d – first student distal wall; S1m – first student mesial wall; S2d – second student distal wall; S2m – second student mesial wall; T1d – first prosthetist distal wall; T1m – first prosthetist mesial wall; T2d – second prosthetist distal wall; T2m – second prosthetist mesial wall; ns -not significant; * - significant p ≤ 0,05; ** - very significant p ≤ 0,01

Statistically significant differences were found between the prosthetists and the first student (Mann-Whitney test) when the distal axial wall's taper was considered. In the case of the values recorded on the mesial axial wall, there were statistically significant differences except those between the prosthetists and the second student (Mann-Whitney test) (table 4).

Table 4 Mann-Whitney test results

	S1d vs T1d	S1d vs S2d	S1d vs T2d	T1d vs T2d	T1d vs S2d	T2d vs S2d	S1m vs T1m	S1m vs S2m	S1m vs T2m	T1m vs T2m	T1m vs S2m	T2m vs S2m
P value	0,0177	0,1062	0,0026	0,5160	0,3401	0,1091	0,0218	<0,0001	0,0002	0,0499	0,2391	0,2556
P value summary	*	ns	**	ns	ns	ns	*	****	***	*	ns	ns
Mann-Whitney U	19	28,50	12	41	37	28,50	20	3	5	24	34	34,50
Difference: Actual	3,721	1,019	6,680	2,959	-2,702	-5,661	6,833	9,037	11,77	4,933	2,204	-2,729
Difference: Hodges-Lehmann	4,292	2,088	7,101	2,236	-2,094	-4,522	6,081	8,831	11,09	5,199	2,363	-3,387

Note: S1d – first student distal wall; S1m – first student mesial wall; S2d – second student distal wall; S2m – second student mesial wall; T1d – first prosthetist distal wall; T1m – first prosthetist mesial wall; T2d – second prosthetist distal wall; T2m – second prosthetist mesial wall; ns -not significant; * - significant p ≤ 0,05; ** - very significant p ≤ 0,01; *** - extremely significant p ≤ 0,001; **** - extremely significant p ≤ 0,0001

Discussion

The total convergence of an abutment will affect the retention and stability of a prosthetic reconstruction [21, 22]. According to the literature, the ideal and clinically acceptable value of it is between 4-6º, respectively 4-14º, but unfortunately, the clinical application thereof is challenging [18,19]. In a study conducted by Mack, the result showed that the minimum axial walls convergence in order to prevent undercuts must be 12º [13]. Goodacre et al. recommend values between 10-20º, while other in-vitro studies suggested 10-16º total axial wall convergence [6].

Based on the data obtained in this study, an unusual taper of the axial walls was found. Surprisingly, the values recorded were higher for mesial walls, except for the values obtained by the first student. This may be explained by the more inaccessible and less visible area, a level at which more attention is likely to be paid to the tooth preparation. The mean values obtained on the mesial walls were within the clinically acceptable range of 10-25°.

Results obtained by the students in researches conducted by Tiu and al. showed a mean value of the mesio-distal convergence angle of 31,49° [22]; a similar study conducted by Mack reveals lower values, 16,34° [13]. Years ago, Nordlander [23] and Eames [24] already demonstrated a mean value of 20° obtained by experienced practitioners. More recent results were reported in a study contucted by Winkelmeyer et al. where the mean total occlusal convergence was 17,9 degrees [25].

In the present study, the mesio-distal convergence angle in most cases, except the mean value of the mesial wall taper registered by the second prosthetist and the first student, is lower than a clinically acceptable convergence angle of 22°. In a study conducted in 2018 by Fahad Abdulla et al. in which the experimented dentists performed teeth preparation, the conclusion was that the mesio-distal convergence angle exceeded the clinically acceptable convergence angle between 10° and 22° [26].

The extremely statistically significant difference was found in the two beginners' case, the values of the second beginner being much higher, as in the case of the two experienced operators, where the values are higher for the second prosthetist.

These data are similar with data from the literature that achieving ideal convergence in the mouth is impossible and does not depend on the work experience or education level of the operator [27, 28, 17].

The values obtained in the study are considerably higher than the ideal values, as demonstrated by Safa et al. in research where students, prosthetists, and dentists do teeth preparation [28].

The limitation of the present study is the difference between hard dental and acrylic teeth structure being an in vitro study. The lack of standardization of the landmarks used to perform the measurements does not allow an accurate assessment of the total occlusal convergence. For an accurate assessment of the abutment axial wall's convergence, clinical trials are needed.

Conclusion

Within the limitation of this study, the total convergence of the axial wall did not depend on the operators' experience or education level. With increased attention and maximum dedication, the distal walls of the teeth, less accessible, can be appropriately prepared. Using diamond with ideal taper for tooth preparation, an ideal preparation of the abutment will not result.

Conflict of interest: None declared

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ORIGINAL RESEARCH

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Evaluation of the correlation between impacted canine and malocclusions.

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Abstract

Introduction: Tooth impaction is defined as the absence of a tooth on the arch, after its normal eruption age. The main reason canines are impacted is the lack of space required for the tooth to erupt.

Aim of study: The main objective of this study is to determine the types of malocclusions associated with canine impaction (Lindauer classification). A secondary objective is to establish the correlation between these parameters and identification of subjects with high risk of canine impaction based on pre-existing malocclusion.

Material and methods: This study was performed on a sample of 20 patients, 9 men and 11 women. The dental casts were subject to Angle classification and various measurements such as arch perimeter, Pont's index, sum of the mesiodistal width of the incisor and arch length were performed. The Lindauer sectorial classification was determined based on the patients' panoramic radiography.

Results: According to the data collected, the Class II /2 malocclusion is more frequent, and it is associated with the impacted canine (approximately 50%). According to the Lindauer classification higher frequency of the impacted canines was found in Sector IV.

Conclusion: The diagnosis for impacted canines is often associated with Class II /2 malocclusion, and according to the Sector classification, it is often localised in Sector IV.

Keywords: malocclusion, tooth eruption, tooth impaction, impacted canine

Introduction

Tooth impaction is the lack of eruption of a tooth in its adequate position on the dental arch within a specific time frame and physiological limits of the dental eruption process [1]. In the present perspective, a tooth is considered impacted if it presents a considerably delayed eruption and also there are clinical or radiographic evidence that prove a future eruption will not take place [2]. A canine is impacted when the tooth has not erupted after the full development of its root, or if the contralateral tooth has erupted for at least 6 months and has a fully developed root [2].

This anomaly is frequently caused by insufficient space required for eruption on the dental arch, causing aesthetic and functional complications, as well as the shortening of the dental arch, causing follicular cysts, canine ankyloses, recurrent infections, pain, external root resorption of the canines and adjacent teeth [3].

The upper impacted maxillary canine comes second after the 3rd molar impaction [4,5]. According to various studies, canine impaction is most often found in palatal position, with a frequency of 80%, and in buccal position with a 20% frequency. Regarding the sex ratio, impacted canines are present twice as often in females. The impacted maxillary canine is twice as often than the impacted mandibular canine and 8% of the patients with impacted canine also display bilateral impaction [4,5].

According to a study conducted by Ericson, the majority of the impacted canines are palatally positioned (85%) and only 15% are buccally impacted canines. Also the unilateral impaction is more frequent than the bilateral one, only 8% of the impacted canines are bilateral. The majority of the impacted canines observed in Caucasians are in palatal position,

while in Asian population the predominant occurrence is in the vestibular position. Related to sex, the impacted maxillary canine is twice more frequent in women than in men, with a ratio of 2.3:1 [1].

The maxillary canine presents a broad spectrum for eruption anomalies, mostly due to the length of the eruption process, hard tissue obstructions, lesions of the soft tissue or some anomalies of neighboring teeth, respectively to the fact that the maxillary canine is the last of the anterior teeth to appear on the dental arch [6]. In order to understand why the maxillary canine is so often impacted, it is important to identify the trajectory that the canine will follow at bone level during the eruption process.

Several radiographs have been used to diagnose impacted canines, such as retro-alveolar radiography, panoramic radiography, occlusal radiography and cephalometric radiography. The mesio-distal location of the crown and tooth angulation, measured on a panoramic radiography, are the two prognostic factors in treating impacted canines [7-9].

The main objective of this study is to determine the types of malocclusions associated (molar class, incisor class) with canine impaction (Lindauer classification). A secondary objective is determining the correlation between these parameters and the identification of subjects with high risk of canine impaction based on pre-existing malocclusion.

Material and methods

This study was performed on a sample of 20 patients with ages between 10 and 46 years old, 9 men and 11 women, patients at the „Natural Smile Dental Clinic by dr. Pop" diagnosed with canine impaction. Based on the dental casts, the Angle classification and incisor classification for each patient was determined. Using the digital calliper and millimetre measurement paper graph, the following parameters were determined: arch perimeter, Pont's index, Inter-premolar and inter-molar widths, sum of the mesiodistal width of the upper incisor and arch length. The following parameters were observed:

- Dental Class Angle;
- Incisor Class;
- Arch perimeter (the mesiodistal width of the teeth measured from the mesial surface of the primary molar all the way to the mesial surface of its contralateral homologue);
- Pont's Index (the transverse arch dimensions – the interpremolar and intermolar distance);
- Sum of the mesiodistal width of the upper incisors;
- Arch length;
- Sectorial Classification of the impacted canines on panoramic radiography.

In order to determine the discrepancy between the existent space on the arch and the space required for teeth alignment, difference between IP (ideal parameter –calculated) and EP (existent perimeter- measured) for each dental arch was evaluated. IP – is the mesiodistal diameter of the teeth. The transversal dental arch discrepancy was also determined by calculating IPD (interpremolar distance), IMD (intermolar distance) respectively, according to the following mathematical formula: SI × 100/80 (IPD) and SI × 100/64 (IMD).

The upper interpremolar width was measured from the centre of the intercuspal groove of the first upper premolars. The lower interpremolar width was measured in the most vestibular point of the contact line between the first premolar and the second premolar. The upper intermolar distance was measured in the central fosse (central to the first permanent molars) and the lower intermolar distance from the central-vestibular cusps of the lower molars.

For the evaluation of the sagittal dimension of the dental arches, arch length was measured, from the anterior midpoint of the arch to the posterior midpoint.

The Lindauer sectorial classification of the impacted canines was determined based on the selected patients' panoramic radiography (figure 1). Sector I is the distal area from the tangent line on the distal surface of the crown and the root of the lateral incisor. Sector II is in a mesial position of Sector I and in a distal position of the bisecting line of the mesiodistal width of the lateral incisor, along its axis. Sector

III is at a mesial distance from Sector II, but at a distal tangent line from the mesial surface of the crown and the root of the lateral incisor. Sector IV includes all mesial areas of Sector III.

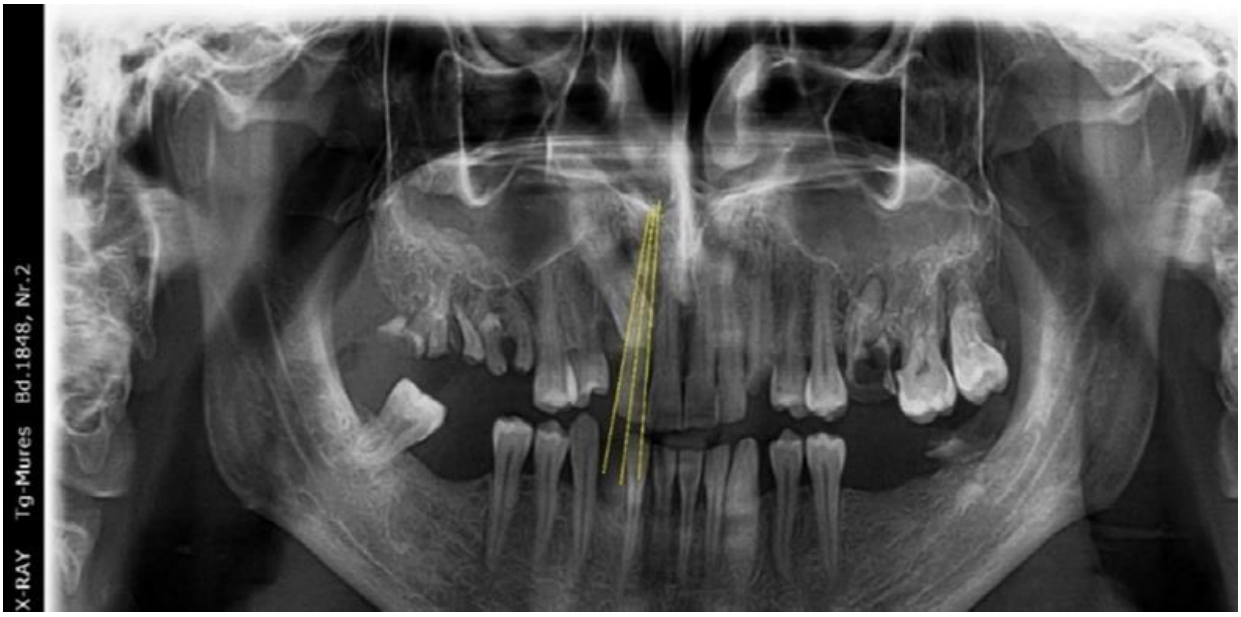

Figure 1. Panoramic radiography with sector tracing

Tangent lines to the mesial and distal surfaces along the axis of the lateral incisor adjacent to the impacted canine were traced. This enabled us to split the respective area in 4 sectors (figure 2) and to determine the sector where the cusp of the impacted canine is situated, for each patient.

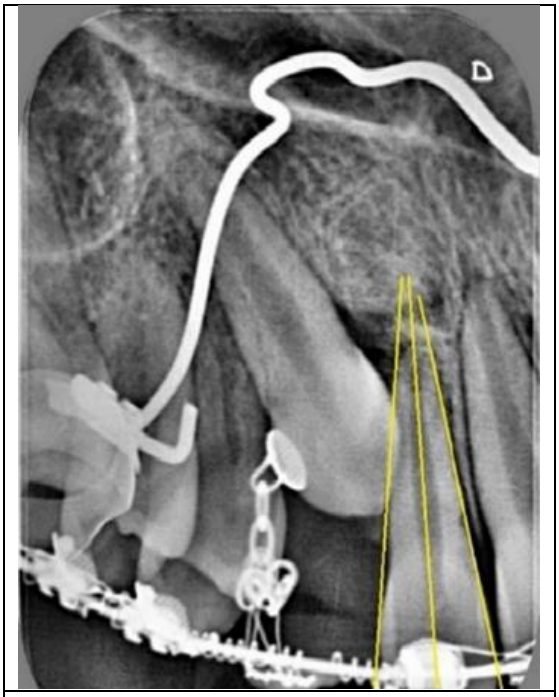

Figure 2. Lindauer sectorial classification

The data was statistically analysed using the descriptive frequency analysis, Student T-test, Chi Square Test and Pearson correlation test. The analysis was performed using IBM SPSS Statistics Version 20 software (IBM Corp. Armonk, New York, United States).

Results

The results of this study were organized in tables and diagrams. First diagram (figure 3) shows the results obtained for Dental Class Angle.

Table 1 integrates the result for the arch perimeter measurements on the dental casts for both arches, respectively the malocclusion type.

Pont's index at a maxillary level and the frequency of transversal crowding in the dental arches are presented in table 2.

The percentage of the mesiodistal width of the incisors is presented in table 3.

The diagram illustrated in Figure 4 presents the frequency of impacted canines.

Figure 5 are illustrates the results for the Lindauer Sectorial Classification of the impacted canine.

Figure 3. Frequency results Angle Class

Table 1. The result for the arch perimeter measurements on the dental casts for both arches, respectively the malocclusion type

Malocclusion type	Maxillary	Mandible
Spacing	7 (36.8%)	5 (26.3%)
Correct alignment	4 (21.1%)	4 (21.1%)
Light crowding (<4mm)	4 (21.1%)	5 (26.3%)
Mild crowding (4-8mm)	3 (15.8%)	4 (21.1%)
Sever crowding (>8mm)	1 (5.3%)	1 (5.3%)

Table 2. Pont's index at a maxillary level and the frequency of transversal crowding

Pont Index – Maxillary	Premolar	Molar
Surplus	5 (26.3%)	7 (36.8%)
Correct Interpremolar width	6 (31.6%)	7 (36.8%0
Light crowding (2-4mm)	1 (5.3%)	0 (0.0%)
Mild crowding (4-6mm)	5 (26.3%)	2 (10.5%)
Severe crowding (6-10mm)	2 (10.5%)	3 (15.8%)

Table 3. The percentage of the mesiodistal width of the incisors

Mesiodistal width of the incisor	Maxillary
Normodontia (28-34mm)	15 (78.9%)
Microdontia (<28mm)	4 (21.1%)
Macrodontia (>34mm)	0 (0.0%)

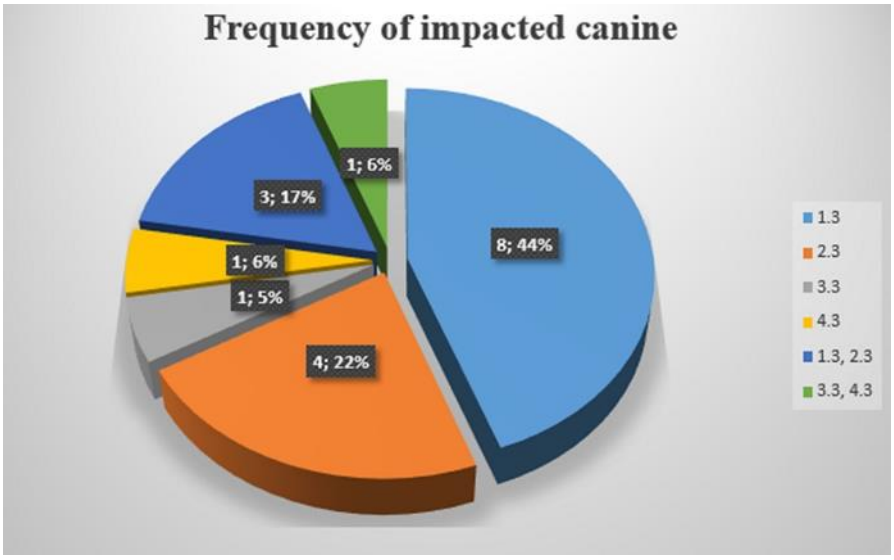

Figure 4. Impacted canine frequency results

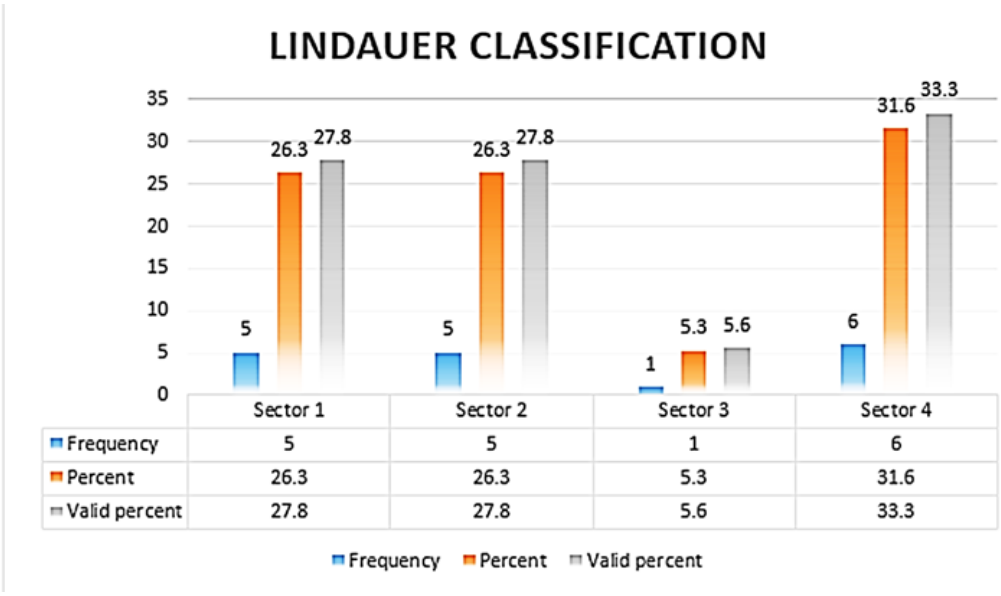

Figure 5. Results of Lindauer sectorial classification

Chi square test determined that the only statistically significant correlation is between the impacted canine and Class Angle, respectively p=0.016 (table 4).

Table 4. Chi square test determined in impacted canine and Class Angle

	Impacted tooth
Class Angle	p= 0.016
Incisor Class	p=0.623
Pont Max PM	p=0.721
Pont max Mol	p=0.088

With respect to the Dental Class Angle, we have observed that for Class I Angle there is a 33.3% frequency; Class II/1 has e 11.1% frequency; Class II/2 has the greatest

frequency, 50.0%; and Class III with a 5.6% frequency.

Regarding the Incisor Class, we have identified Class I-10.5%, Class II/1 – 21,1%; Class II/2 – 36,8% and Class III – 31,6%.

For the measurements performed on the dental casts we have the following results:

- Malocclusion with spacing at maxillary level 7 (36.8%), and spacing at mandible level 5 (26.3%);
- Light crowding at maxillary level 4 (21.1%), and at mandible level 5 (26.3%);
- Mild Crowding (4-8mm) at maxillary level 3 (15.8%), and at mandible level 4 (21.1%);
- Severe crowding (>8mm) at maxillary and mandible level 1 (5.3%).

Discussions

The permanent canines are highly important due to their role in determining the form of the dental arch, participating in the functional occlusion as well as in the aesthetic aspect. Determining the precise position of the impacted canine is crucial in choosing the right surgical approach and best access area, as well as in determining the correct orthodontic forces.

The best option in determining the position of the impacted canine is the Cone-Beam CT, although it can be costly [10]. This study has used panoramic radiographies to evaluate the position of the impacted canine, because these types of radiographies are usually performed on patients following an orthodontic treatment, minimising the exposure to radiations. The aforesaid mentioned radiographies present sufficient data for the subject of this study.

It has been reported that 8% of the impacted canines are bilateral [8]. This study shows that 22.3% are bilateral, and 77,8% are unilateral. The percentage resulted in this study regarding the bilateral impaction is significantly greater than the previous studies.

Regarding the age of diagnosis of the impacted canine, the study included patients with age between 10 and 46 years old, unlike other studies which are predominantly conducted on an age interval between 13 to 15.

McConnell et al remarked that patients with lack of transversal space in the anterior area of the dental arch had impacted canines [8]. The present study asserts that patients with impacted canines presented the following:

- Interpremolar distance 31.6%, and correct intermolar distance 36.8%;
- Interpremolar surplus 26.3%, intermolar surplus 36.8%;
- Light interpremolar crowding 5.3%, and intermolar respectively 0.0%.

The cases of severe interpremolar crowding are 10.5% and respectively intermolar 15.8%. Similarly to our results, a study conducted by Tadinada A et al. determined that the transversal maxillary deficiency is not a main factor in the canine impaction [11].

Unlike the study of Chaushu and Becker (1999) on panoramic radiography, which chose not to mention the sectorial classification, this study has used the positioning of the impacted canine cusp on the 4 levels Lindauer described, in order to determine its various types of positions [12]. We have determined positions in Sector I and II with a 27,8% frequency, Sector III 5,6% frequency, whereas the frequency in sector IV – 33.3% is similar to the results in our study. A different study conducted in India in 2009 asserts that for Sector I the frequency is 75,67%, and Sector IV has a 38,46% [13]. Lindauer et al discovered that 78% of the impacted canines have the tips of the cusp in sectors II, III and IV [14].

After correlating the information obtained in the study we observed that the frequency of dental class II/2 Angle has a higher frequency of 50%, associated with canine impaction, closely followed by Class I Angle with a 33.3%, where the impacted canines are predominantly unilateral at maxillary point, and more frequent in the first quadrant. Therefore, the malocclusion in Class Angle in fact depends on the positioning of the impacted canine (1.3, 2.3, 3.3 or 4.3).

Conclusions

- Between the maxillary canine and the mandibular canine, the most affected by impaction is the maxillary canine.
- Most frequent canine impaction is unilateral (50%).

- The impacted canine is most frequently associated with malocclusion Class II/2 Angle.
- Regarding the transversal size of the dental arch, the impacted canine is predominantly associated with normal arches, or those that present a space surplus, rather than the ones with crowding.
- According to Lindauer's Sectorial classification, the impacted canine is most often situated in Sector IV.

Conflict of interest: None declared.

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CASE REPORT

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Rehabilitation of the frontal teeth with palatal veneers by using T-Scan occlusal analysis - case report.

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Abstract
Pathological tooth wear occurs in young patients. The rehabilitation of these teeth must be performed accurately, considering the occlusal relationships and the correct distribution of the masticatory forces. The therapeutic approach must be as minimally invasive as possible.
In this case presentation, six palatal veneers were realized for the aesthetic and functional rehabilitation of a young patient's upper frontal teeth. The restorations were made on refractory casts, from feldspathic ceramics, allowing a proper esthetic. The occlusal rehabilitation involves the mounting of the casts in a semi-adjustable articulator. The six veneers were adapted functionally by using the Bio-Art A7 Plus articulator. Due to the adhesive techniques and the existing interocclusal space at this level, the teeth's preparation was limited to the enamel. The deep chamfer was placed equigingivally. During the try-in of the restorations, the esthetic evaluation was done. The adhesive technique was used to bond the veneers to the tooth surfaces. After the cementation, the esthetical results were evaluated. During the prosthodontic treatment, T-Scan III digital analysis was performed to detect occlusal problems, to establish the treatment directions, and to evaluate the results.
Conclusions: The use of the adhesively bonded feldspathic palatal veneers allows a successful esthetic and functional rehabilitation. The digital occlusal analysis, realized using the T-Scan system, improves the prosthodontic treatment quality and durability.
Keywords: Tooth wear, minimally invasive, palatal veneer, adhesive technique, T-Scan

Introduction

The tooth wear is a physiological process that means loss of the tooth structure. In situations where this wear occurs rapidly, especially in young patients, causing esthetic or functional problems or tooth sensitivity, this wear is pathological [1]. It is due to dental contacts and the surface friction resulting from functional movements of the mandible or different parafunctions. It can affect the lateral teeth's occlusal surfaces or the incisal edge of the frontal teeth [1].

The recommended therapeutic approach in restoring the pathological wear in current clinical practice is the most conservative tooth preparation by using minimally invasive techniques and adhesive cementation of the restorations [2,3].

The ceramic veneers with minimum wall thickness can be used for the minimally invasive frontal teeth approach because of their benefits: biocompatibility, esthetic and mechanical outcomes [3].

The indications and contraindications of the adhesive restorations are a controversial topic in the literature. Several authors have shown that bruxism is a contraindication to the use of ceramic veneers [4]. Magne et al. demonstrated a 40% failure rate in patients with bruxism [5]. Others recommend the nocturnal or/and diurnal wearing of the splints, even after the prosthodontic treatment, for the prevention of the failure [4]. The splint decreases muscle hyperactivity, and the bruxism activity during periods of stress [6,7].

To obtain long-lasting results in the case of restorations with feldspathic ceramic veneers, the use of the mock-up and the adhesive cementation technique is essential [8]. The therapeutic success depends mainly on the knowledge of the material's physical and technical characteristics, as well as the correct assessment of the clinical situation [9,10].

Feldspathic ceramic contains silica powder or quartz, in a ratio of 46-66% aluminum oxide and liquid glass-based materials. It offers a particular aesthetic, with high translucency, but

it is fragile, having a resistance of 56.5 MPa to fracture. In current practice, it is indicated for restorations in the frontal area, with a thickness of 0.5 mm in minimally invasive preparations, in areas that will not receive mechanical loads [9,11].

The occlusal analysis can be performed by using a digital system, T-Scan III (Tekscan). This system records the dental contacts, can measure the masticatory forces. Records the duration and timing of each contact during intercuspation, offering the possibility of a two- or three-dimensional analysis of occlusion [12]. T-Scan allows the establishment of the occlusal diagnosis [13]. The assessment of the center of force, the location of the premature contacts, is an essential aspect in the prosthetic treatment of patients with pathological abrasion.

Case presentation

A 25-year-old male patient presented for oral aesthetic rehabilitation, being disturbed by the upper frontal teeth's appearance, that had been reduced in length.

From the personal antecedents, we find out that the patient has the habit of biting his nails from adolescence and he has also nocturnal bruxism.

The patient's informed consent was obtained regarding the processing of personal data, photographs, measurements, and treatment results.

The clinical examination revealed the hypertrophy and hypertonia of the masseter muscles and more than two millimeters loss of length of the upper frontal teeth's clinical crown (Figure 1). All the teeth were vital and not sensitive to temperature.

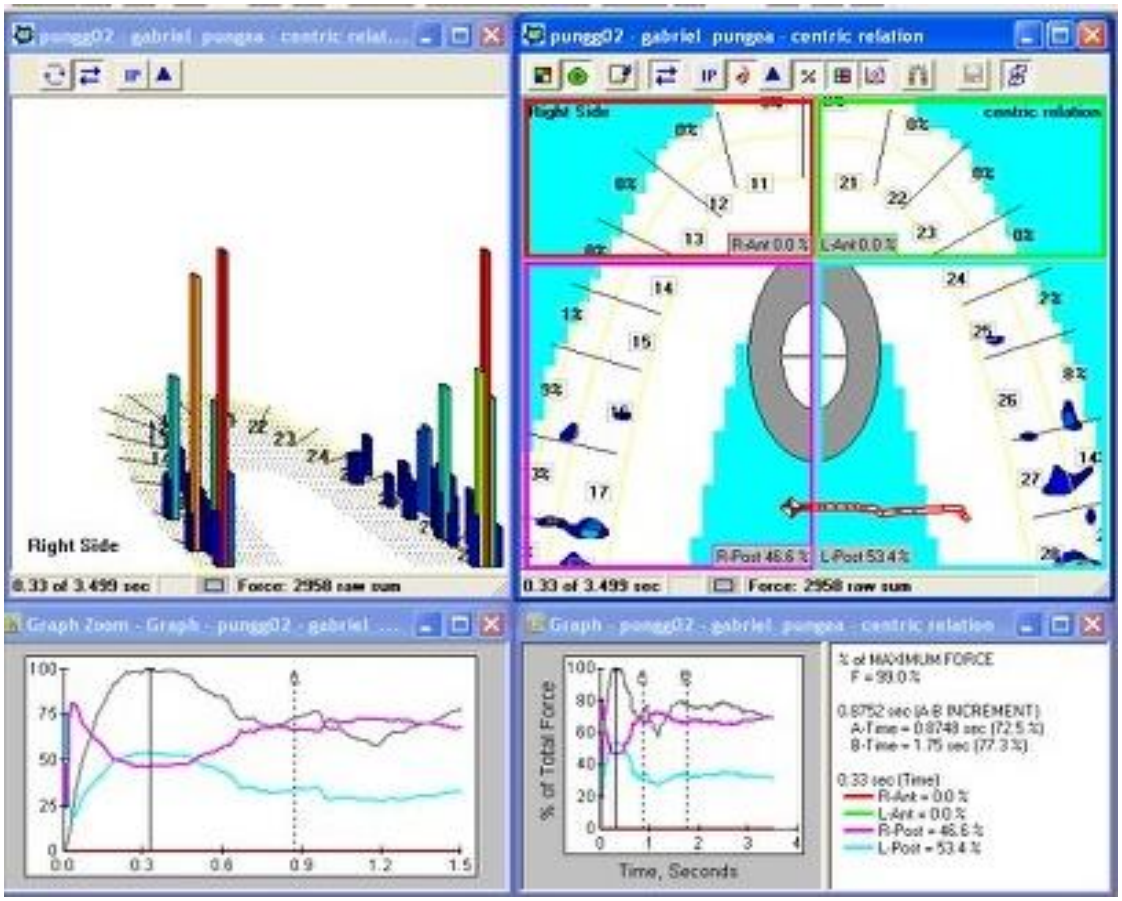

Figure 1. Modification in the length of the clinical crown of the frontal teeth

Photographs and impressions were taken. The Elite facial Bio-Art I facebow was used to facilitate the mounting of the casts on a semi-adjustable articulator to examine the functional contacts. Radiographs were performed to establish an orthodontic treatment plan, but the cephalometric measurements (Zuerich analysis) disclaimed the orthodontic treatment.

The T-Scan III (Teksan) was used for objective analysis of the occlusal contacts to elaborate the prosthodontic treatment plan (Figure 2).

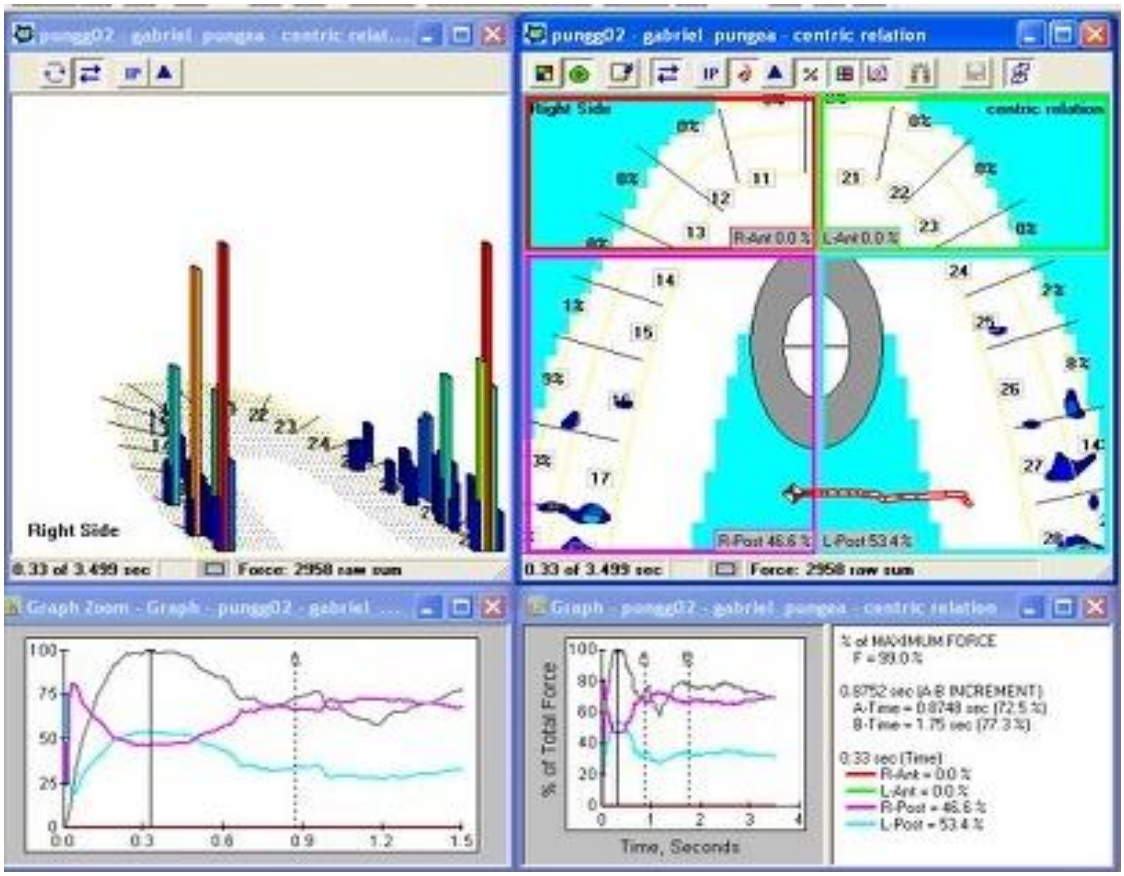

Figure 2. Initial T-Scan registration – the absence of the occlusal contact in the frontal region

The goal of the rehabilitation had been to realize six palatal veneers from feldspathic ceramics with minimally invasive preparation on the frontal teeth and to reestablish the contact surfaces, the frontal guidance in propulsion, the canine guidance in laterality.

One month of nocturnal splint therapy had been deconditioning the muscle contracture caused by bruxism. A T-Scan reevaluation had been done; it was registered a lack of contacts in the frontal area and excessive forces at the posterior teeth.

A mock-up had been performed to preview the esthetic and functional results. After one week of accommodation, when the T-Scan registration was repeated, the results of the recordings were improved. The masticatory forces had been more evenly distributed, the full arch presented occlusal contacts. Because of prematurity on the right first molar, a selective grinding was performed.

The palatal surface of the frontal teeth had been prepared minimally invasive with a fine-grained football diamond bur (Figure 3). For the preparation of the equigingival deep chamfer finish line, a 010 size, red-marked, round-end tapered diamond bur had been used. On the labial surface, a bevel was realized without preparation of a finish line. The surfaces were finished with Arkansas stones and orange-colored Soflex (3M) discs.

Figure 3. Minimally invasive preparation of the palatal surface – deep chamfer finish line

The minimally invasive preparation was limited to the enamel to ensure the perfect adhesion of the veneers. For the finish line's display during the one-step impression, the double cord technique had been used (000 sizes non-impregnated cord and 0 sizes impregnated cord). Poliivynilsiloxane was used for an accurate impression (Variotime Dynamix-Heavy Tray, Variotime medium flow, Heraeus) and for the interocclusal records (Occlufast rock, Zermack). (Figure 4.)

The working casts were realized from a refractory material (Figure 5) and mounted in the Bio-Art A7 Plus semi-adjustable articulator.

To evaluate the esthetical outcomes of the restorations, the Variolink Esthetic (Ivoclar) try-in paste was used (Figure 6).

Figure 4. Interocclusal record with polyvinylsiloxane – indications regarding the future length and direction of the incisal edge

Figure 5. The working cast – realized from refractory material

Figure 6. The try-in of the restorations – the difference regarding the length

The adhesive bonding was realized with neutral, dual-cure Variolink Esthetic DC (Ivoclar) composite resin. The total etching technique was used; silane was applied to the restoration's internal surface after the hydrofluoric acid etch. At the end of the cementation process, the marginal seal of the restorations had been verified and finished.

A new T-Scan recording was performed (Figure 7). The biting forces were more evenly distributed, and the occlusal contacts in the frontal area were reestablished, the frontal and also the canine guidance was restored.

The length of the frontal teeth was restored, and the esthetical outcomes were satisfactory (Figure 8).

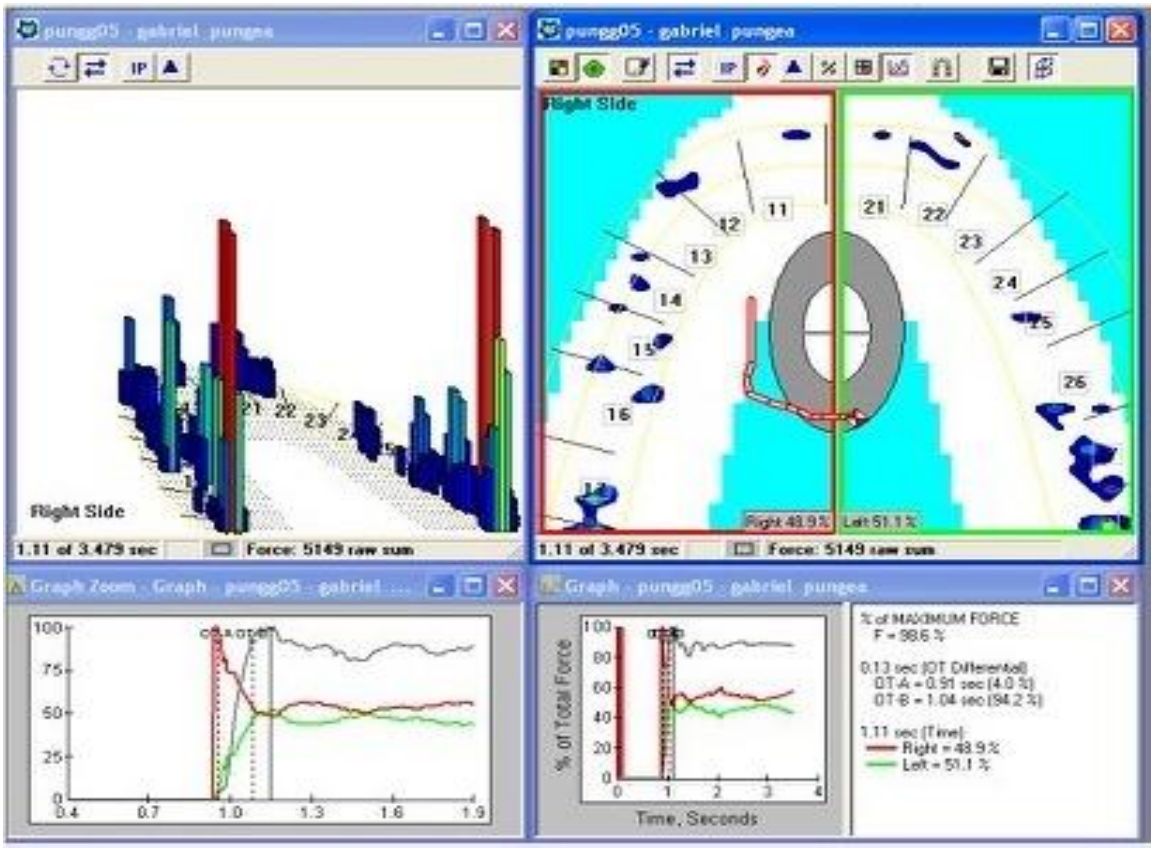

Figure 7. The final T-Scan – restored occlusal contacts in the frontal region

Figure 8. The final aspect of the restorations after cementation

Discussions

In current clinical practice, there are several options for the esthetic rehabilitation of the compromised anterior teeth. Those rehabilitation methods which involve the preparation for the crowns are very invasive and outdated [14].

New progress regarding the adhesive techniques contributes to increasing the mechanical properties of the bonded ceramic to the conditioned enamel, making it possible to obtain good clinical results in frontal rehabilitation [9,15]. The minimally invasive preparation is recommended in all cases to obtain the best adhesion of the ceramics to the tooth structure [9].

In this study, the preparation was limited to the enamel, because the vertical space in the intercuspal position allowed the achievement of adequate thickness of the ceramic veneers. The equigingival placement of the finish line facilitated the cementing procedures, making it easier to apply the rubber dam. The use of the rubber dam is recommended in case of adhesive cementation [9].

For the correct registration of the subgingivally or equigingivally placed finish line, the enlargement of the gingival sulcus is recommended [16]. For this purpose, the use of retraction cords is an effective technique.

The dental surfaces were cleaned, sandblasted, treated with 37% orthophosphoric acid for 25 seconds. The bonding agent was applied after a previous drying. The internal surface of the restorations was also sandblasted and treated with hydrofluoric acid, silane was applied, according to the recommendations of several authors [17].

The surface treatment of the veneers differs according to the type of the ceramics, but the hydrofluoric acid etch, and silane application is mandatory in all cases [9].

Patients with significant tooth wear in the anterior region suffer from a loss of clinical crown height and the possibility of developing an edge-to-edge incisal relationship. The esthetic appearance and also the function is compromised. Generally, the anterior and canine guidance is lost and needs to be reestablished [18].

In our case, the anterior guidance was restored in the propulsion movement and the canine guidance in laterality.

After the cementation, new T-Scan recordings demonstrated the equal distribution of the masticatory forces. Occlusal contacts were detectable at the frontal teeth in the intercuspal position. This digital diagnostic method reduces the subjective interpretation of occlusal analysis data, can provide the registration of the dynamic occlusion [19], and can contribute to our restoration's functional evaluation.

The fracture resistance of the feldspathic veneers is a controversial topic in the literature. The majority of clinical studies reviewed report a low incidence of fractures. However, other authors indicate a much higher rate of fractures, especially in case of bruxism [20].

Conclusions

The use of the feldspathic palatal veneers allows a successful esthetic and functional rehabilitation in terms of compliance with the protocols regarding the preparation, cementation, and occlusal balancing.

The digital occlusal analysis, realized using the T-Scan system, improves the prosthodontic treatment quality and durability.

Conflict of interest: None declared.

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