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SUBJECTIVE ASSESSMENT OF AESTHETICS RELATED TO COMPLICATIONS OF IMPLANT THERAPY IN THE MAXILLARY AESTHETIC REGION

СУБЈЕКТИВНА ПРОЦЕНКА НА ЕСТЕТИКАТА ПОВРЗАНА СО КОМПЛИКАЦИИ ОД ИМПЛАНТНАТА ТЕРАПИЈА ВО МАКСИЛАРНИОТ ЕСТЕТСКИ РЕГИОН

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Abstract

Introduction: In contemporary dentistry, aesthetics has become a primary concern, with increasing demand from patients, seeking optimal visual outcomes. Alongside this demand, complications that affect aesthetic, results have become a growing challenge. This study aims to evaluate the impact of complications on the aesthetics of suprastructures in the maxillary aesthetic region. **Material and method:** The research was conductedat a private dental practice "Dr.Bajraktarov" in Strumica.The study involved an assessment of the aesthetic impact of prosthetic superstructures in the maxillary aesthetic region. Evaluations were performed both by patients and by clinicians. **Results:** Among the subjects who experienced complications, 86.36% had a deterioration in aesthetics. Most of the subjects estimated that they have significant deterioration of aesthetics (47.36%). Clinicians, however, reported an even higher percentage of significantaesthetic deterioration identifying major isssues in 57.89% of cases. **Conclusions:** A Variety of complications can negatively affect the the aesthetic outcomes of prosthetic restorations in the maxillary anterior region. These complications should be carefully considered during diagnosis, treatment planning, and execution, as they play a crucial role in patient satisfaction and overall treatment success. **Keywords:** dental implants, esthetic, complications, aesthetic assessment.

Апстракт

Вовед: Бидејќи во современата стоматологија, естетиката навлегува на широка врата и станува исклучително барана од пациентите, како и од бројните компликации поврзани со естетиката, главната цел на овој труд беше поставена - да се направи проценка на ефектот на компликациите врз естетиката на супраструктурите во максиларната естетска зона. **Материјал и метод:** Истражувањето е направено во една приватна стоматолошка ординација „Д-р. Бајрактаров“ во Струмица. Извршена е проценка на влијанието на протетските супраструктури во максиларниот естетски регион на естетиката од испитуваната популација и од лекарите. **Резултати:** Од испитаниците кои имале компликации, 86,36% укажале на влошување на естетиката. Поголемиот дел од испитаниците проценили дека имаат значително влошување на естетиката (47,36%), за разлика од клиничарите, каде значително влошување на естетиката поради компликациите е забележано кај 57,89%.Заклучоци: Постојат бројни компликации кои можат да го нарушат постигнатиот естетски ефект во максиларната фронтална регија. **Клучни зборови:** Дентални импланти, естетски, компликации, естетска проценка.

Introduction

Dental implants, along with their associated suprastructures, constitute an essential component of contemporary dental practice. Beyond their primary role in replacing missing teeth and restoring critical functions within the oral cavity, dental implants contributes significantly to the aesthetics rehabilitation of the anterior region.

The focus of modern dentistry has consistently been, and shall continue to be, the dentist's responsibility to fulfil the requirements for a fully functional and visually appealing dentition, tailored to the unique characteristics of each patient. The field of dental implantology has advanced remarkably in recent years with continual improvements in surgical techniques, biomaterials and prosthetic technologies. These advances have enabled general dental practi-

tioners to integrate implant procedures more readily into their practices, expanding patient access to implant-supported restorations.

It is crucial for dentists to recognize that complications may arise either during or after the surgical process, as well as during the placement of prosthetic components, potentially jeopardizing the overall treatment outcome. Early complications during implantation which may directly affect the immediate aesthetic outcome of the suprastructures are considered to be: infection, edema, ecchymoses, hematomas, emphysema, bleeding, dehiscences and sensitive alterations. Late complications, occurring after initial healing can affect the aesthetics of prosthetic restorations placed over dental implants, are considered to be: perforations of the mucoperiosteal flap, maxillary sinusitis, mandibular fractures, loss of osseointegration, bone defects, and of course the occurrence of peri-implantitis and other infectious conditions of the tissues occluding dental implants[1].

The successful establishment of aesthetic qualities in the superstructures supporting dental implants is largely contingent upon a comprehensive understanding of biological, periodontal, and surgical principles[2].

Various elements have been identified that significantly affect the aesthetic quality of definitive prosthetic superstructures and the long-term efficacy of oral implantology. The first group of elements pertains to periodontal factors, which include the morphological characteristics and positioning of the gingiva, the periodontal biotype, the positioning of the lower lip in both relaxed and smiling conditions, and the interocclusal space. The second group is associated with surgical interventions, which involve the ability to regenerate soft tissues and alveolar bone, correct implant positioning, and the absence of the need for flap elevation. The final group of relates to prosthetic rehabilitation, encompassing the morphology and interrelationships of suprastructures, the interaction of prosthetic devices with adjacent soft tissues,and the careful planning of prosthetic devices[3,4].

According to the findings of Ramanauskaite and Sader[5], key factors that influence the aesthetic success of prosthetic superstructures over implants placed in the anterior region of the oral cavity include the presence of interdental spaces gingivaltissue near a dental primarily depends on the clinical attachment level of the adjacent tooth.

The extent of tissue loss at the beginning of treatment plays a crucial role in determining the predictability of aesthetic success for dental implants. As the loss of alveolar bone and soft tissue increases, achieving an ideal aesthetic outcome becomes significantly more difficult. Furthermore, aesthetic challenges vary considerably when comparing the replacement of a single tooth to the replacement of multiple teeth in the aesthetic zone.

It is important to note that recent scientific literature increasing focuses on the issue of insufficient mucosal volume around implants, particularly because non-invasive evaluations of soft tissue volume remains complex[6].

Expectations from implant therapy in today's dental practice have evolved substantially compared to previous decades. The growing number of implants placed in aesthetic zones is directly associated with a rise in complications related to such treatments. Therefore, it is essential to thoroughly document aesthetic complications and to define the associated risk factors[7].

Evidence gathered from the literature indicates that the aesthetic outcomesexperienced by patients after the application of suprastructures on dental implants depend on a variety of factors. Accordingly, this research focuses on the complications that may arise following the placement of suprastructures on dental implants located in the aesthetically critical maxillary anterior region. Identifying these complications, and exploring methods for their prevention and management represents a significant responsibility for dental clinicians involved in implant placement and prosthetic restoration[8].

Given the increase importance of aesthetics in contemporary dentistry-driven largely by growing patients expectations-this study aims to evaluate the impact of complications associated with implant therapy on the aesthetic outcomes following the placement of superstructures in the maxillary aesthetic region.

Material and method

This study involved a total of 163 respondents, consisting of 79 males (48.47%) and 84 females (51.53%) with and average age of 54 years. The research was conducted at a private dental office „Dr. Bajraktarov“ in Strumica, Republic of North Macedonia, between Mayand October 2022.

Participants were required to meet specific inclusion criteria: they myust have undergone implant treatment within the past two years, havra permanently fixed superstructure, and have used for a minimum duration of six months.

All patients who met the defined inclusion criteria were invited to participate in a follow-up examination. This group also included patients who presented at the clinic with complaints related to their dental implants or prosthetic superstructures. A comprehensive medical and dental history was taken from each patient, with particular emphasis of their main complaints-especially those related to aesthetics.

An additional component of the study involved a survey designated to evaluate how existing complications affected the patients' personal perception of aesthetic eval-

uations. Simultaneously, a small portion of the questionnaire was completed by the dentist-clinician who assessed the aesthetic impact of the complications from a clinical perspective.

The questionnaire was fully completed by all participants, including the three dentists who form part of the implant therapy team at the clinic.

The clinical evaluations involved two key assessments":

1. Assessment of the impact of prosthetic superstructures in the maxillary aesthetic region in terms of aesthetics

   This form of assessment is based on patient responses to questions regarding the aesthetic implications of prosthetic rehabilitation for those with dental implants in the upper frontal region. Patients were e asked to choose t from the options: Improved aesthetic effect, Worsened aesthetic effect, or No impact on aesthetics. Respondents who noted a decline in aesthetic quality were subsequently asked to evaluate the severity of this decline, with options including significantly, moderately, or satisfactorily deteriorated aesthetics.
2. Ultimately, the clinicians involved in the interventions conducted an evaluation of the effects of prosthetic superstructures positioned over dental implants in the maxillary aesthetic area on overall aesthetics. The results were categorized according the degree of aesthetic impact as foolows: significantly deteriorated aesthetics, moderately deteriorated aesthetics, or satisfactorily deteriorated aesthetics.

Results and discussion

The analysis showed a total of 277 dental implants were placed across the entire study population. It was also noted that the average number of dental implants per patient was 1.680982 ± 1.086991, with a range from 1 to 8 implants. The relationship between the number of patients and the dental implants placed is presented in Table 1. The average duration of implant therapy, defined as the time from the placement of dental implants in the studied group, was found to be 20.07362 ± 17.12027 months, with a range of 10 to 59 months.

Tabele 1. Number of dental implants per subject

Number of implants per subject	Subjects	Percentage
1	94	57,67
2	44	26,99
3	18	11,04

Tabele 2. Type of suprastructures

Type of suprastructure	Subjects	Percentage
Solo crowns	79	48.47
Bridge with maximum 4 artificial teeth	21	12.88
Bridge with 5-6 artificial teeth	59	36.19
Bridge construction with more than 7 artificial teeth	4	2.46

The analysis of the studied population reveals that solo crowns in the anterior maxillary region are the most frequently utilized type of prosthetic superstructure, comprising just under 48.47% of the cases. The next most common type of prosthodontic appliance was bridge construction, which connects both canine teeth and is present in 36.19% of the respondents. Furthermore, 12.88% of the participants, equating to 21 individuals, reported having bridge constructions with a maximum of four teeth. Of these, 20 individuals had bridges that included the two central and two lateral incisors, while one individual had a bridge that spanned teeth 11-23. Additionally, a small subset of four subjects (2.46%) had bridge constructions with more than six teeth, including one subject with a bridge from 15-24, another from 15-25, and two subjects with bridges covering teeth from 16-26 (Table 2.).

The findings indicate that complications were present in 22 participants from the studied population, which corresponds to 13.49% of the entire sample analyzed (Table 3.).

Tabele 3. Assessment of the aesthetic complications

Complications	Subjects	Percentage
Present	22	13.49
Absent	141	86.51

Of the total number of respondents who experienced complications from dental implants, it was noted that in 86.36% of the subjects there was a deterioration in aesthetics due to the present complication, while 13.63% of the respondents indicated neither a deterioration nor an improvement in aesthetics from the complications themselves (status quo condition) (Table 4.).

Tabele 4. Influence of complications on aesthetics

influence	Subjects	Percentage
Better aesthetics	0	0 %
Worsen aesthetics	19	86,36 %
No influance	3	13,63 %

Furthermore, each of the subjects made a subjective assessment of the degree of deterioration in aesthetics due to the complications present in the maxillary region. Thus, the majority of the subjects estimated that they had a significant deterioration in aesthetics (47.36%). A smaller proportion of respondents indicated that they had a moderate deterioration in aesthetics (31.58%), while only 21.06% of respondents indicated that they had a minimal deterioration in aesthetics (Table 5.).

Tabele 5. Grading of the aesthetic effect by the patients

grading	Subjects	Percentage
significantly impaired aesthetics	9	47,36 %
moderately impaired aesthetics	6	31,58 %
minimal impaired aesthetics	4	21,06 %

Gradation of the deterioration of the aesthetic effect in patients during the study was also performed by the doctors, based on their subjective assessment. Most clinicians indicated that there was a significant deterioration in aesthetics due to the complications present (57.89%). Moderate deterioration of achieved aesthetics was assessed by 31.58% of the superstructures with complications, while 10.53% of clinicians indicated that the complications present after implantation of the maxillary frontal region lead to a minimal disruption of the achieved aesthetics (Table 6.).

Tabele 6. Grading of the aesthetic effect by the clinicians

influence	Subjects	Percentage
significantly impaired aesthetics	11	57,89 %
moderately impaired aesthetics	6	31,58 %
minimal impaired aesthetics	2	10,53 %

The importance of aesthetics in contemporary life and human functionality is increasingly recognized. With patients placing greater emphasis on achieving an appealing appearance and smile, there has been a notable rise in the demand for dental implants, resulting in a continuous increase in their application. The advancements in the characteristics of these implants provide a valid rationale for this growing demand. As the number of individuals undergoing implant therapy continues to expand, dental professionals must navigate the associated challenges and potential complications inherent in these complex restorative interventions. To minimize complications, it is imperative to prioritize thorough preoperative preparation. The processes of diagnosis and treatment planning should be informed by a careful evaluation of current risk factors, and the assessment of the advantages of implant therapy should follow a detailed anamnestic procedure, alongside comprehensive medical, dental, psychological, and radiographic evaluations.

Throughout the research, endosseous dental implants were consistently employed across all cases studied. To achieve the research aims, only one specific type of implant from Implant Swiss was utilized. Some participants underwent a two-phase surgical technique with delayed loading, while others experienced immediate implantation. The study did not differentiate between the types of dental implants or the loading methods of the dental implants. Moreover, the investigation did not focus on the types of prosthetic superstructures; instead, it considered patient satisfaction with the aesthetic results following the placement of these superstructures as the primary measure.

In our study, we found that 86.36% of patients reported a decline in aesthetic quality attributed to the complications they experienced, while 13.63% noted no change in aesthetics. Among the respondents, 47.36% experienced a significant decline in aesthetics, 31.58% reported a moderate decline, and 21.06% indicated only a minimal decline. Clinicians also assessed the aesthetic impact of these complications based on their subjective observations. A majority, 57.89%, of the clinicians reported a significant deterioration in aesthetics, while 31.58% noted a moderate decline, and 10.53% observed only a minimal disruption in aesthetics following complications from the implantation in the maxillary frontal region. It is important to highlight that the higher percentage of significant aesthetic deterioration reported by clinicians may be attributed to their heightened sensitivity in identifying even minor imperfections in the outcomes.

The influence of superstructures on dental implants significantly affects the perception and outcomes of smile aesthetics, with complications further complicating these effects. This leads to a diverse interpretation of aesthetics among different groups, including the general public, den-

tal students, and specialists across various dental fields. Such differences likely explain the varying degrees of aesthetic satisfaction reported by patients. However, the study's limitations are exacerbated by the lack of subjective measures to evaluate the impact of complications on the aesthetics of superstructures. Aesthetics is fundamentally a personal experience, heavily influenced by the subjective desires of patients who engage with dental services. Therefore, we contend that their evaluations can be interpreted as having positive implications, thereby enhancing the relevance of this study.

Moreover, another constraint of this investigation is the application of diverse implant types, loading strategies, and superstructure variations. Given the broad spectrum of research possibilities in this field, we hope that this study will motivate additional research that will clarify the aesthetic consequences of the various complications that may occur during the postoperative period of dental implant therapy. In summary, we believe that the results presented will be beneficial for clinicians in grasping the aesthetic implications of complications associated with implant therapy in the anterior region of the maxilla.

Conclusion

The analysis of the collected data and the study results leads to several key conclusions regarding the influence of complications arising from implant therapy in the maxillary frontal region on aesthetic outcomes. A significant majority of respondents reported that complications resulted in a decline in aesthetic quality. Subjective evaluations of aesthetic deterioration due to complications in the maxillary region revealed that most respondents perceived a significant decline, with clinicians reporting an even greater extent of disruption to aesthetic outcomes.

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PERIODONTAL ASPECTS FOR ACHIEVING SUCCESSFUL FIXED PROSTHODONTIC TREATMENT

ПАРОДОНТОЛОШКИ АСПЕКТИ ЗА ПОСТИГНУВАЊЕ НА УСПЕШЕН ФИКСНО ПРОТЕТИЧКИ ТРЕТМАН

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Abstract

In recent years, astechnological advancements have significantly improved the quality of life, the desire for an attractive smile has become an increasingly important aspect of personal appearance and self-confidence. Today's dental patients not only seeking solutions to functional and medical concerns, but also have high expectations regarding the aesthetic outcomes of dental procedures and restorations. The smile plays a crucial role in defining one's facial aesthetics, and can result in harmonious and beautiful appearance. Achieving a pleasant smile and optimal a red-white aesthetic (the harmony between teeth and gingival tissues) is only possible when the health of the supporting periodontal structures is maintained or enhanced. Therefore, prosthodontists must have a thorough understanding of the biological width, accurately assess its dimensions, and assess the gingival biotype concerning the position of the finish line and the margin of the artificial crown. These considerations are essential to preserving the integrity of the supporting tissues of the abutments (teeth restored with prosthetic restorations). The prosthodontist also should be able to anticipate the behavior of both soft and hard tissues in response to prosthetic intervention to support long-term periodontal health and functional stability. In patients where the biologic width vilated and a new prosthetic constructionis required, corrective interventions such as surgical crown lengthening or the use of orthodontic techniques may be necessary to re-establish a healthy relationship between the restoration and the surrounding periodontium. **Keywords:** biological width, gingival biotype, aesthetics, biologically oriented preparation, preparation margins, correction of violation of biological width.

Апстракт

Во време кога развојот на технологијата значително го подобрува животниот стандард, желбата да се има естетски задоволителна насмевка стана многу важна компонента на живеењето. Пациентите, освен лекувањето на патолошките состојби, при спроведувањето на протетичката терапија имаат високи очекувања поврзани со крајниот естетски изглед на изработените реставрации или спроведените терапевтски процедури. Насмевката е еден од најзначајните аспекти на убавината која влијае на физичкиот изглед на една индивидуа. Дизајнирањето на насмевката (во стоматологијата) се базира на уметнички и научни принципи кои, кога се применуваат заедно, може да искреираат убава насмевка.Убава насмевка подразбира здрави и правилно подредени заби и здрави орални меки ткива. Познавањето на концептот на биолошката ширина, одредувањето на нејзината категорија идетерминирањето на биотипот на гингивата се од огромно значење за сочувување на пародонталното здравје. Во таа насока, изборот на дизајн и позиционираност на границата на препарација во однос на гингивата, влијаат врз одржувањето на интегритетот на потпорниот апарат на забите носачи на протетичката конструкција. Протетичарот треба да предвиди какво ќе биде влијанието на тераписките процедури и протетичките реставрации врз меките и тврди орални ткива, со цел сочувување и подобрување на пародонталното здравје. Во ситуации кога биолошката ширина е веќе компромитирана, а треба да се изработи нова протетичка конструкција, методите кои се достапни за нејзина корекција се хируршко продолжување на клиничката коронка и спроведување на одредени ортодонтски техники. **Клучни зборови:** биолошка ширина, биотип на гингива, естетика, маргини на препарација, биолошки ориентирана препарација, методи на корекција на нарушување на биолошката ширина.

Introduction

Periodontal health plays is a critical factor in the long-term success of prosthetic restorations, making careful treatment planning essential. The selection of an appropriate prosthetic approach significantly influences both the functional outcome and the longevity of the restoration.

Errors in prosthetic planning-such as inadequate assessment, inappropriate material selection, or poorly fitted fixed restorations-can lead to biomechanical disruption of

the stomatognathic system, compromise periodontal stability, and ultimately affect the patients's overall oral and systemic healt[1].

Improperly designed or executed prosthetic restorations may not only contribute to the development or progression of periodontal disease[2], but also result in chronic inflamed of the surrounding tissues. Such conditions can impairoral function, hinder hygiene maintenance, and detract from facial aesthetics, ultimately diminishing the patient's self-esteem and quality of life[3].

Morphological and functional disturbances of the stomatognathic system associated with periodontal pathology occur up to five times more frequently than those caused by dental caries[4]. Periodontal disease is an inflammatory condition that affectsperiodontal tissues (cementum, periodontal ligament, alveolar bone, and gingiva)[5], often leading to tooth extraction and subsequent prosthetic treatment.

Proper finishing and polishing of prosthetic restorations in accordance according to the manufacturer's material specification guidelines is critical[6], as surface roughness can facilitate bacterial biofilm formation.

Achieving successful prosthetic treatment requires close collaboration between periodontists and prosthodontists[7], to enhance restoration longevity, maintain periodontal health, and improve patients' quality of life[8]. The aesthetics and durability of prosthetic restorations directly depend on the harmony and biofunctionality between the prosthetic restoration and the periodontium[7].

The aim of this review article

The aim of this review article is to synthesize current literature on the interrelationship between Periodontology and Fixed prosthodontics, with the following objectives:

- to emphasize the importance of the biological width and gingival biotype, and to guide the selection of appropriate tooth preparation techniques and optimal positioning of crowns' marginsposition,
- to provide a detailed analyzes of the biologically oriented preparation technique and its clinical implications,
- to study the available therapeutic approaches for correction biological width violation.

Material and method

A research was conducted using the Pubmed, Research Gate and Science Direct databases. The search was performed using the following keywords: biological width, gingival biotype, aesthetics, biologically oriented preparation, preparation margins, correction of violation of biological width.

From the numerous results generated by these keyword, articleswere selected based on their relevance to key topics of interest-specifically, those that address the concepts of the biological width and gingival biotype, the types of tooth preparation type and margin positioning, detailed descriptions of the y oriented preparation, and methods for correcting biological width violation.

Results

The analysis of numerous studies published on this topic, confirms the strong connection between respecting adherence to periodontal principles and the fabricationof fixed prosthetic restorations, both in terms achieving optimal aesthetic requirements of patients and in terms of fulfilling functional requirements. The longevity of fixed prosthetic is highly dependent on the preservation of biological width across all its variations. Also, this review highlights the critical importance of selecting the appropriate preparation technique and accurately positioning the prosthetic margins in accordance with the periodontal condition of the teeth, as a these factors are key to maintaining or improving periodontal health.

At the same time, throughthe analysis of the available papers during the literature review to fulfill the objectives of this review article, a comparison of the available methods for correction of the biological width violation from old fixed prosthetic constructions was made.

Concept of Biological Width

The human body is vulnerableto invasion by various pathogens (bacteria and viruses) and foreign bodies. Ectoderm-derived tissues play a vitalrole in the body's defense mechanism against these harmful agents.In this context, the ectodermal tissue complex – comprising the junctional epithelium and underlying connective tissue, collectively referred to as "Biological Width" – acts as a natural shield around the tooth. When its integrityis maintained, the biological width effectively shields s the alveolar bone from infections and diseases[9].

Biologic width (BW) is defined as the physiologic dimension of the junctional epithelium and connective tissue attachment. Itextends from the cervical portion of the clinical crown to the alveolar bone crest[10]. The biologic width is a measurable entity, calculated from the sulcus base (with an average depth of 0.69 mm), including the junctional epithelium (0.71–1.35 mm) and the supracrestal connective tissue (1.07 mm), resulting in an average biological width of 2.04 mm[11].

When fabricating fixed prosthetic restorations, preservation of the biological width is essential for maintaining periodontal health[13]. Any irritation or disruption to the bio-

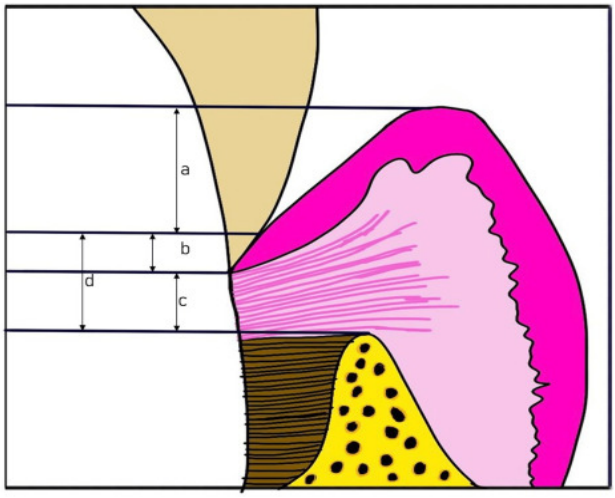

Figure 1. *Schematic representation of biological width components: a) Gngival sulcus of 0.69 mm, b) Epithelial attachment of 0.97 mm, c) Connective tissue attachment of 1.07 mm, d) Biological width (b+c)*[12]

logical width can lead to the periodontium damage during prosthetic rehabilitation. Fixed prosthetic restorations that invade biological width predispose the involved teeth to subgingival caries and uncontrolled inflammatory responses, ultimately leading to periodontal tissue destruction[11].

In cases where subgingival preparation is necessary, care must be taken to avoid disrupting disrupting the integrity of the junctional epithelium or connective tissue during preparation[15] or impression-taking using an oversized retraction cord. Even when the retraction cord is of optimal dimensions, but remains in the sulcus for more than 15 minutes (the retraction fluid as a chemical agent, along with the mechanical effect of the cord itself), may cause permanent alterations to gingival morphology. Subgingival finish line should not extend deeper than 0.5 to 1 mm, as it is impossible for the clinician to detect where the sulcular epithelium ends, and the junctional epithelium begins[15]. Additionally, a minimum distance of 3 mm from the crown margin to the alveolar crest should be maintained to prevent alveolar bone resorption[10]. Other studies have found that alveolar bone damage occurs when the crown margin is less than 2.7 mm from the alveolar crest[16].

The critical distance from the artificial crown margin to the alveolar crest that avoids bone damage is referred to as the "biological zone". It consist of the connective tissue attachment, epithelial attachment, and 0.5 mm of the apical part of the gingival sulcus. The biological zone measures 2.5 mm buccally and orally and is larger proximally[17].

Categories of Biological Width

Before tooth preparation, it is essential to assess the distance from the gingival margin to the alveolar crest to ensure that biologic width is respected. This measurement is typically performed using a periodontal probe local anesthesia[10].

The probing should be carried out mid-facially (Figure 2.)[16] and at the facial/interproximal line angles.

Figure 2. *Assessment of the distance from the gingival margin to the alveolar crest*[16]

Based on probing measurements, patients are classified into three categories: normal crest, low crest and high crest patients[18] (Figure 3.).

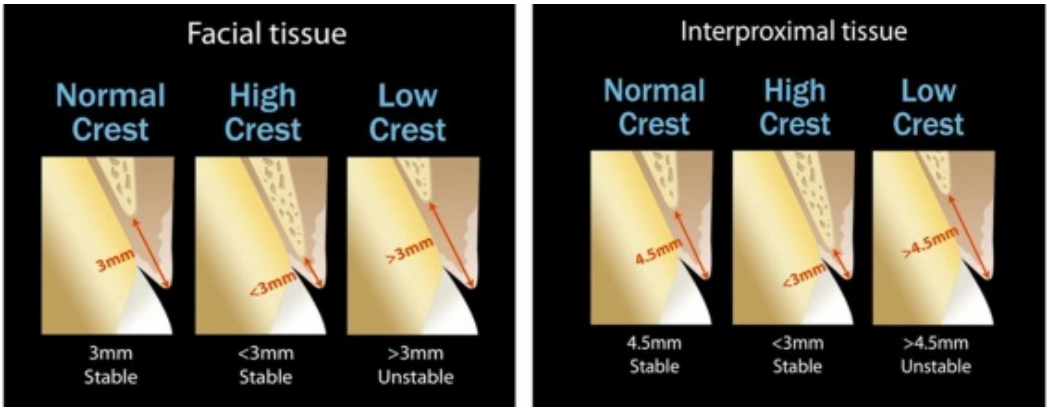

Figure 3. *Categoriesof Biological Width*[19]

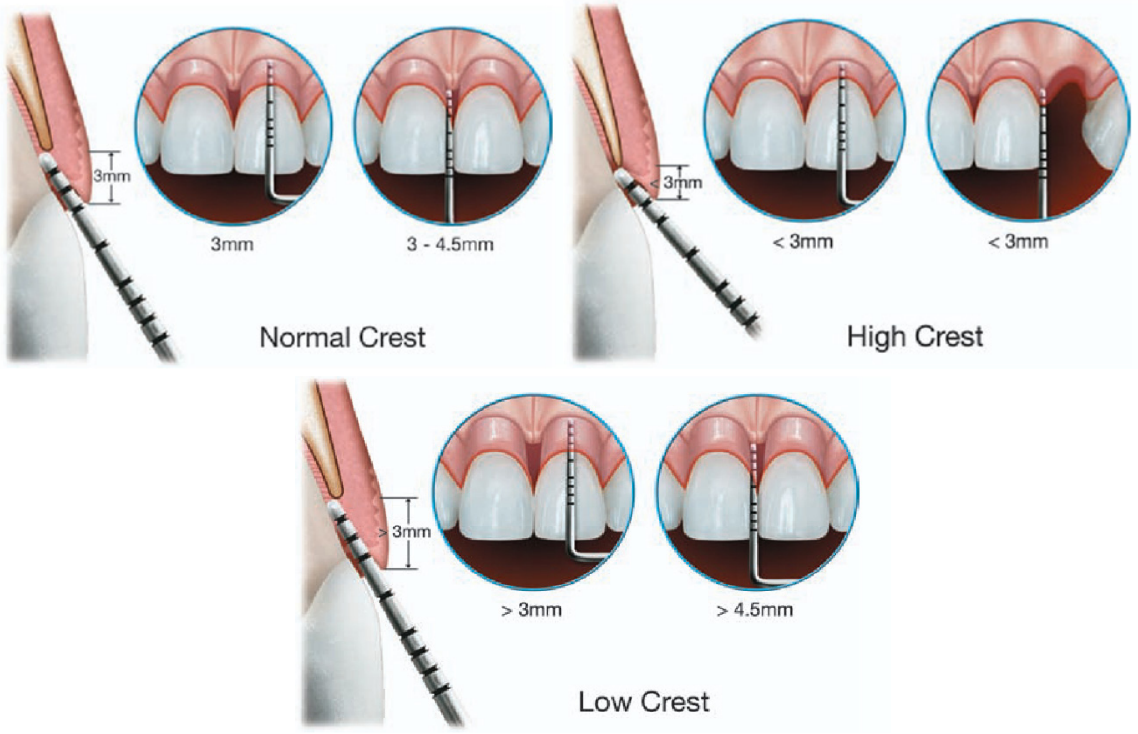

Figure 4. *a) Normal Crest, b) High Crest, c) Low Crest*[16]

Normal Crest: Approximately 85% of patients belong to this category; on the vestibular and oral sides BW measures 3.0 mm, while on the proximal surfaces, it measures up to 4.5 mm (Figure 4a); a dimension of 3 mm is accepted as the average value. In these patients, the gingival tissue typically remains stable over the long term. Crown margins should not be positioned at a distance less than 2.5 mm from the alveolar crest i.e. the gingival tissues generally remain healthy if the crown margin is positioned 0.5 mm subgingival.

High Crest: 2% of patients exhibit biological width values below 3 mm. Placing crown margins subgingival in these patients risks persistent gingival inflammation due to proximity to the alveolar crest.

Low Crest: About13% of patients have biological width values exceeding 3 mm, and sometime it is greater than 4.5 mm on proximal surfaces[18] (Figure 4c). The junctional epithelium often becomes damaged during retraction cord application. Patients with a low crest respond differently to prosthetic procedures depending on sulcus depth:

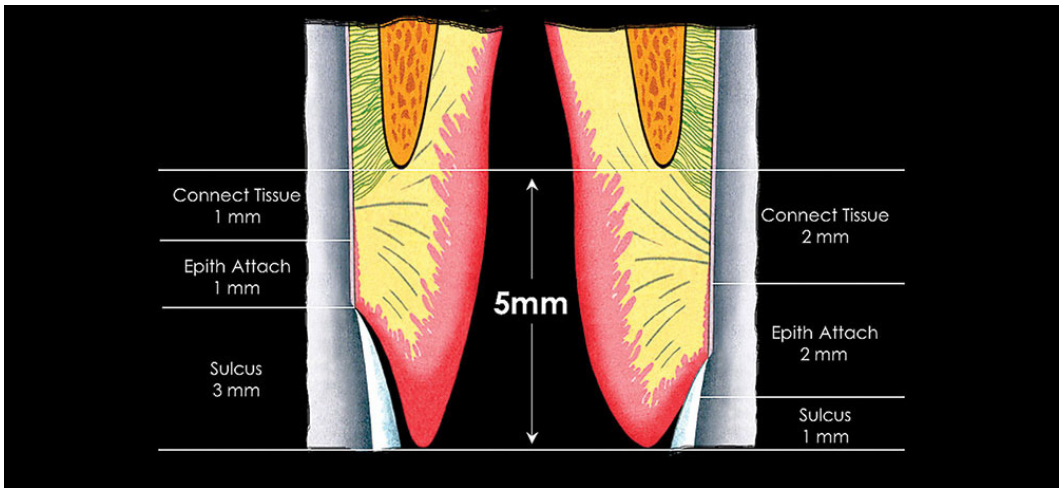

Figure 4. ***Variations in Biological Width in the Low-Crest patient*** *(the total height of gingiva above the alveolar bone is 5 mm)*

some tend towards gingival recession, while others maintain a stable gingival response.

Variations within this crest type depend on sulcus depth (Figure 5)[20]: in cases of a deep sulcus, both the epithelial attachment and the underlying connective tissue are small in dimension, whereas in cases of a shallow sulcus, both the epithelial attachment and connective tissue are larger.

Left - An average biologic width of 2 mm, with an epithelial attachment of 1 mm and a connective tissue attachment of 1 mm; the sulcus depth is 3 mm (the recession might followany restorative procedure);

Right - A total biologic width of 4 mm, with an epithelial attachment of 2 mm, anda connective tissue attachment of 2 mm; the sulcus depth is 1 mm (there is a minimal risk of recession).

Although both cases involve patients with reduced alveolar ridges, the prosthetic treatment approach will differ accordingly:

- In the first case, gingivectomy is recommended prior toinitiating restorative procedures in order to increase the clinical crown length[20].
- In the second case, careful tooth preparation is essential, as subgingival placement of the crown margin in such patients may easily result into gingival recession, particularly given that this ridge type often exhibits a thin gingival biotype[20].

The Significance of Assessing the Patient's Alveolar Crest Category

When preparing anterior teeth for indirect restorations, clinicians must evaluate the patient's alveolar crest category. This assessment guides the optimal placement of the finish line[21] and is primarily based on sulcus depth, as follows:

- If the sulcus depth is ≤ 1.5 mm, the crown margin should be placed approximately 0.5 mm below the crest of the marginal gingiva.
- For sulcus depths exceeding 1.5 mm, the crown margin should be positioned at half the sulcus depth.
- In cases where the sulcus depth is greater than 2 mm, a gingivectomy may be indicated to extend the clinical crown[22].

Aesthetic Considerations of the Artificial Crown concerning the Gingival Morphology and Alveolar Crest Category

In natural teeth, the base of the sulcus bottom ideally aligns with the cementoenamel junction, ensuring harmonious balance between red (soft) and white (hard) tissue-sachievingred-white aesthetic. Gingival morphology is often associatedwith tooth shape and form, which can be categorized as triangular, oval, or square[23].

- *Square-shaped teeth* typically odder more favorable aesthetic outcomes due to their longer proximal contact areas and reducedinterdental papillae.
- *Triangular-shaped teeth* have interdental contacts placedincisaly, necessitating more tissue to fill interdental spaces. These cases carry a higher risk of gingival recession and the development of black triangles[24].

In patients with a normal alveolar crest, if interdental papilla damage occurs during treatment, it is recommended measurement with a graduated probe. When the distance from the alveolar bone crest to the interdental papilla is less than 5 mm, tissue regeneration often restores the papillae, filling black triangles. Conversely, distances greater than 5 mm generally do not permit tissue to regenerate adequately, resulting in persistent black triangles.

Assessment of Biological Width Violation

Biological width violation is diagnosed when the distance between the crown margin and the alveolar crest measures less than 2 mm, regardless of the number of probing sites. For reliable reliable assessment, measurement should be takenon healthy tissues and teeth not involved in restorative procedures to account for individual variations based on biological width categories[25].

Clini signs indicative of biological width violation due to extended restorations include:

- Discomfort or pain upon gentle probing beneath the crown margin
- Clinical attachment loss
- Alveolar bone resorption
- Gingival recession
- Periodontal pocket formation
- Chronic gingival inflammation
- Gingival hyperplasia[26].

Gingival Biotype and Periodontal Health in Fixed Prosthodontics

The periodontal phenotype, comprising gingival biotype (the three-dimensional volume of the gingiva) and alveolar bone morphology (the thickness of the buccal lamella), plays a crucial role in determining treatment outcomes[27].

The gingival biotype is classified as either thick (≥2 mm) or thin (<1.5 mm). Approximately 85% of the population exhibits a thick biotype, which is associated with enhanced periodontal health and resistance to inflammation. The remaining 15% possess a thin biotype, characterized by translucency and a higher susceptibility to recession and aesthetic issues[25].

- *Thick biotype:* Characterized byfibrotic soft tissue and densebone structure,a thick periodontium, a wide zone of keratinized gingiva, and flat gingival contours;teeth crowns are square-shaped, withbroad proximal contacts[29]. These tissues tend to respond predictably to surgical procedures, with minimal bone resorption observed post-extractio[30]. If any inflammation, it responds with mild edema, cyanotic gingiva, and bleeding upon probing, while the hard tissues exhibit bone loss and periodontal pocket formation[18].
- *Thin biotype:* Characterized by translucent gingival tissue, with delicate and thin periodontium, and minimal zone of attached gingiva (prone to recession), triangular-shaped crowns, and small proximal contacts positioned incisally, sharp alveolar bone contours, and minimal bone tissue over the buccal side of the tooth roots (prone to fenestration and dehiscence)[29].Due to gingival translucency, the metal edge of a metal-ceramic construction or the abutment of an implant may be visible. During the inflammation, soft tissues respond with redness and recession, while alveolar bone with rapid loss[18]. After surgical interventions, predicting tissue positioning during healing is difficult. Upon extraction, rapid bone resorption occurs in the apical direction[31].

Given these differences, the thick biotype generally demonstrates greater resistance to periodontal breakdown, with a tendency toward periodontal pocket formation, whereas the thin biotype is more prone to recession, especially following inadequate preparation or biological width violation[32].

Implications for Fixed Prosthetic Planning

Variations ingingival sulcus depth, tissue thickness, and alveolar crest position must be carefully considered during treatment planning[33]. Accurate identification ofthe gingival biotype is crucial; as appropriate management during tooth preparation helps minimizes risks of tissue resorption and other complications affecting both soft and hard tissues. Inadequate preparation that disturbs the biological may induce gradual tissue changes, including a transition from thick to thin biotypes or vice versa[34]. Notably, the thin biotype is particularly susceptible to recession, emphasizing the importance of positioning preparation margins supragingival whenever feasible.

Types of tooth preparation

Fixed prosthetic restorations cemented onto previously prepared teeth (abutments) offeran alternative for replacing tooth structure, restoring their form, function, and aesthetics[35].

Various preparation techniques have been described in the literature for fabricating fixed dental restorations. They are mainly categorized into horizontal preparations (chamfer, shoulder or bevel shoulder) and vertical preparations (feather edge(or knife-edge) and biologically oriented preparation technique [BOPT])[36].

Vertical designs reduce the marginal space or gap of the restoration and provide a less irritable environment in the gingival sulcus[37]. Despite this, and despite the different preparation techniques, clinicians more often prefer the horizontal preparation for practical reasons. It is visible on the prepared tooth, on the impression, and facilitates the adaptation of the final restoration[38].

Compared to conventional methods, biologically oriented preparation involves eliminating the natural appearance of the tooth and creating a new appearance of the tooth and the surrounding soft tissues, defined by a temporary construction, emphasizing the importance of the fabrication protocol and the implementation of the therapeutic plan. Therefore, this preparation technique determines the new appearance of the tooth, supports the marginal gingiva, guides its healing and reinsertion, and facilitates its thickening[36].

Regardless of the applied preparation technique, ensuring stability and a solid marginal adaptation is crucial for the longevity of the restoration. Apical migration of the gingiva is considered a serious complication arising from inadequate planning of the prosthetic treatment and management of soft tissues during the procedure[39]. This may be related to several etiological factors, such as positioning the preparation margins deeply subgingivally, iatrogenic trauma to the gingiva during preparation or impression taking, excessive contouring of the marginal edge of the restoration positioned subgingivally, and careless techniques in cases of thin gingival biotype[40].

The importance of the finish lineandmarginal adaptation of ceramic restorations has been extensively studied. The horizontal chamfer-type preparation and the vertical preparation are the most conservative and commonly used. However, it has been established that the chamfer-type preparations are more frequently used due to its minimally invasive approach and superior marginal adaptation[41].

Tooth preparation for fixed prosthetic restorations is a routine procedure and it has been recognized that clinicians

do not follow the same standardized approach to finish line of preparation in all patients.

Types of Margin placement

The longevity of a prosthetic restoration is directly influenced by its marginal fit. Inadequate internal fit between the restoration and the prepared tooth and inadequate fit of the cervical margin of restoration to the finish line of preparation are crucial factors that play an important role in marginal integrity and in the preservation of pulpal and periodontal health[43].

Therefore, from a periodontal perspective, the most important thing is type of preparation that will be performed (horizontal or vertical); if it is a horizontal preparation, the position of the finish line in relation to marginal gingiva is very important: supragingival, equigingival or subgingival[44]. The main difference between horizontal and vertical preparation is that in horizontal preparation the finish lineis determined by the dentist during the preparation, while in vertical preparation the cervical margin of the restoration is determined in dental lab by the dental technician[45], there is no visibleline of reference between the prepared and unprepared tooth structure.

Equigingival margins placement induces greater biofilm accumulation and gingival irritation than subgingival and supragingival positioning[46]. This placement can be performed in aesthetic zones if it is possible to provide a well-polished smooth surface at the gingival(cervical) margin of the restoration[47].

Supragingivalmargins placement, better oral hygiene can be practiced and usually periodontal disease and secondary caries, which are lesions that develop near existing dental restorations, have not been detected. This type of marginal does not adversely affect the periodontium at all. Due to the visibility of the margin, this type of preparation is performed in the posterior regions or non-esthetic zones[48]. However, this preparation can also be performed in the esthetic zone using translucent restorative materials such as resin adhesive cements[44].

Due to caries-induced cavities, tooth imperfections resulting from enamel hypoplasia or enamel infractions, and for aesthetic reasons, the margin of the future crown often has to be positioned **subgingivally**. The gingival attachment is affected by the margin of the restoration, causing a persistent inflammatory reaction that worsens over time due to the patient's inability to maintain proper oral hygiene[10]. This is an area where plaque is retained and it is impossible to completely clean it even with an ultrasonic instrument[49]. Gingival recession and bone loss occur since the body attempts to provide space for tissue to reattach[1]. This is especially common in patients whosealveolar bone is very sharp around the entire tooth[10]. A thin gingival biotype is also at higher risk of recession[22]. Proper planning of the positioning of the preparation margins, proper rounding and polishing of those surfaces, and of course, maintaining biological widthand no violation of this space, are inevitable in order to ensure periodontal health[49]. Given the fact that subgingival margins do not allow good oral hygiene, implies a need for increased monitoring or checkups for these specific group of patients.

Precise internal and marginal adaptation is essential for the final result and long-term successof a prosthetic restoration. Marginal discrepancy (gap) results in a large space

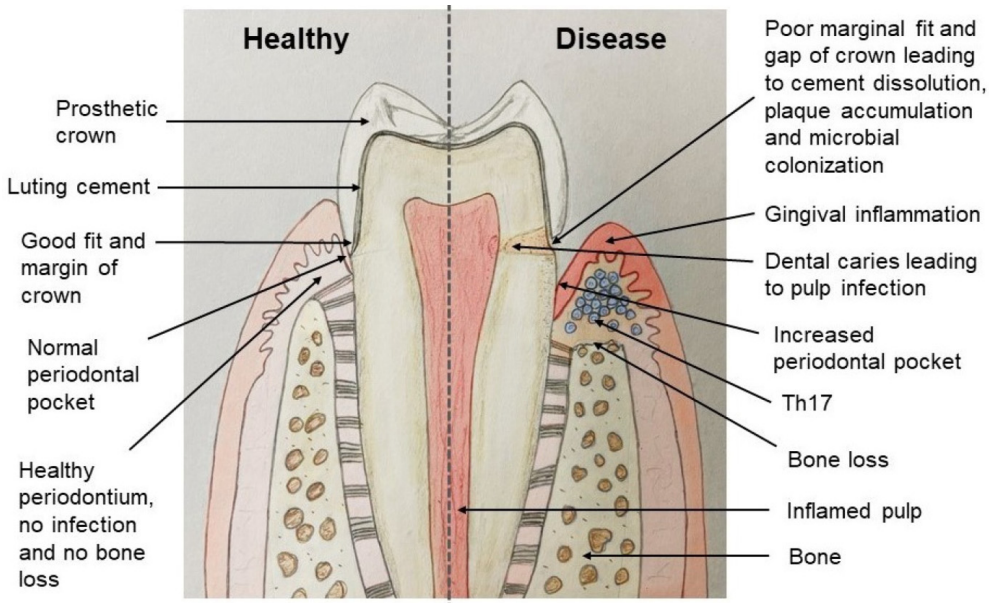

Figure 6. *Good marginal fit of the crown and a poor marginal fit leading to consequence[6]*

between the restoration and the tooth which is later filled with thick cementum more susceptible to external influence, likesaliva, resulting in cementum dissolution, plaque accumulation, microcracks, microleakage and marginal discoloration, an increase in crevicular fluid flow, caries, pulpal tissue infection and ultimately periodontal disease and bone loss, leading to complete failure of the prosthetic treatment[43].

Biologically oriented preparation

Another valuabletechnique is vertical preparation, which today has been slightly modified and called biologically oriented preparation[45]. It is a technique that aims an anatomical tooth core that simulates the appearance of a tooth to be created that will be without a visible finish line[36]. This new approach, known as biologically oriented preparation, although very similar to the classic vertical preparation (feather edge preparation), differs from it in that the enamel-cementum junctionis erased during the preparation, after which then, in the laboratory, a new final margin of the construction is produced. At the same time, minimal gingival curettage (gingitage) is performed circularly around the tooth; in this way, the aim is to create a new connection of the soft tissue with the prosthetic construction. This technique is used in periodontally healthy teeth, and can be applied in both the aesthetic zone and the posterior region; it achieves highly aesthetic and clinically satisfactory results in terms of soft tissue stability, as well as an appropriate relationship between the crown and the gingiva, and also minimizes tooth tissue loss[46].

Akey component of biologically oriented preparation relies on the fabricationof an immediate[45] temporary construction that will provide support for the formation of a new positionof marginal gingiva[52]. The temporary construction will allow healing and thickening of the gingiva to the desired level of the cervical margin of the definitive restorationcrown[36]. The procedure for creating temporary crowns is very important, as it helps the adjacent soft tissue to adapt its shape and location to the new prosthetic design, on the other hand, to determine the new position of the marginal gingiva[51,36]. This extends the lifespan of the construction, which is significantly longer in constructions that rest on teeth (abutments) prepared this way, unlike a construction made on teeth prepared with a horizontal preparation where recession is more common[51,53,54], due to the reduction of bacterial infiltration and maintainance of the periodontal health[38,55].

It is also important to note that this finish-line technique is simpler and faster in terms of tooth preparation, impression taking, fabrication of temporary crowns, and final restoration design[45]. In fixed prosthetic restorations using

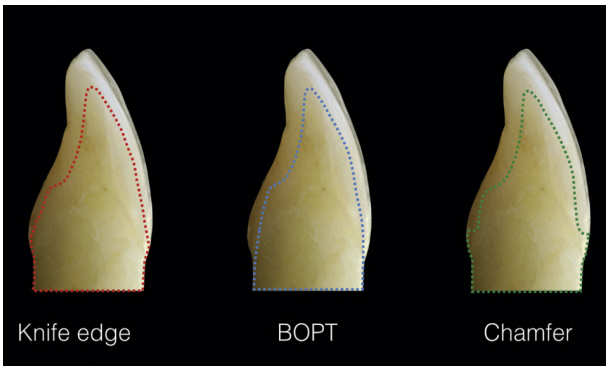

Figure 7. *Types of preparation[56]*

vertical tooth preparation, gingival thickening is often observed over time, alongside by stable marginal closure, and optimal aestheticoutcome[36].

Follow-up examinations revealed no significant difference in periodontal health between intact teeth and those prosthetically restored using biologically oriented preparation, without a finish line. Carnevale G. et al, concluded that precision of marginal fit is was more important than the exact location of the margin[57]. Gingival recession has not been found associated with biologically oriented preparations, unlike horizontal preparations[36]. Marginal gingival displacementis a common complication of fixed dental restorations most often resulting fromcompromised marginal fit or iatrogenic soft tissue damage during preparation[52,53,58,59]. Serra-Pastor et al, (2023) recommend this preparation as a retreatment when there are periodontal complications in the aesthetic region[53].

Correction of biological width violation

When a tooth fracture or carious lesion extends close to the alveolar crest, restorative procedures become more complex due to the risk of violating the biological width. Additionally, aesthetic demandsoften require the margins of the restoration to be inserted below the gingival margin, which means that in such situations the margin of the restoration would be inserted deep into the gingival sulcus and would encroach on the dimensions of the biological width[60].

Biological width violation, can be addressed in one or two ways: surgically through alveolar crest osteotomy, to reposition the bone further from the cervical margin of restorationor orthodontically forces by extrusion of the tooth, whereby the crown margin is moved further from the bone. Therefore, correction of the biological width violation can be archived by:

- Surgical crown lengthening procedure
- Orthodontic extrusion[61].

Surgical crown lengthening

Surgical crown lengtheningis performed to position the margins of the artificial crown on healthy tooth structure, avoid violation of the biological width and improve r aesthetic outcomes. Selecting the appropriate crown lengthening technique, an individualizedapproach for each patient is needed, with special attention to the crown/root/alveolar bone relation[62].

Indications for clinical crown extension are: biological width violation, deficiency of tooth substance due to deep or extremely large cavities, caries localized subgingivally, (i.e. on the cementum of root of the tooth), short or insufficient clinical crown, excessive, uneven, asymmetric and unaesthetic gingival tissue, teeth with significantly pronounced occlusal or incisal wear, in clinical cases with limitedinterocclusal space due to supra-eruption of the tooth[63].

Contraindications for this method are very deep caries or a fractured tooth that requires a large area bone tissue removal, an unjustified compromise that needs to be made even though aesthetic moment cannot be achieved, when the tooth cannot be restored, or a tooth in which there is a possibility of compromising the zone around the bifurcation[62].

Some complications that can occur after these surgical methods are excessive elongation of the clinical crowns and the appearance of so-called black triangles in teeth with a triangular shape of the anatomical crown and thus unsatisfactory aesthetics, then root hypersensitivity and tooth mobility which can be transitory or permanent, and root resorption, a complication that is the most serious, but also the most rarely observed after these procedures[64].

CBCT as an aid in the treatment plan

CBCT or three-dimensional computed tomography is a highly valuable in diagnosing the dimensions of the biological width. It allows for precise measurement of the distance between the crown margin and the alveolar bone and thus assess whether there is biological width violation. The data from these scans can be used in the planning of the future prosthetic restoration, once the biological width has been successfully re-established following surgical therapy.

Based on the desired design of the future prosthetic fixed restoration, and with the help of these scans, individual surgical guides can be created, through which the future gingiva can be contoured and the bone tissue remodeled so that it would be possible to achieve a harmonious white-red esthetic, establish symmetry, and determine the finish line of preparation so as not to affect the biological width. The ultimate result of the therapeutic procedures performed is

Figure 8. *Digitally designed surgical guide using CBCT*[65]

healthy dentition, with healthy supporting tissues and achieved aesthetics[66].

Orthodontic techniques

Slow method - orthodontic forces are applied gradually to promote slow eruption of the tooth. This eruption is to create sufficient space for the biological width, to bring the margin into an ideal position so that the body can respond appropriately to heal the tissues that have become diseased as a result of the compromised biological width[47].

Rapid method - this technique aims for tooth eruption within a few weeks at the desired level, with a subalveolar fibrotomy being performed once a week to stop the growth of the bone and gingiva that follow the tooth in its eruption[47].

Forced eruption - this method treats teeth that cannot be treated otherwise and teeth with a poor prognosis[67]. It is performed when it can be estimated that the root to future prosthetic crown ratio would be at least 50/50. It is indicated in teeth with deep cavities in the root region or fractures that end subgingivally, when the conventional method of clinical crown extension with osteotomy is not possible. This method is contraindicated in: teeth in the anterior region, with an inadequate clinical crown-clinical root ratio (when the root is smaller than the future restoration), small occlusal space for the required eruption space, potential periodontal problems[68].

Forced eruption with fibrotomy - This technique is a combination of orthodontic treatment and supraalveolar fiber removal. The alveolar bone and marginal gingiva are modeled before orthodontic treatment, and a fiberotomy is performed once every 7-10 days[69].

Conclusion

Collaboration between periodontists and prosthodontists is essentialfor the success of fixed prosthetic treatment, ensuring both functional and aesthetic outcomes. A thorough periodontal assessment and proper maintenance of oral hygiene are essential before prosthetic treatment. The biological width plays a vitalrole in periodontal health, acting as a natural shield for the periodontium. Identifyingthe gingival biotypeshelps predict the gingival tissue response to prosthetic restorations and serves as a diagnostic tool in selecting appropriate preparation techniques for successful fixed prosthetic therapy.

Differently positioned preparation margins and different design have their advantages and disadvantages: Supragingival margins, while aesthetically less favorable, allows easieroral hygiene and there is no risk of secondary caries or periodontal disease. In contrast, subgingival margin localization is indicated in the aesthetic zone, but is a predilection site for accumulation of dental plaque. In equigingival positioning of the margins, a well-polished smooth surface should always be ensured at the cervical margin of the restoration.

Violation of biological width (by the crown margin) inevitably leads to periodontal complications.In cases where the biological width is violated or when the crown marginmust be repositionon healthy tissue, and after removing an existing restorations (supported by teeth with a horizontal preparation and where tissue consolidation is not expected), methods for correction the biological width violation are surgicalcrown lengthening and certain orthodontic techniques.

Biologically oriented preparation, in addition to the fact that the preparation technique and the impression method are simpler, this technique is minimal invasive to the tooth substance and there is a stable gingival response even after many years of using the restoration. Also, this preparation technique is a technique of choice when retreatment with a new prosthetic construction is required when there is pathology of the periodontal tissues, especially in the aesthetic region.It is indicated after removing an existing restoration supported by teeth with vertical preparation.

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NON-SURGICAL ENDODONTIC TREATMENT OF PERIAPICAL LESION- A CASE REPORT

НЕХИРУШКИ ЕНДОДОНТСКИ ТРЕТМАН КАЈ ПЕРИАПИКАЛНА ЛЕЗИЈА – ПРИКАЗ НА СЛУЧАЈ

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Abstract

The dental pulp reacts unfavorably to traumatic dental injuries. Common adverse outcomes are pulp necrosis and infection of the root canal system which are most often accompanied by the development of periapical lesion. These lesions arise due to microbial invasion from the necrotic pulp tissue, leading to acute or chronic inflammation. **Aim:** To evaluate the effectiveness of non-surgical endodontic treatment in managing inflammatory periapical lesions. **Material and method:** A 23-year-old patient came to the Clinic of Dental Diseases and Endodontics with continuous pain in the upper left quadrant persisting for 2-3 days. Clinical examination revealed an old composite restoration on tooth 24 and acute pain upon vertical percussion. Radiographic imaging Showed the presence of a periapical lesion associated with the affected tooth. We performed conservative non-surgical treatment of tooth 24. **Result:** In this case, we encountered a periapical lesion, which was most likely caused by occlusal trauma. The non-surgical endodontic treatment, which included multiple visits for intracanal medications, gave us the success of the therapy, which we confirmed with retroalveolar radiographs taken over a period of 3 and 6 months. **Conclusion:** Proper instrumentation is one of the key factors for the success of endodontic therapy and at the same time the apical part of the canal is difficult to prepare. It is also necessary to thoroughly examine the pulp chamber, canals and associated pathology to ensure complete debridement of the entire root canal system. This increases the chance of long-term successful endodontic therapy. **Keywords:** Apical periodontitis, nonsurgical root canal treatment, necrosis, lesion.

Апстракт

Забната пулпа реагира неповолно на трауматски забни повреди. Неповолни реакции се некроза на пулпата односно инфекција на коренскиот канал и најчесто пратена со периапикална лезија која се развива како резултат на микроорганизми од некротичното ткиво на пулпата, што доведува до акутно или хронично воспаление.**Цел:**Нехируршки ендодонтски третман како ефективна терапија за воспалителни периапикални лезии. **Материјал и метод:** Пациентка 23 годишна дојде на Клиниката за Болести на заби и ендодонт со симптоми на континуирана болка во горен лев квадрант 2-3 дена. При клиничкиот преглед можеше да се забележи стара композитна реставрација на заб 24. Субјективен анамнестички податок беше и акутна болка на вертикална перкусија. По направена радиографија на коренскиот канален систем се гледаше периапикална промена. Спроведовме конзервативен нехирушки третман на заб 24. **Резултат:** Во овој случај се соочивме со периапикална лезија, која најверојатно била предизвикана од оклузалната траума. Спроведовме нехирушкиот ендодонтски третман кој вклучи повеќектартни посети, а во интерсеансниот период аплицираме интраканална медикација. Успешниот исход од терапијата го потврдивме со ретроалвеоларни снимки направени во период од 3 и 6 месеци. **Заклучок:** Инструментацијата е еден од клучните фактори за успехот на ендодонтската терапија. Апикалниот дел од каналот е тешко да се подготви, но исто така мора темелно да се испита комората на пулпата и коренските канали за да се обезбеди комплетен дебридман на целиот систем на коренскиот канал. На тој начин се зголемува шансата за долгорочна успешна ендодонтска терапија. **Клучни зборови:** Апикален периодонтитис, нехируршки третман на коренскиот канал, некроза, лезија.

Introduction

Periapical lesions arising from infections originating from necrotic pulp tissue, which can be caused by deep caries or trauma, are referred to as Lesions of Endodontic Origin (LEO). In the presence of bacteria and their byproducts, the periapical tissues initiate an immune response, leading to the development of various types of periapical

lesions, including granulomas, periapical cysts, or abscesses[1, 2]. The prevalence of these lesions varies among studies, with clinical evidence suggesting a higher prevalence of cystic lesions in cases with larger lesion sizes. However, large granulomas can also be observed. The final diagnosis of periapical lesions requires histopathological examination[3].

Treatment options for managing periapical lesions encompass a spectrum ranging from nonsurgical endodontic treatment to surgical interventions, such as apicoectomy or tooth extraction. However, in alignment with minimally invasive endodontics, nonsurgical endodontic treatment is favoured. The objective of this approach is to eliminate or reduce the bacterial load within the root canal system, thereby creating a conducive biological environment for the healing of periapical lesions[4]. The success of the healing process depends on the treatment protocol, including the selection of irrigation solutions and intracanal medicaments[5, 6]. These factors play a crucial role in modulating the host's immune response, ultimately aiming to achieve the primary goals of endodontic treatment: eradication of periapical infection and prevention of periapical reinfection. The success rate of initial nonsurgical endodontic treatment has been reported to be as high as 97%[7]. However, treatment failures may occur, often attributed to the presence of residual bacteria or retained foreign bodies that trigger inflammatory and immune responses, leading to bone destruction in the periapical region[8]. Therefore, root-end resection and retrograde under the microscope have emerged as an alternative approach for managing periapical lesions, offering more predictable treatment outcomes[9, 10]. The selection between surgical and nonsurgical endodontic treatment for managing periapical lesions remains a controversial issue despite numerous studies demonstrating no significant difference in success rates[11,12]. Nonetheless, the inclination towards conservative treatment is still favoured by many clinicians when considering nonsurgical endodontic management[13].

This article presents successful nonsurgical endodontic treatment of periapical lesions in clinical case with a follow-up period ranging from 3 to 6 months.

CASE 1

A 23-year-old patient came to the Clinic of Dental Diseases and Endodontics with symptoms of continuous pain localized in the upper left quadrant persisting for the pas 2-3 days. Clinical examination revealed an old composite restoration on tooth 24. The patient also reported acute pain on vertical percussion during subjective anamnesis. A periapical radiograph on the affected tooth revealed changes consistent with periapical pathology and suggested a root canal system resembling a a Vertucci type

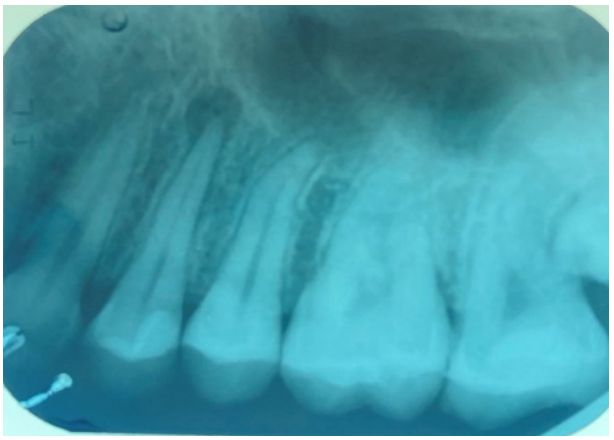

Figure 1. *Periapical lesion on tooth 24*

IV configuration)(Figure 1). We performed conservative non-surgical treatment of tooth 24.

After isolation with a rubber dam, the old composite restoration was removed, and an access cavity was expose

Figure 2. *Determinatin of working lenght with apex locator*

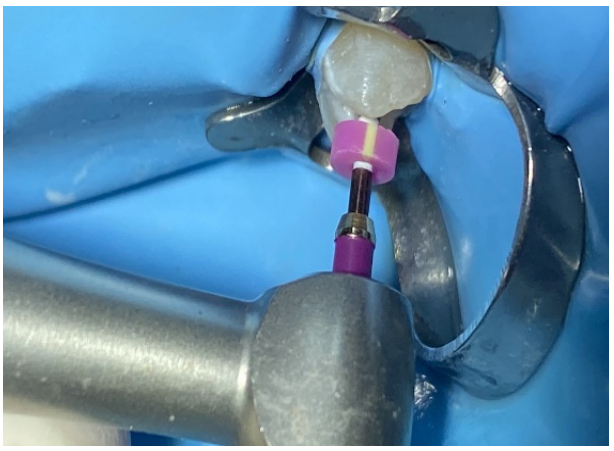

Figure 3. *.Machinig the canals with Nickel titanium rotary files*

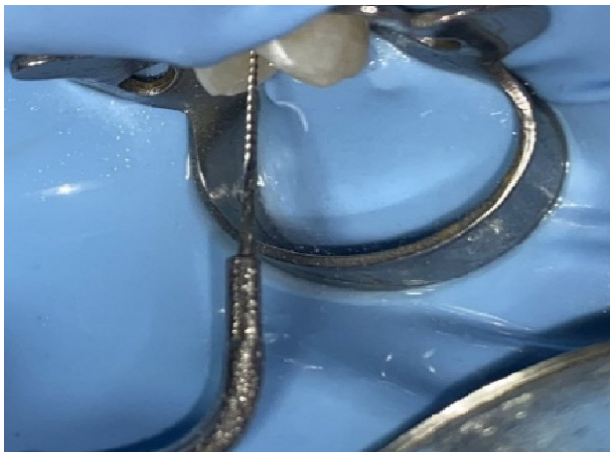

Figure 4. *Ultrasonic irrigation*

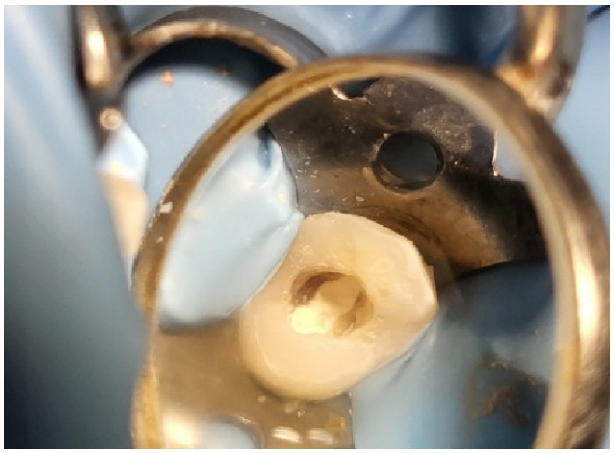

Figure 5. *Filling of calcium hydroxid paste*

in the pulp chamber. Canal patency was initially established using a Kerr expander (0.8, 10) and with the help of an apex locator, the exact working length of the root canals was determined (Figure 2). The next phase was mechanical cleaning of the canals with nickel titanium rotary reamers with a taper of 0.4 to 0.15 0.25 size (Figure 3). Between each phase of changing the rotary instrument, ultrasonic irrigation was performed for 3x20 seconds in each canal with 5.25% sodium hypochlorite (NaOCL), abundant irrigation with saline and 17% EDTA liquid with repeated irrigation with saline (Figure 4). The canals were dried with sterilized paper points and then the canals were filled with calcium hydroxide paste (CaOH) for 1 week (Figure 5). The cavity was obturated with Glass-ionomer cement.

In the second phase of treatment, the patient was recalled for a final obturation. The temporary filling was removed and the same irrigation protocol was repeated, including ultrasonic activation. The chosen technique for definitive obturation was Single Cone in which was used two-component epoxy resin AH 26 plus that positively

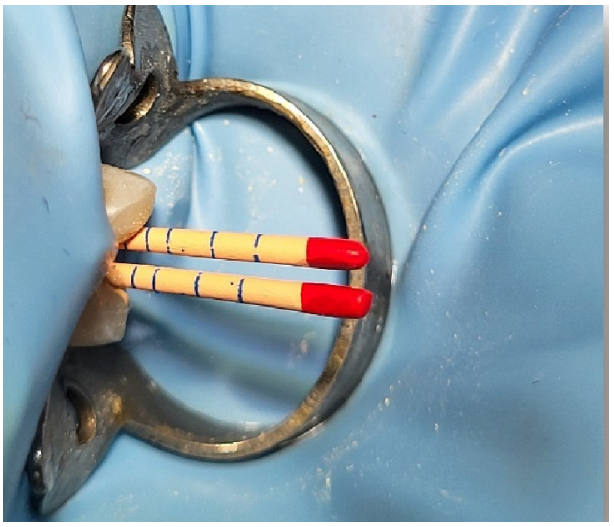

Figure 6a. *Final obturation with guta percha points*

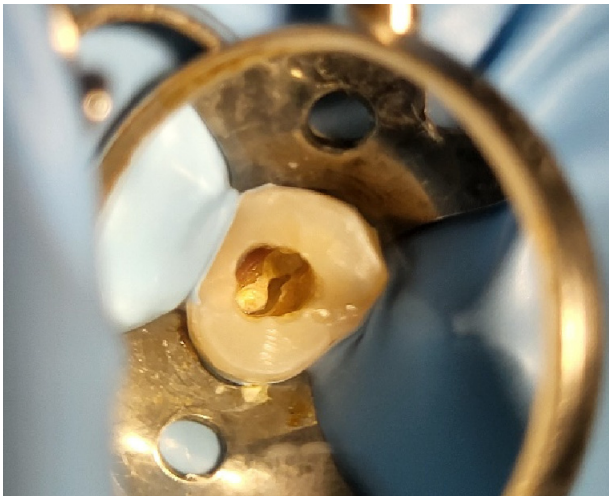

Figure 6b. *Final obturation*

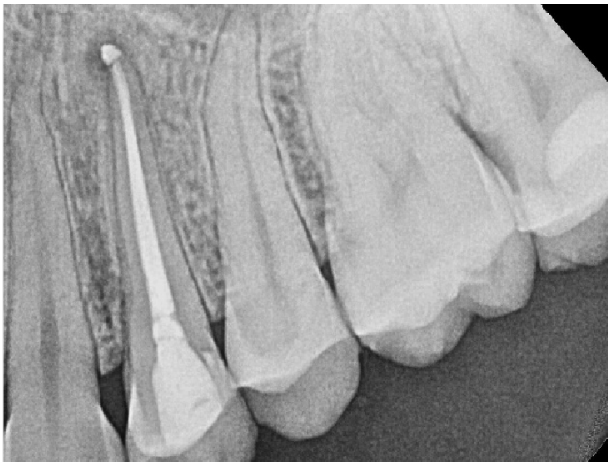

Figure 7. *Intraoral radiographic*

Figure 8. *Composite Restoration*

adheres to the canal walls and gutta-percha points with a 0.4 taper and a size of 0.25 are inserted (Figure 6 a,b). After obturation digital intraoral radiographic was taken. (Figure 7). Finally, a new composite restoration is applied. (Figure 8).

Discussion

Recent studies found a high prevalence of bacterial biofilms in the root canals, even in treated teeth with apical periodontitis, especially in cases involving large lesions and cysts[14]. Marina Fernandes et al. (2010) stated that a nonsurgical approach should always be adopted before considering surgery, with the success rate reaching up to 97%[7,15]. The primary objectives of endodontic treatment, as reported by Shilder H., are to thoroughly clean, shape, and seal the root canal system in three dimensions. This approach aims to effectively treat or prevent apical periodontitis and preserve natural teeth[16,17]. The presented case in this article exhibited periapical lesions caused by various factors, including occlusal trauma, dental injury, and failed endodontic treatment. This case involved microorganisms from necrotic pulp as a result of trauma, leading to periapical infections and subsequent bone destruction.

In this case, the irrigation protocol featured the use of abundant 3% sodium hypochlorite activated by ultrasonic agitation, followed by 17% EDTA to eliminate the smear layer. A systematic review and meta-analysis of randomized controlled trials conducted by Kasidid Ruksakiet et al. (2020) found that sodium hypochlorite significantly, but not completely, mechanically and chemically eliminated endodontic infections during root canal therapy[18]. Many studies have revealed that the efficacy of sodium hypochlorite on endodontic biofilm is accelerated with ultrasonic agitation, and other researchers have reported that ultrasonic activation of irrigants improves debridement, disinfection, and smear layer removal, resulting in better cohesion between the sealers and the dentin tubules, preventing apical leakage and tooth fracture[19,20]. Calcium hydroxide was used as an interappointment intracanal medication to enhance root canal disinfection by targeting the remaining bacteria that cannot be eliminated by chemomechanical irrigation[21]. Based on its broad bactericidal effects and high pH, calcium hydroxide creates a consistently favorable condition for periapical healing when placed intracanal for less than 28 days[22,23].

Periodic clinical examination and radiographic testing were conducted at a 6-months intervals.The healing process of the periradicular tissue after endodontic infection is completely controlled by nonsurgical root canal treatment.

Conclusion

Instrumentation and irrigation are critical factors for the success of endodontic therapy, although preparing the apical part of the canal remains challenging. The dentist must also thoroughly examine the pulp chamber, root canals and associated pathology to ensure complete debridement of the entire root canal system. This increasing approach significantly increases the chance of long-term successful endodontic therapy.

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CYSTS AND CYSTIC TUMORS IN THE JAWS: A CLINICO - PATHOLOGICAL STUDY

ЦИСТИЧНИ ЛЕЗИИ И ТУМОРИ ВО ВИЛИЦИТЕ: КЛИНИЧКО-ПАТОЛОШКА СТУДИЈА

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Abstract

Objective: The objectives of this study are to retrospectivelyanalyse large cysts and cystic tumors in the jaws that present overlapping features in radiographic differential diagnosis, to determinate their prevalence and tendency rates following surgical treatment, and to evaluate the relationship between lesion size and the likelihood of relapse. **Material and methods:** Hospital records of patients with large cysts and cystic tumors (>2 cm), surgically treated at the University Clinic for Surgery of the Face, Jaws and Neck - Maxillofacial Surgery in Skopje, over a period of 3 years were analyzed. Histopathological confirmation ofthe jaw cysts and cystic tumors was performed at the Institute of Pathological Anatomy in Skopje. All patients underwent preoperative 3D Cone Beam CT scanning/ orthopantomogram ('Panorex) (3D CBCT/OPG). The data were tabulated and statistically analyzed. **Results:** Among the 52 patients, 79% were diagnosed with cysts, while the remaining 21% had cystic tumors. Radicular cysts were the most common with 46%, and ameloblastomas were the most common with cystic tumors consisting of 13%. Cystic tumors in the jaws showed a statistically significantly higher tendency to relapse compared to cysts (p= 0.002966); Ameloblastomas showed a higher tendency to relapse than CGCT (p = 0.259796). Keratocysts relapse significantly more often than other cysts (p=0.043459). Large cysts relapse significantly more often than small ones (p=0.011). **Conclusion:** 3D CBCT/OPG are valuablediagnostic tools for evaluating large cysts and cystic tumors in the jaws, but the definitive diagnosis requires histopathological analysis. Odontogenic keratocysts and ameloblastomas are locally aggressive lesions with a high tendency for recurrence, and this feature should be taken into account when planning surgical intervention. **Keywords:** Cysts; cystic tumors; jaws; recurrence.

Апстракт

Цел: Целите на ова истражување се ретроспективна анализа на големи цисти и цистични тумори во вилиците кои се наоѓаат во меѓусебна радиографска диференцијална дијагноза, утврдување на нивната застапеност и склоност кон рецидивирање по хируршкиот третман, како и поврзаност на нивната големина со рецидивантноста. **Материјал и методи:** Анализирани се болничките истории на пациенти со големи цисти и цистични тумори (>2 см), оперирани на Универзитетската клиника за хирургија на лице, вилици и врат - Максилофацијална хирургија во Скопје, во временски период од 3 години. Виличните цисти и цистични тумори се хистопатолошки потврдени на Институтот за патолошка анатомија во Скопје. Кај сите пациенти предоперативно е реализирана компјутерска томографија/ортопантомограм (CBCT/OPG). Податоците се табеларно прикажани и статистички анализирани. **Резултати:** Од вкупно 52 пациенти, 79% имале цисти, а преостанатите 21% цистични тумори. Од големите цисти најчести беа радикуларните цисти со 46%, а од цистичните тумори најчести беа амелобластомите со 13%. Цистичните тумори во вилиците покажаа статистички значајно поголема склоност кон рецидивирање во однос на цистите (p= 0,002966); Амелобластомите покажаа поголема склоност кон рецидив отколку CGCT (p = 0,259796). Кератокистите рецидивираат значително почесто од другите цисти (p=0,043459). Големите цисти значително почесто рецидивираат од малите (p=0,011). **Заклучок:** CT/OPG се корисни дијагностички методи за големи цисти и тумори во вилиците, но дефинитивната дијагноза се поставува со хистопатолошка анализа. Одонтогени кератоцисти и амелобластомите се локално агресивни лезии со голема тенденција за рецидив, и оваа особина треба да се има во предвид при планирање на хируршката интервенција. **Клучни зборови:** Цисти; цистични тумори; вилици; рецидивантност.

Introduction

Many lesions in the jaws exhibit a radiographic appearance that resembles cysts, making diagnosis based solely on imaging a differential diagnostic dilemma. Jaw lesions encompass a wide spectrum and may originate from both dentogenic and non-dentogenic origin. The majority of this lesions are benign and some of them are malignant[1], which complicates the preoperative radiographic diagnosis and surgical treatment plan.

Jaw cysts have a radiographic appearance of unilocular or multilocular radiolucent lesions of varying size and shape[2]. Cysts and cystic lesions in the jaws may be associated with an impacted, or unerupted tooth[3]. The most common radiographic dilemma of jaw lesions associated with an impacted tooth is between cysts, but also between cysts and odontogenic tumors, such as follicular and odontogenic keratocysts (OKC), and ameloblastoma as an odontogenic tumor[3,4].

Unilocular lesions not associated with an impacted tooth are oftenindicative residual cysts, primordial odontogenic keratocysts, and ameloblastomas, odontogenic myxomas, traumatic cysts, and idiopathic bone cavities. Multilocular radiographic presentations are most commonly suggestive of odontogenic primordial keratocysts and tumors such as ameloblastomas, odontogenic myxomas, central giant cell tumor (CGCT), and central A-V (arteriovenous) hemangioma.

Cystic lesions vary in size; some of them, although benign, are locally aggressive, grow tosignificant dimensions, and have a high tendency to recur. Among these lesions, odontogenic keratocysts and ameloblastomas are considered the most aggressive and have a high recurrence rate[5].

The goal of surgical treatment is complete removal of cysts and cystic tumors to prevent recurrence and ensure minimal postoperative morbidity. The most commonly used surgical techniques in the treatment of cystic lesions in the jaws are: Enucleation Partsch II cystectomy or curettage as the most commonly used surgical treatment, Partsch I cystotomy and En bloc resection in recurrent large cysts and cystic tumors[5,6,7,8,9,10]. In large odontogenic cysts, where there is a risk of jaw fracture during their complete removal, the Evocyst method has also been described as a treatment, which involves the application of intracystic negative pressure through a hand-made device. According to the study by Castro-Núñez et al. this method demonstrated excellent results in terms of filling the defect with newly formed bone, with a high rate of osteogenesis in less than 3 months, which is significantly faster compared to conventional techniques that require up to 12 months for complete healing[7].

The objectives of this study are to evaluate large cysts and cystic tumors in the jaws that present radiographically differential diagnosis, to determine their prevalence, and their recurrence after surgical treatment, and to assess the relationship between the size of the cysts and cystic tumors and the ability to recur.

Material and methods

The study represents a retrospective analysis of 52 patients with large cysts and cystic tumors (>2 cm), surgically treated at the University Clinic for Surgery of the Face, Jaws and Neck - Maxillofacial Surgery in Skopje, in the period between January 2020 and April 2024. All jaw cysts and cystic tumors were postoperatively histopathologically confirmed at the Institute of Pathological Anatomy in Skopje. Preoperative radiodiagnostics with 3D Cone Beam CT scanning or orthopantomogram (Panorex) (3D CBCT/OPG) was performed. The dimensions of the cysts and tumors were measured in the PlanmecaRomexis[5.3.5.80] program. The obtained results are tabulated and statistically analysed, and the significance of the differences between the groups was determined using the Chi Square test and Fisher exact test. The inclusion criterion was that the patients had undergone surgery 12 months before the conclusion of the study on April 1, 2024.

Results and discussion

Cysts and cystic lesions of the jaws oftenpresent with similar clinical and radiographic features but the definitive diagnosis reliant on histopathology analysis. Accuratepreoperative diagnosis is crucial for selecting the appropriate surgical approach, as certain cystic lesions are locally aggressive and have a high recurrence rate[11].

In our study, cysts were foundin 41 patients (79%) while cystic tumors were diagnosed in 11 patients (21%) (Table 1).

Table 1. Prevalence of cysts and cystic tumors in the jaws.

Diagnosis	Number (N)	Percentage (%)
Cysts	41	79%
Cystic tumors	11	21%
Total	52	100%

Fisher's exact test determined confirmed that cysts were significantly more prevalent than cystic tumors at $p<0.05$ (Table 2).

Table 2. Prevalence of cysts and cystic tumors in the jaws. Fisher's exact test < 0.00001. The result is significant for $p<0.05$.

Diagnosis	Cysts	Cystic tumors	Total
Cysts	41	0	41
Cystic tumors	0	11	11
Total	41	11	52

Figure 1. *Basal cell nevus syndrome (Gorlin-Goltz Syndroma): multiple basaliomas, epidermal cysts, and multiple OKCs.*

These findingswith epidemiological date from the Republic of North Macedonia and studies such as Rees et al.[12] on a Chilean population that at 4777 patients with cysts and odontogenic tumors and with the results in the study by Nayak et al.[13]. where odontogenic cysts are significantly more prevalent than odontogenic tumors. This difference in the percentage prevalence of cysts and cystic tumors could be due to the pathogenetic mechanism; cystic tumors are numerically significantly rarer because their development depends on neoplastic mechanisms, which occur much less frequently compared to the inflammatory and developmental processes in the jaws that cause odontogenic and non-odontogenic cysts[14,15].

Histopathologically, in our study, radicular, residual, follicular cysts and OKC were confirmed, one of which is part of Basal Cell Nevus syndrome or Gorlin-Goltz Sy (Figure 1); and ameloblastomas and GCT as cystic tumors

Table 3. Histopathological spectrum of cysts and cystic tumors in the jaws.

Diagnosis	Number (N)	Percentage (%)
Radicular cysts	23	44%
Residual cysts	8	15%
Follicular cysts	7	13%
Odontogenic keratocysts (OKC)	3	6%
Ameloblastoma	7	13%
Giant cell tumor (GCT)	4	8%
Total	52	100%

Table 4. Recurrence of jaw cysts and cystic tumors. χ^2=8.8283 p=0.002966. The result is significant at p<.05.

Recurrence	Cysts	Cystic tumors	Total
Recurred	8	7	15
Did not recurred	30	3	33
Total	38	10	48

- of which 1 (one) is part of Cherubism and is not included in the study. In percentage terms, radicular cysts were the most common, and OKC was the least common (Table 3). Our results are in accordance with numerous studies that investigated the prevalence of odontogenic cysts in different populations[16,17,18,19].

Statistic analysis using Chi Square test determined that cystic tumors in the jaws were significantly more likely to recur compared to cysts, at p<0.05 (Table 4); some cystic tumors recurred multiple times (Figure 2).

Of the 41 patients with cysts, 3 patients had less than 12 months since their last surgery and were excluded from the statistical analysis for recurrence, i.e., a total of 38 patients with cysts were included in the statistical analysis for recurrence. The Chi-Square test determined that keratocysts (OKC) recurred significantly more than other cysts for p<0.05 (Table 5), which is in accordance with the numerous data from the available literature that investigated the recurrence rate of OKC. Although these results may have some value in predicting the risk of recurrence after surgery, the results of these studies should be viewed with caution due to the limited number of subjects. Blanas et al. reported a recurrence rate of OKC of 17%–56%[20], while Malas et al. from 28.2%[21].

The high recurrence of OKC in the literature is the thin cystic epithelium[22], incomplete removal of the cyst[23] or the

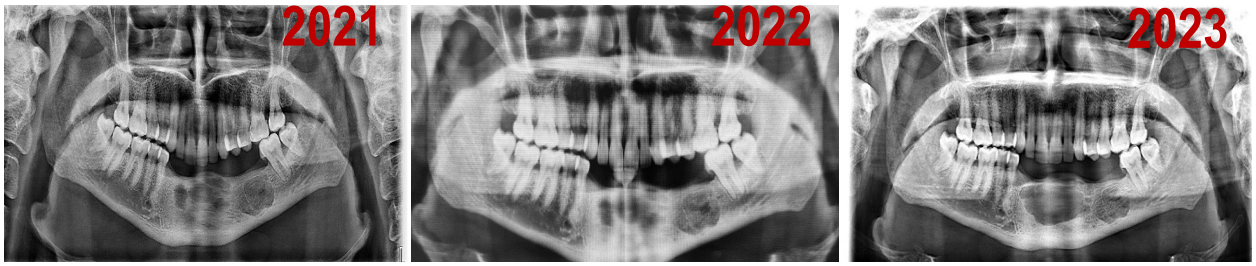

Figure 2. *OPG of ameloblastoma in the mandible that has recurred multiple times.*

Table 5. Cyst recurrence. χ^2=4.0775 p=0.043459. The result is significant for p<0.05.

	OKC	Other cysts	Total
Recurred	2	6	8
Did not recurred	1	29	30
Total	3	35	38

Table 6. Recurrence among cystic tumors; χ^2=1.2698 p=0.259796. The result is not significant for p<.05.

	Ameloblastoma	GCT	Total
Recurred	5	2	6
Did not recurred	1	2	4
Total	6	4	10

Table 7. Percentage of recurrences in cystic tumors of the jaws

Diagnosis	Recurred (%)	Did not recurred (%)	Total
GCT	50%	50%	100%
Ameloblastoma	83%	17%	100%

Table 8. Relationship between cyst size and recurrence. Median: 33 χ^2=6.3409 p=0.011. The result is significant for p<.05.

	„Large cysts“	„Small cysts“	Total
Recurred	6	2	8
Did not recurred	8	22	30
Total	14	24	38

presence of satellite cysts[24]. Jung et al. conducted an epidemiological study where they examined the relationship between the size of keratocysts and the differences between different therapeutic approaches in terms of keratocyst recurrence. The authors found that recurrence increases with increasing lesion size, indicating a significant association between these 2 (two) parameters. In addition, enucleation after decompression showed a higher recurrence rate (35.8%) compared to enucleation (27.1%), but this difference was not statistically significant. However, a significant correlation was found between the recurrence of OKC and the parameters examined, such as lesion size, multilocular form, and type of surgical intervention[25]. These findings emphasize the need for careful monitoring of patients with OKC, especially those with larger and multilocular lesions, in order to timely diagnose possible recurrence. Pylkkö et al. confirmed the association of OKC recurrence with the presence of satellite cysts. Namely, in patients with histopathologically confirmed satellite cysts, OKC recurred in 50% of cases, while in patients without satellite cysts this percentage was 17%[26].

Of the 11 cystic tumors, one patient with a cystic tumor had less than 12 months since their last surgery and was excluded from the statistical analysis. Of the 10 patients with cystic tumors, 6 were ameloblastomas and 4 were Giant cell tumors (GCT). The Chi-Square test determined that ameloblastomas and GCT have a high propensity for recurrence (Table 6), but of these, ameloblastomas recurred more frequently with 83% versus 50% recurrence in GCT (Table 7).

In their study Ajila et al. determined recurrence after conservative surgical treatment of ameloblastomas of 64.9% (148/228), and after radical surgical treatment 12% (25/207). From their results it was concluded that the main factors contributing to recurrence are multilocularity of the tumor, follicular histological type and conservative treatment method. Based on this systematic review, the authors recommend a radical approach for the treatment of solid/multicystic ameloblastomas in order to reduce the recurrence rate[27]. The high recurrence rate after conservative surgical treatment of ameloblastomas compared to recurrence after radical surgical treatment has been confirmed in most available studies[28,29,30]. Cystic tumors even

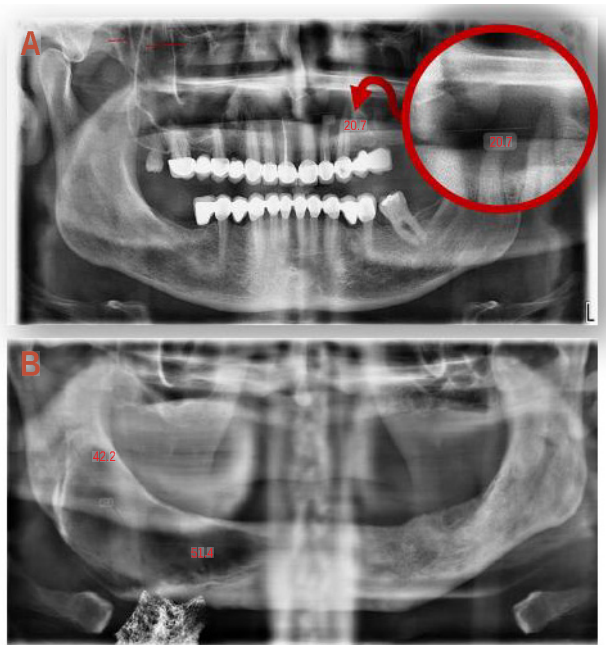

Figure 3. ***A:*** *Radiographic view of a radicular cyst with the smallest measured dimension in the study of 21 mm.* ***B:*** *Radiographic view of a residual cyst with the largest measured dimension in the study of 94 mm.*

recur multiple times. According to available data, regardless of the location of the GCT, partial resection or curettage is associated with a high recurrence rate, which can reach up to 70%, on the other hand, wide resection is associated with a significantly lower recurrence rate, of about 7%[31].

The largest residual cyst had a dimension of 94 mm (Figure 3). Large cysts demonstrated a significantly higher recurrence rate than small cysts, i.e. the larger the cysts, the greater the possibility of recurrence (Table 8).

The relationship between these two parameters was also confirmed by Fidele et al., who found that keratocysts with larger dimensions recurred significantly more than keratocysts with smaller dimensions[24].

Conclusion

Radiographic features play an important role in narrowing the differential diagnosis, and guiding the treatment of jaw cysts and cystic tumors. Histopathological findings are the "gold standard" in establishing a definitive diagnosis. Cysts are significantly more common than cystic tumors, and OKC has a significantly higher tendency to recur than other jaw cysts. Cystic tumors in the jaws recur significantly more often than cysts, and among them, ameloblastomas recur more often than GCT. Large cysts are more likely to recur.

The results of our study indicate the need for careful planning of surgical intervention for cystic lesions in the upper and lower jaw with the ultimate goal of avoiding recurrence of the lesion.

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TREATMENT MODALITIES IN PATIENTS WITH MALOCCLUSION CLASS II DIVISION 1 WITH ORTHODONTIC APPLIANCES

ТРЕТМАНСКИ МОДАЛИТЕТИ КАЈ ПАЦИЕНТИ СО МАЛОКЛУЗИЈА II КЛАСА 1 ОДДЕЛЕНИЕ СО ОРТОДОНТСКИ АПАРАТИ

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Abstract

Malocclusion Class II division 1 is a sagittal anomaly characterized by distinctive extraoral appearance. In malocclusion Class II division 1, in addition to the distal position of the mandible, there is also a protrusion of the maxillary anterior teeth with varying degrees of expression. The choice of treatmentfor malocclusion Class II division 1depends on several factors, includingthe degree of the antero-posterior discrepancy, the degree of expression of the malocclusion, the patient's ageandtheir level ofcooperation. Nowadays, if there is an indication, treatment without extraction is increasingly used. For this purpose, appliances (extraoral or intraoral) that perform distalization of the maxillary molars are used, thereby creating space distally and correcting the Class II division 1 malocclusion. The **aim** of this study was to gather sufficientdata through the searched literature that will help us in evaluating the variations of malocclusion Class II division 1, as to make a treatment plan according to the type of malocclusion, to assess whether there are indications for the use of a fixed appliance for distalization of the maxillary molars, as well as to choose the appropriate fixed orthodontic appliance for orthodontic therapy. Whilst searching through the literature, we found through the modern scientific databases PubMed, Google Schola, Embase, Cochrane Central Register of Controlled Clinical trials, PMC, NLM, Web of Knowledge, Scopus, LILACs,that we will use to achieve our goal.Both recent andolderliterature publications about this problem, special emphasis was given to the different approaches and the use of appropriate devices for the distalization of the maxillary molars and thus the correction of malocclusion Class II division 1. Mobile and functional orthodontic appliances are often preferredfor mild or moderate Class II malocclusion during the patient's growth period. In patients in whom it is necessary to distalize the maxillary molars, to correct a malocclusion Class II division 1, foruncooperative patients and for those in whom the growth period has passed, fixed appliances for distalizing the maxillary molars are the right choice for orthodontic therapy. The selection of afixed appliance for maxillary molardistalizationin the correction of Class II malocclusion depends on the orthodontist. All appliances achieved molar distalization, created additional space and Class II malocclusion correction. Fixed distalization appliances for maxillary molars that have skeletal anchorage have been shown to be more stable with no loss of anchorage, than fixed distalization appliances that have dental anchorage. **Keyword:** malocclusion Class II division 1, molar distalization, fixed functional appliances.

Апстракт

Малоклузија II класа 1 одделение претставува неправилност во сагитален правец, со изразен екстраорален изглед на пациентот. Кај малоклузија II класа покрај дисталниот однос на мандибулата, постои и протрузија на максиларните фронтални заби со различен степен на изразеност. Која терапија кај малоклузија II класа 1 одделение ќе ја примениме зависи од повеќе фактори, меѓу кои се степенот на антеро-постериорната дискрепанца, степенот на изразеност на малоклузијата , возраста, како и соработката на пациентот.Денес, доколку постои индикација, се повеќе се употребува третман без екстракција. За таа цел се користат апарати (екстраорални или интраорални) кои вршат дистализација на максиларните молари, со што се создава простор дистално и се коригира малоклузијата. Главна **цел** на овој ревијален труд, ни беше да преку пребараната литература се здобиеме со доволно податоци кои ќе ни помогнат во проценување на варијациите на малоклузија II класа 1 одделение, да се направи план на третман според видот на малоклузијата, да се процени дали постојат индикации за употреба на фиксен апарат за дистализација на максиларните молари, како и да се направи правилен избор на фиксниот ортодонтски апарат. Од пребарувањето на литературата, податоците што ги пронајдовме преку современите научни бази PubMed, Google Schola, Embase, Cochrane Central Register of Controlled Clinical trials, PMC, NLM, Web of Knowledge, Scopus, LILACs, ќе ни послужат за да ги реализираме нашите цели. Проследувајќи литературни публикации за оваа проблематика постари и понови, посебен акцент е даден на различните пристапи и употреба на соодветни апарати за дистализација на максиларните молари и со тоа корекција на малоклузија II класа 1 одделение. Мобилните и функционалните ортодонтски апарати може да бидат избор на терапија кај благо или умерено изразена малоклузија класа II во период на раст на пациентот. Кај пациенти кај кои е потребно да се дистализираат максиларните молари, да се коригира малоклузија II класа 1 одделение, пациенти кои не соработуваат и кај кои е поминат периодот на раст, фиксните апарати за дистализација на

максиларните молари се правиот избор за ортодонтска терапија. Кој вид на фиксен апарат, кој овозможува дистализација на максиларните молари, ќе се употреби при коригирање на малоклузија II класа 1 одделение според Angle зависи од возраста на пациентот, степенот на изразеност на малоклузијата и од одлуката на ортодонтот. Сите апарати постигнале дистализација на моларите, создавање простор и корекција на малоклузија II класа 1 одделение. Се покажало дека фиксните апарати за дистализација на максиларните молари кои имаат скелетна анкаража се постабилни во однос на загубата на упориштето, од фиксните апарати за дистализација кои имаат дентална анкаража. **Клучни зборови:** Малоклузија II класа 1 одделение, дистализација на молари, фиксни функционални апарати.

Introduction

Crowding, protruded teeth and other irregularities have affected humanssince ancient times. Historical evidence showsattempts and efforts to correct these irregularities, as demonstrated by Corruccini et al.[1] Orthodontic appliances that were made during that period have been found among both the Greeks and the Etruscans.

Nowadays, the need and demand for orthodontic therapy is increasing. People are becoming increasingly aware of dental irregularities, especially facial deformities that occur due to the inharmonious ratio of the jaws, which will have significant consequences on appearance.

Malocclusion is a condition that includes both morphological and functional irregularities of the masticatory system. Milić et al.[2] emphasize the importance of accurate diagnosis to identify the type and cause of the malocclusion, which is essential for providing effective treatment.

Communication among therapists was significantly facilitated when Edward Angle first introducedthe classification of malocclusions in 1899. He divided them into 3 groups: malocclusion Class I, malocclusion Class II, which was divided into 2 subgroups: malocclusion Class II division 1, malocclusion Class II division 2 and malocclusion Class III. Bishara et al.[3] made a classification system is based on the correlation of the mandibular first molars to the maxillary first molars.

Many authors considered this division to groups to be unreliable because Angle took only the molar correlation as the main criterion, and each malocclusion has many variations that affect the choice of therapy. But despite its limitations, the Angle classification is still used worldwide for communication between dentists and orthodontists.

Class II malocclusion is an irregularity in the sagittal direction, with a pronounced extraoral appearance of the patient. Angle, according to the placement of the maxillary incisors, divided it into Class II, division 1 and Class II, division 2.

In Class II malocclusion, division 1, in addition to the distal relationship of the mandibular dental arch, there is also a protrusion of the maxillary anteriorteeth, which can be of varying degrees of severity, as stated by Kanurkova[4]. It can be with an overjet, which can be slightly increased (greater than 3 mm), moderately increased (5-6 mm) and extremely increased (greater than 10 mm), while in the vertical direction it can be with an open bite or a deep bite.

The molar relationship is describedby occlusion of the mesiobuccal tubercle of the maxillary first molar with the distal surface of the mandibular second premolar and the mesial surface of the mandibular first molar.Additionally, the maxillary canine occludes with the distal surface of the second mandibular incisor and the mesial surface of the mandibular canine.

As explained by Kanurkova[4], the maxillary dental arch is usually narrow, irregular, elongated, and V-shaped. It has a narrow, underdeveloped apical base, and sometimes a crossbite is observed due to the underdeveloped maxilla in the transverse direction. The maxillary incisors are protruded, which can be variably expressed with crowding or spacing.

Patient's profile is convex, the head shape is doligocephalic, the lips are incompetent, the upper lip is protruding forward and is short, which makes most of the maxillary incisors visible. The maxillary incisors are protruding and often lie on the lower lip. These patients often also have oral breathing due to the presence of nasal obstruction.

In addition to the anamnesis, clinical examination and cephalometric analysis, the analysis of dental casts are particularly important, which will help with making the correct diagnosis of malocclusion more easily. Dental castsprovide a detailed overview, athree-dimensional view in sagittal, transverse and vertical directions and are of great importance if they are taken during the period of mixed dentition, (ages 8 to 11), when we need to see if there will be space for the permanent canines and premolars.

As a cause of the occurrence of malocclusion II Class, division 1, in addition to heredity which is a dominant factor, there are other etiological factors such as compromised breathing and swallowing functions, tongue thrusting, impaired TMJ function, the presence of pathological processes in the TMJ as well as the presence of bad habits - thumb sucking. When these habits occur during the primary dentition, the probability of it occurring in the permanent dentition is very high. Lip muscles activity also influences the retroclination of the maxillary and mandibular incisors.

The use of formula feeding - bottles with soft nipples in infancy can contribute to formation of retrognathism of the mandible and orthodontic irregularity - protrusion of the maxillary incisors., as explained by Radumilo et al.[5]

Furthermore, from the primary dentition, the malocclusion is transferred to the mixed and then to the permanent dentition.

As demonstrated by Tehranchi[6], the most common therapeutic options used in patients during the growth period are functional appliances, which can be mobile (Activator, Bionator, Frankel and Twin block appliance) or fixed (MARA appliance, cemented Twin block appliance, Herbst appliance), which stimulate the mandibular growth in the condyle area, or further in the treatment plan, a facial arch can be included - Headgear appliance, which can be with a support at the Cervical level - Cervical headgear or a with a high support - High pull headgear or a combination of both types can be used.

In patients where growth is complete, a fixed orthodontic appliance can be used as camouflage method, without tooth extraction, using intermaxillary elastics for Class II or with distalization of the maxillary first permanent molars (Pendulum appliance, Headgear facial appliance and mini-screw therapy for distalization of the maxillary molars).

The choice of orthodontic appliance primarily depends on the type and severity of the Class II malocclusion and the patient's coopeartion with the orthodontists.

Literature provides extensive data on the different morphological variations of Class II malocclusions, the reason for their occurrence and treatment options.

Children with chronic rhinitis, adenoid hypertrophy, tonsillar hypertrophy, and deviated nasal septum may develop oral breathing due to partial or complete upper airway obstruction, as reported by Lyu et al.[7]. Oral breathing alters the structure of the temporomandibular joint and periarticular muscle group, often leading to mouth breathing. This often results in Class II malocclusion and changes in the maxillofacial hard and soft tissues, affecting maxillofacial appearance and development.

As demonstrated by Cozza et al.[8], the presence of thumb sucking and the presence of a positive mandibular angle in mixed dentition are closely associated with transverse occlusal disharmony. This disharmonyis characterized by reduced maxillary intercanine and intermolar width, increased transverse intermaxillary discrepancy, and increased frequency of crossbite.

In the longitudinal studies of Vasquez et al.[9] the incidence of malocclusion II Class divison 1 in mixed dentition, if it is a maxillary protrusion, is 14.8%, which is similar to the previous study by McNamara[10] which is 13.8%. While in mandibular retrusion the prevalence is much higher, about 60% of the examined group with malocclusion II class. The prevalence of malocclusion II Class division 1 is 18-34% globally.

Hereditary factors play a dominant role in the formation of Class II division 1 malocclusion, which, combined by environmental factors, can lead to forming more severe expression of this malocclusion, as concluded by Uribe et al.[11].

According to the longitudinal study conducted by Bacetti et al.[12] it is emphasized that in the examined group in the deciduous dentition with diagnosed Class II malocclusion is expressed in a more severe degree in mixed dentition with pronounced molar and canine relationship in Class II and with an increased overjet.

It is necessary to have a good knowledge of the cause of the occurrence of malocclusion Class II division 1 and according to this knowledge to give an appropriate treatment plan.

In addition to the history and clinical examination, it is necessary to have a cephalogram, photographs, as well as a studio model, on which a gnathometric analysis will be performed. All these data obtained will help us in the correct choice of therapy.

There are six possible morphological variations of Class II malocclusion, described by Fisk[13]: the maxilla and teeth are anteriorly positioned in relation to the cranium, the teeth in the maxilla are anteriorly positioned in relation to the normally positioned maxilla, the mandible may be of normal size but distally positioned, or a condition where the mandible is positioned normally but the teeth in the mandible are positioned distally, or there may be a condition where there is a normally positioned mandible and a prognathic-anteriorly positioned maxilla, or combinations of all these conditions.

Aim of the study

The aim of this study is to analyze treatment approaches in patients with malocclusion Class II division 1, as perceived through data gathered from the literature.

Material and methods

The data obtained from our literature will supportus in achieving our goals. The studies analyzed spanthe last 20 years, with the exception of the original older publications that all newer studies use as a basis.

By following the literature publications on malocclusion Class II division 1, through a search of the modern scientific databases PubMed, Google Schola, Embase, Cochrane Central Register of Controlled Clinical trials, PMC, NLM, Web of Knowledge, Scopus, LILACs, we aim to deepen and broaden ourknowledge, i.e. expand the already existing knowledge and understanding of the different morphological variations of malocclusion II class, the etiology of their occurrence, and thus to determine the correct treatment plan and provide appropriate treatment.

The studies have been systematically organized to analyzeand compare the results obtained by various authors on

the effects of fixed orthodontic appliances for distalization of maxillary molars, as appliances for the correction of Class II division 1 malocclusion.

Following older and newer literature publications on this issue, special emphasis is given to the different approaches and use of appropriate appliances for distalization of maxillary molars and thus correction of Class II division 1 malocclusion.

We reviewed the literature publications through the scientific databases PubMed, Google Schola, Embase, Cochrane Central Register of Controlled Clinical trials, PMC, NLM, Web of Knowledge, Scopus, LILACs with keywords: Malocclusion Class II division 1, etiological factors of malocclusion II class, maxillary prognathism and mandibular retrognathism, distalization of maxillary molars, treatment of malocclusion Class II division 1.

Discussion

Class II division 1 malocclusion is a complex malocclusion that can manifest as dental, skeletal or combined. The main dental features are proclination of the maxillary incisors, while skeletal changes include a distal position of the mandible in relation to the cranial base and a prognathic position of the maxilla. Thedistal mandibular position can occur due to insufficient development of the base of the lower jaw, while prognathism of the maxilla is formed due to an increased elongated apical base due to the increased dimension of the spinal plane, which is diagnosed when measuring a profile cephalogram. The overjet in this class can be very pronounced, as notedby Moyers[14].

All the features of Class II division 1 malocclusion diagnosed in the primary dentition tend to persist intomixed dentition stage, and when the malocclusion is not corrected, they are transferred to the permanent dentition, as pointed out by Baccetti et al.[12]. In Class II division 1 malocclusion, due to the proclination of the maxillary incisors and skeletal disorders in the orofacial region, the lips are incompetent. Thesepatients attempt to close their lips by activatingcircumoral muscles that cause the mandible to move forward, but at the same time they pull the lower lip under the maxillary incisors, causing the lower lip to rest on the maxillary teeth, and they place the tongue between the incisors to touch the lower lip, which causes the formation of an open bite. Strong contraction of the muscles of the lower lip, retroclination of the mandibular incisors may occur[4].

The sagittal relationship of the upper jaw, i.e. the angle of maxillary prognathism (SNA), and the results obtained indicate that there may be a correctly positioned maxilla in relation to the cranial base, while the angle of mandibular prognathism (SNB) in Class II malocclusion is significantly lower than 80 degrees, as analyzed by Pavlović et al.[15]. This indicates that the mandible is positioned retrognathic position in relation to the cranial base. The angle of the sagittal relationship of the maxilla to the mandible is significantly higher, greater than 2 degrees in Class II malocclusion. This angle in Class II malocclusion cannot be corrected during growth, but it can become increasingly pronounced, therefore orthodontic therapy is required as soon as possible.

According to the results of the study, Radumilo et al.[5] found that the mandible and maxilla are rotated backward and downward, resulting in a steep occlusal plane and several morphological variations of this malocclusion. Due to this type of placement of the maxilla and mandible, there are several morphological variations of this malocclusion.

According to the results of the studies by Latorre et al.[16], there are no significant differences between the male and female populations in the measurements of cephalography skeletal parameters in Class II malocclusion.

Therapy of Class II division 1 malocclusion begins in early childhood. For this purpose, mobile, functional appliances, fixed or fixed orthopedic devices for the correction of maxillary prognathism and mandibular retrognathism can be used. Which type of orthodontic appliance will be used will depend on the patient's age, the degree of severity of the orthodontic malocclusion, the direction of jaw growth, as well as the patient's cooperation.

There are a number of treatment modalities used in the correction of Class II malocclusion, which depend on many factors: the type of malocclusion, the motivation of the patients, the presence of diseases and the expertise of the orthodontist.

Whether a non-extraction treatment or an extraction approach is chosen will depend not only on the degree of crowding, but also on the direction of growth of the orofacial structures, the facial profile, and the sagittal and vertical relationship of the jaws.

If an extraction approach is chosen, then 8 rules should be observed, as stated by Nielsen[17]: the patient should be postpubertal, i.e. when growth and development are minimal, the sagittal relationship of the jaws (ANPog) should be less than 5 degrees, the sagittal relationship of the apical bases (ANB) should be less than 6 degrees, with minimal protrusion of the mandibular incisors, mild to moderate crowding of the mandibular incisors, adequate distance between the apices of the teeth and the palatal cortical plane to allow for proper torqueing of the maxillary incisors, there should be normal size of the maxillary incisors, and there should be no pronounced curve of Spee. If possible, the extraction approach should be avoided, and the primary goal should be distalization of the molars, i.e. to bring the teeth to a Class I relationship.

Distalization of the maxillary first molars is conservative and increasingly popular non-extraction treatmentto correct Class II malocclusion and that non-extraction treatment has become quite popular as a treatment option in the last decade if there is an indication for it, as noted by Alogaibi et al.[18]. According to McNamara[10], mandibular retrognathism is the most common feature of Class II division 1 malocclusion in growing children and ideally, treatment should focus on correcting the skeletal discrepancy with the use of functional appliances while the individual is still in intensive growth and development. This will ultimately result in the achievement of a beautiful smile, excellent functional occlusion, and a beautiful facial profile for the patient.

The functional appliance activate the neuromuscular reflex that leads to jaw development and eruption of the teeth in normal relationship of the upper and lower jaw, notes Long and Casamassimo[19].

The distalization of the first permanent molars and their influence on the position of the second and third molars have been investigated. If the second and third molars are erupted and distalization is initiated, they will also move distally, reports Bowman[20]. He notes that this movement can lead to loss of anchorage or the appearance of tipping of the teeth.

In addition to the distal displacement of the molars, what happens next is also of particular importance. According to Bowman[20], once the molars are distalized, they should be held in that position to allow for the movement of the remaining maxillary teeth to reduce the protrusion of the maxillary anterior teeth, correct the overbite, close the spaces that will be created by these movements, and achieve a Class I placement of the canines.

Indications and contraindications for appliances for distalization of maxillary molars have been outlined by Almuzian et al.[21]. The indications are: Class II relationship, weak to moderate overjet, deviation of the medial line, mild crowding, interceptive therapy for canines placed more to the palatum, correction of mesial displacement of molars due to premature extraction of primary molars. Contraindications are: protrusive profile or proclined incisors, increased overjet, thin labial gingival biotype, buccally placed molars, pronounced crowding (more than 6 mm), and posterior crossbite.

As analyzed and reported by Kinzinger et al.[22], appliances are much more effective when the second permanent molars have not erupted, but distalization is still possible after the eruption of the second molars.

The choice of appliance to be used to correct Class II, mandibular retrognathism, and control maxillary overgrowth will depend on the patient's age and the orthodontist's choice. The plan for orthodontic or orthopedic treatment depends on the severity of the malocclusion and the age of the patient.

Appliances used for mandibular growth modification during the active growth period:

1. Removable appliances

Removable appliancesconsist of a base or acrylic plate withretention hooks placed to stabilize the appliance, active elements such as orthodontic screws are also incorporated into the appliance, which will allow correction of the transverse underdevelopment of the upper jaw. When using these appliances, the forces are intermittent and they act on the teeth and alveolar ridges reports Mitchell[23].

Therapy can continue further in mixed dentition with the application of the function regulator or Fränkel appliance. It is a bimaxillary functional appliance constructed by Fränkel in 1967 and the most optimal time for its application is mixed and early permanent dentition.

This appliance consists of acrylate shields and pads placed in the vestibule of the oral cavity.These components function to separate, the lips and soft tissues from the cheeks. Wire elements of the appliance connect the vestibular shields with the pads and provide better stability of the appliance, and stimulation of certain orofacial functions, it has the ability to eliminate pressure on the muscles of the orofacial region, and at the same time it can enhance growth, which leads to development of the narrow apical base of the maxilla[4].

Among the very orthodontic options for the treatment of Class II malocclusion, the Fränkel appliance has remained one of the most commonly used appliances for many years in patients during the growth period, as reported by Sanz et al.[24]. Despite the widespread use of this appliance, apart from the changes that may occur in the mandible, there is still limitedinformation in the literature on other dentoskeletal changes when using Fränkel appliance for the correction of Class II malocclusion.

2. Twin-Block

TheTwin-Block appliancefirst introduced by William J. Clark in 1982 is among the most widely used appliances for correction of Class II malocclusion. As many as 75% of British orthodontists claim that this appliance is their firstchoice[25].

Treatment with this appliance is carried out in two phases: active correction of the anteroposterior relationship and establishment of vertical dimensions; and retention phase, which maintains the achieved corrected incisor relationship until intercuspation of the buccal segments is achieved.

What distinguishesthis appliance is that it consists of two separate parts, one appliance for the maxilla and one appliance for the mandible. Thecorrection of the malocclusion is achieved by transmitting forces with occlusally inclined planes at an angle of 70 degrees, which cover the posterior

teeth and force the mandible to slide forward during closure. This brings the intermaxillary relationship to normal.

The primary purpose of the Twin Block appliance is to induce elongation of the mandible by stimulating growth of the condylar cartilage of the TMJ and slowing down the growth of the maxilla, reported Bacceti et al.[26].

3. The bionator

The bionator is a removable functional appliance designed by Wilhelm Balters in the 1950s. It works by influencing orofacial muscles and promotin ganterior positioning of the mandible. For its fabrication, it is necessary to take a construction bite, in tet-a-tet. Patient cooperationis also of great importance[27].

There are several types of bionators: type I, II and III. In Angle Class II malocclusion, a type I bionator is used. The standard shape consists of an acrylic body, which extends from the oral side of the lower dental arch, up to 2mm above the mucosa in the area of the premolars and molars of the upper dental arch[4].

The use of theBionator, promotestongue positioning, which helps establish a functional oral cavity that is essential for the proper development of the orofacial system and directs the activity of the muscles for proper growth and development[27].

4. The Herbst

The Herbst appliance was first introduced by Emil Herbst in 1905 at the Berlin Dental Congress, and Panchers mentioned it in a discussion of several papers published in the late 1970s. This is a fixed functional orthodontic appliance for the correction of Class II malocclusion and for distalization of the first permanent maxillary molars, which with its light continuous forces slows down the growth of the maxilla and stimulates the growth of the mandible. The purpose of this appliance is to transition the maxilla and mandible from an irregular to a normal occlusion[28].

The Herbst appliance consists of bendscemented onto the first maxillary and mandibular permanent molars. These bends are connected to a set of telescopic mechanisms with metal obstacles, which apply a light force to the maxilla that acts upward and backward, and a strong force to the mandible that acts forward, stimulating its growth and development[29].

5. The Mandibular Anterior Repositioning Appliance-MARA

The Mandibular Anterior Repositioning Appliance[30] - MARA is a fixed functional appliance designed to correct-the overjet and Angle's Class II malocclusion. It was designed by Douglas Toll in 1991.

The basic mandibular anterior repositioning appliance consists of stainless steel crowns that are placed on the first permanent maxillary and mandibular molars. The lower appliance has a horizontal arm that extends laterally from the crown of the lower molar, and the upper molar crown has a vertical arm that guides the lower jaw forward into the desired position by sliding it. When properly placed, the only way for the patient to bite is to slide the lower jaw forward so that the lower horizontal arm slides in front of the arm of the appliance[30].

The mandibular anterior repositioning appliance reduces the overjet by moving the teeth. In Class II corrective appliances such as the mandibular anterior repositioning appliance, the mandibular teeth are proclined in the front, while the maxillary teeth are retroclined, thus camouflaging the different size of the jaws. In patients with a deep bite, it leads to a lift of the overbite and an increase in the lower third of the face.

This appliance is ideal for patients with minimal cooperation and in whom the mandible is underdeveloped. It is worn for about 7 months and during this time it gently repositions the lower jaw forward. If the patient has previously had problems with the temporomandibular joint or headaches and ear problems, with this therapy these problems will fade away.

6. The Forsus

The Forsus appliance is a fixed functional appliance that is used in combination with fixed appliances and allows for distalization of the molars. It works by moving the maxillary teeth distally and the mandibular teeth mesially, moving the mandible into the desired position. It is used instead of a headgear or instead of using elastics.

The appliance consists of a spring which is fixed at one end to the bends of the first permanent maxillary molars on each side, and at the other end is placed on the arch of the fixed appliance on the mandible in the space between the canine and the first premolar. These springs move the mandible into the desired anterior position. The orthodontist will determine the size and strength of the appliance in the same way as he would for the elastics. He will also determine at what period of treatment it will be used states Bishara[31].

The Forsus appliance corrects Class II malocclusion by moving maxillary teeth distaly and mandibular teeth mesialy. It replaces headgear or elastics. It also reduces the ANB angle, overjet, overbite, while improving molar relationships and facial height.

7. The Jasper Jumper

The Jasper Jumper appliance is a fixed functional orthodontic appliance, regarded asan effective alternative option for the treatment of Class II malocclusion. It consists of an intraoral flexible power element and an anchorage part. It is an appliance that is well tolerated by patients. This appliance uses light continuous forces for Class II cor-

rection, according to the principle of dentoalveolar changes, and is useful if the growth and development of the jaws is nearing completion or has already been completed.Itsonly significant skeletal effect is theinhibitionof maxillarygrowth[32].

In their study, Patel et al.[32] compared the effects of the Jones jig appliance and the pendulum appliance, and concluded that when using both appliances, the maxillary central incisors had labial tipping, protrusion, and mild extrusion, and the maxillary premolars had mesial displacement in both groups, but in the group using the Jones jig appliance, the mesial displacement was more pronounced, and extrusion of the premolars also occurred, which means a greater loss of anchorage during distalization of the molars. In both groups, distal displacement, distal tipping, and mild intrusion of the maxillary first molars occurred. The average value of distalization of the molars at each month, as well as at the end of treatment, was similar in both groups.

8. Frog

Frog is an appliance designed for distalization of the maxillary first molars, which corrects Class II malocclusion. The classic Frog appliance includesof bends for the maxillary first molars and occlusally wire rests on the premolars fixed with composite on the occlusal surface.A palatal acrylic button that connects the wire elements and a screw. It resembles a frog, hence its name. It contains a special expansion screw that is activated from the anterior[33].

Burhan A.S.[33] conducted a study in which he included 2 groups of subjects. In the first group, the subjects wore only a Frog appliance, while in the second group, in addition to the Frog appliance, a high-traction headgear was included. He concluded that in the first group, the Frog appliance enabled: distalization of the maxillary first molars but with a large loss of anchorage, axial tipping of the maxillary molars occurred, mesial movement of the premolars that served as anchorage, and posterior rotation of the mandible occurred. While in the other group, these side effects were minimal or even completely eliminated due to the use of the headgear.

These appliances have the disadvantage that when worn, the anchorage can loosen, leading to molar tipping, extrusion with the appearance of an open bite, and an increased overjet.

Appliances used for distalization of maxillary first molars:

1. The headgear

The headgear was first introduced in 1860 by William Kingsley. It consists of two main components: a facebow and support elements that can be worn either around the neck - neck strap or overthe head - head cap. The facebow is divided into an outer bow and an inner bow that are interconnected by elastic traction. The inner bow is usuallyattachedto the first permanent molars, but can also be securedwith splints or functional appliances[31].

Thekey mechanismof orthopedic treatment with a headgear is the compression of the maxillary sutures, which modifies the growth and type of bone apposition in the sutures of the maxilla. As a result, the normal downward and forward development of the maxilla is suppressed or prevented, allowing the mandible to grow and develop normally[29].

The most appropriate type of headgear for the distalization of maxillary molars and the correction of Angle Class II malocclusion is one with occipital traction, with a force of 400 to 600 grams, and worn for 12 to 16 hours per day, pointed out Bishara[31]. The force vector should be directed distally and pass through or above the center of resistance of the maxillary molars.

2. Pendulum

In 1992, James Hilgers introduced and described the pendulum as an orthodontic appliance used for distalization of the first maxillary molars, correction of Angle's dental Class II, correction of rotated maxillary first permanent molars, and transversal expansion of the maxilla by placing an ortodontic screw[4].

The pendulumappliancemaybe usedindependeltyor inconjunctionwith a fixed appliance. The appliance contains an acrylic plate and two types of wire elements: pendulum springs and anterior retention elements. The reduced acrylic plate, or Nance acrylic button, rests on the palate, and springs are connected to it, which are a source of light, continuous forces with a posterior direction of action. The bandscemented onthe first permanent molars have palatal tubes for attaching the springs from the appliance[27].

According to Byloff and Darendeliler34the pendulum appliance distalizes the maxillary molars by 1.2 mm per month with a force of 200-250 grams on each side of the dental arch. Diaz et al.[35] conducted a study in which a patient wearing a pendulum appliance distalized the maxillary molars by 1 mm per month, using a force of 200-250 gr.

Indications for using the pendulum appliance are: in patients who need to provide space in the sagittal and transverse directions, correcting Class II according to Angle and providing space for accommodating the maxillary canines, derotation of the maxillary permanent molars and when it is necessary to correct the mesial position of the maxillary first molar during premature extraction of the second deciduous molar[23].

3. The Distal Jet

The Distal Jet is an appliance consisting of a pair of bilateral tubes connected to an acrylic Nance button and NiTi springs that generate a force of 240 grams. The wire from the Nance button is connected to the premolars' anchorage metal bends. Bends are also placed on the maxillary first molars[14].

The Distal Jet appliance requires minimal patient cooperation because it is fixed, acts with a constant force on the molars, resulting in a smaller distal tipping of the maxillary molars during their distalization than other appliances, concluded Ferguson et al.[36]. In comparison, the headgear, although more hygienic, requires greater patient cooperation. Both appliances have an almost equivalent value of distalization of the maxillary molars, but the Distal Jet appliance has better control of changes in facial height[36].

Conclusion

The treatment of patients with malocclusion Class II division 1 depends of morphological variations of the malocclusion itself and the time period in which the patient consulted an orthodontist.Treatment may begin with removable appliances Twin block appliance during the patient's intensive growth period. This appliance guides the maxilla and mandible in a direction which will allow for easier correction of the malocclusion.

Fixed orthodontic appliances play a crucuial role in the correction of Angle Class II division 1 malocclusion by addressing both skeletal and dental discrepancies. These modalities include devices such as the headgear, pendulum appliance, Herbst appliance, distal jet, Jusper Jumper, MARA, Forsus appliance, frog and other distalization techniques, which work by modifying jaw growth, repositioning teeth and improving occlusal function.In some cases, in addition to the use of fixed appliances, it is necessary to extract premolars in the maxillary dental arch.

Advancements in fixed orthodontic therapy have ledto more effective, stable and predictable outcomes, often reducing the need for extractions or surgical intervention.However, whenlarge skeletal discrepancies are present, an orthodontic-surgical approach may be required.

The choice appropriate appliance depends on the severity of malocclusion, patient compliance and treatment goals. Ongoing research and technological improvements in fixed modalities will continue to enhance treatment efficacy and long-term stability.

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DIAGNOSIS AND TREATMENT PLAN FOR CLASS II DIVISION 1 MALOCCLUSION

ДИЈАГНОЗА И ПЛАН НА ТРЕТМАН НА МАЛОКЛУЗИЈА II КЛАСА 1 ОДДЕЛЕНИЕ

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Abstract

Growth conditioned by endogenous and exogenous factors may occur irregulary, which shall result in altered morphology in the dentofacial region and the appearance of malocclusions in the sagittal, vertical, and transverse planes. ClassII division 1 malocclusion is a sagittal anomaly with distinct morphological variations that reflect the extraoral appearance of the patient. Class II division 1 malocclusion is an anomaly in antero-posterior direction characterized by a distall placement of the mandible to the maxilla with varying degrees of labial inclination of the maxillary frontal segment. Regarding the vertical discrepancy in class II division 1 malocclusion, large variations are noticed from the appearance of a deep overbite in the hypodivergent type of facial growth to an open bite in the hyperdivergent growth pattern. There are several literature data on class II division 1 malocclusion, the etiological factors influencing the formation of malocclusion, and orthodontic treatment of this malocclusion. Orthodontic diagnosis is gathered through medical and dental history, clinical examination, and records that include gnatometric analysis of studio models, analysis of photographs, and radiographic recordings. **Aim:** The aim of this study is to evaluate the morphological variations of class II division 1 malocclusion, to follow the endogenous and exogenous factors and functional disorders that conditioned its formation, and the appropriate treatment plan that shall be applied to achieve: stable occlusion, proper mastication function, proper functioning of the temporomandibular joint, harmonious facial aesthetics and a beautiful smile on the patient face.
Keywords: Class II division 1 malocclusion, etiological factors for class II division 1 malocclusion, therapy of class II division 1 malocclusion.

Апстракт

Растот условен од ендогените и егзогените фактори може да се одвива со неправилен тек, што ќе резултира со променета морфологија во дентофацијалната регија и појава на малоклузии во сагитална, вертикална и трансверзална рамнина. Класа прво одделение малоклузијата е аномалија во сагитална насока со изразени морфолошки варијации кои даваат одраз на екстраоралниот изглед на пациентот. КласаII 1 одделениемалоклузија е аномалија во антеро-постериорен правец која се карактеризира со дистално поставената мандибула во однос на максилата со различен степен на лабијална накосеност на максиларните фронтални заби. Во однос на вертикалните отстапувања кај малоклузија класа II прво одделение се забележуваат големи варијации, од појава на длабока вертикална инцизална стапалка кај хиподивергентниот тип на раст на лицето до отворен загриз кај хипердивергентниот начин на раст. Постојат повеќе литературни податоци за малоклузија класа II прво одделение, етиолошките фактори кои влијаат на формирањето на малоклузија, и ортодонскиот третман кај оваа малоклузија. Податоците за малоклузијата се собираат преку медицинска и дентална историја, клинички преглед и записи кои вклучуваат гнатометриска анализа на студио модели, анализа на фотографии и радиографски снимања. **Цел:** Цел на оваа студија е да ги процениме морфолошки варијации на малоклузија класа II прво одделение, да ги проследиме ендогените и егзогени фактори и функционални нарушувања кои условиле нејзино формирање, и соодветниот план на терапија кој ќе се примени за да се постигне: стабилна оклузија, правилна функција на мастикација, правилно функционирање на темпоромандибуларниот зглоб, хармонична естетика на лицето и убава насмевка на лицето на пациентот.
Клучни зборови: малоклузија класа II прво одделение, етиолошки фактори за малоклузијата класа II прво одделение, терапија на малоклузија II прво одделение.

Introduction

The morphological characteristics of growth and development in the orofacial complex, the position of the jaws with the cranial base and the development of dentoalveolar structures is an individual and genetically determined process. Growth, conditioned by external and internal factors, can occur with irregularities, resulting in altered morphology in the dentofacial region and malocclusions in sagittal, vertical and transverse planes.

Class II division 1 malocclusion is a sagittal and dental anomaly, characterized by a distal positioning of mandibular dental arch related to maxillary dental arch, and there is protrusion of maxillary frontal teeth, that can be mild, moderate or severe, states Kanurkova[1].

According to Mitchell[2], the labial inclination of maxillary frontal teeth, a hallmark of this malocclusion, increases their vulnerability to trauma. If cases where the horizontal incisal overlap is pronounced the mandibular incisors may fail to contact the maxillary incisors, and instead come into contact with the palatal mucosa, indicating a supraposition.

Regarding vertical deviations in class II division 1 malocclusion, large variations are observed, from the appearance of a deep overbite in the hypodivergent type of facial growth to an open bite in the hyperdivergent type of growth.

Based on the cephalometric analysis in class II division 1 malocclusion, an increased ANB angle is often noted, that in most cases there is a distal position of the mandible, mandible is retropositioned while the maxilla is placed in the normal position. But there are also cases where, in addition to the distal position of the mandible, there is also the prognatics of the maxilla.

A skeletal class II represents anteroposterior discrepancy between the basal parts of the maxilla and the mandible. This can result from a small or distally positioned mandible, a large or anteriorly positioned maxilla or a combination of both factors[4].

During puberty, the growth of the mandible tends toexceed maxillary growth. According to Gill[6], 0 pubertal peak in growth in boys occurs later and lasts longer than girls. This difference in the growth of mandibule and maxilla is a favorable prognosis in the treatment of skeletal malocclusions II class. In patients undergoing a growth spurt and are diagnosed with class II malocclusion, dentoalveolar compensation can often occur, labial tipping of mandibular teeth and palatal inclination of maxillary incisions.

The terminal plane, defined by the distal surfaces of the second deciduous molars plays a crucial role in determining the eruption path of the first permanent molars. In class II division 1 malocclusion, a distal placement of the mandibular second deciduous molar leads to a distal shift in the terminal plane. As Phulari[5] explains, this distal placement results in the first permanent mandibular molar erupting in more distal position, creating a distal interrelation of the buccal segment.

A retrospective study conducted by Pădure et al.[11] analyzes the etiology of class II division 1 malocclusion in patients with a dominant hereditary factor, and those where - the cause of malocclusion is bad habit. The study included patients aged 7 to 23-years of both gender, with dental and skeletal class II division 1 malocclusion. The results revealed that hereditary factor in the etiology of class II division 1 malocclusion is represented in 41%, compared to 13% when the cause of class II division 1 malocclusion is a bad habit - digit sucking. Notably, in the group where bad habits were the primary cause, 66.7% were girls. This higher prevalence among females was attributed to the emotional factor present in girls.

Patients with a history of digit sucking frequently exhibit facial asymmetry directly linked to the unilateral or inconsistent nature of this habit.

This group also demonstrated a 100% occurrence of a convex facial profile, accompanied by a pronounced curve of Spee. The persistent habit inhibits mandibular growth, alters incisor positioning, and results in an increased labial inclination of the maxillary incisors. In this group the overjet exceeds 8 mm, highlighting the severity of the dental displacement.

Patients with this malocclusion often have nasal obstruction and mouth breathing. The upper lip tends to be underdeveloped, and the pressure on the labial surfaces of the maxillary incisors is insufficient. Consequently, the tongue exerts strong anterior forces, contributing to the protrusion of the maxillary incisors

A characteristic feature of this class II division 1 malocclusion, is lip incompetence, caused by the proclination of the maxillary incisors. The lower lip is positioned behind the maxillary incisors, a placement that further enhancesthe retrusion of mandibular incisors and the protusion of maxillary incisors.

During swallowing, the lip musculature become active to establish lip contact. In this process the mandible is placed in an anterior position. The tongue moves anteriorly to touch the lower lip, further intensifying the protrusion of maxillary incisors. In class II division 1 malocclusion, a partial performance of lip function, leading to a disruption in the equilibrium of orofacial muscular forces.

In addition to the disordered breathing function, bad oral habits such as digit sucking or pacifier use, and tongue pressure between teeth can all affect occlusal development. Insufficient transversal development of the maxillary dental arch-caused by reduced intra-oral air pressure and increased activity of the buccal musculature leads to constriction of the buccal segments of the maxillary dental arch. As a result the maxillary dental arch becomes elongated and compressed, often taking the shape of the Latin letter “U” or “V”. According to Zuzhelova[8] this compression of the maxillary arch, may lead to unilaterally or bilaterally cross-bite.

Proffit[9] emphasizes that the bad habit of digit sucking can result in an open bite and interfere with the eruption while promoting excessive eruption of the posterior teeth. Placing a finger between the anterior teeth positions the mandible downward and hinders the eruption of the front teeth. The lack of interocclusal contact affects jaw development, alters the vertical equilibrium of the posterior teeth and contributes to their prolonged eruption. Due to the morphological characteristics of the jaws, a 1 mm elongation of the posterior segment, may result in a 2 mm anteri-

or open bite, thus contributing to the development of an anterior open bite. Open bite is observed in approximately 50% of the three-year-old patients, but in a significant number of cases, it self-corrects, if the bad habit is eliminated.

The facial profile is convex, and the degree of convexity depends on the distal positioning of the lower jaw, the anterior position of the upper jaw, the protrusion of maxillary incisors and the retrusion of mandibular incisors.

The prevalence of class II division 1 malocclusion in the Western European population ranges from 25–33%. Research has shown that the SNA and SNB angles which determine maxillary prognatism and mandibular position are inherited. In this type of malocclusion, the mandibula is retruded (Gill)[6].

The class 2 division 1 malocclusion occurs in deciduous dentition and often persists into the mixed and permanent dentition. In the deciduous dentition it is presented up to 40% of cases, while in the permanent dentition its prevalence varies from 14.7-24.6% depending on the population studied (Kanurkova[1]).

Material and methods

In order to achieve the objectives of this study, we were using data obtained from a comprehensive review literature available in data bases such as PubMed, Google Scholar and Elsevier. The research articles we analyzed focus specifically to class 2 division 1 malocclusion. We systemized the data related to this type of malocclusion included the variations, endogenous and exogenous factors contributing of affected patients and outlined corresponding treatment plans.

The study sample consisted of patients aged 3 to 18 years, both genders equally represented.

The literature reviewed included authoritative textbooks, published by Elsevier, Wiley-Blackwell, as well as review articles, prospective, retrospective, longitudinal studies and case reports.

All data were organized and analyzed in accordance to the predetermined goals.

Discussion

Functional disorders of the craniofacial complex causes irregular development of the occlusion during the period when proper tongue posture, swallowing and chewing habits should be established. A thorough understanding of the dental occlusion development is essential for recognizing irregular development and begin the treatment of malocclusion.

According to Nanda[3] the influence of soft facial structures affects the appearance of class II division 1 malocclusion that we have identified and traced in our literature review. The development of the orofacial region is affected by the muscular activity of the tongue, lips and cheeks. Within this dynamic and complex environment, the position of the teeth and the shape of the dental arches are defined by the balance of muscular activity of the cheeks, lips and tongue, which is why there is a large variability in the form of dental arches.

The tongue, in particular, has a formative role in occlusal development. Its placement at the bottom of the oral cavity, whereby the pressure from the oral side of the dental arches is less intense, results in reduced transverse growth of the maxilla and diminished sagittal growth of the mandible. As a consequence a cross bite may develop in the buccal segment, and in the incisal segment, it leads to formation of an open bite.

Literature data further reveal that oral breathing is frequently associated with anatomic obstruction such as septum deviation and chronic nasal congestion. The activity of the muscles of the cheeks that interrupt the transversal development of the alveolar processes dominates, while the hypotonia of the orbicularis oris results to the appearance of incompetent lips.

Thilander[10] emphasizes the critical role of medical history (anamnesis) as the first step in orthodontic treatment that seeks to diagnose clinical changes of malocclusion and identify the causes of its occurrence. In this context, particular attention is paid to the patient's general health , with an emphasis on whether drugs are used that are important for the formation of malocclusion, especially in patients with metabolic diseases that certainly affect the growth and reaction of tissues, it is also reported whether anti-inflammatory drugs are being taken that affect bone development. It is recorded whether the patient has a tendency to respiratory allergies that affect breathing and respiratory capacity. From the anamnestic data, attention is paid to the hereditary factor, the existence of bad habits, diet, diseases in early childhood, because these are factors that influence the development of bone and soft tissues in the orofacial region.

From our literature it has been established that patients with class II division 1 malocclusion, often exhibit alterations in facial symmetry, facial profile, lip positioning and temporomandibular joint function-findings particularly emphasized in studies of Graber[7].

In our assessment we followed functional tests to evaluate TMJ mobility, the mandibular position at rest, and its path during maximum mouth opening and closing. We observed parameters related to the data on swallowing, the position of the tongue and lips, the type of chewing, the way of respiration, the presence of phonetic disorders.

According to the a comprehensive diagnosis involves gnatometrics analysis on study models which is conducted in three planes transverse, sagittal and vertical.

Since orthodontic patients are often children during the period of rapid growth and development, when skeletal and dentoalveolar structures have not yet reached their full maturity, the application of X-ray imaging is an essential tool for accurate diagnosis and growth predictions and treatment planning.

It is recommended that the initial X-ray be taken during a period of mixed detention, around the age of seven.

Class II division 1 malocclusion is described as a dental and skeletal anomaly in which soft tissue structures camouflage the underlying bone and dentoalveolar configurations. Therefore it is necessary to apply cephalometric analyzes to accurately determine at which level of the orofacial region a deviation from normal growth and development has occurred resulting in sagittal irregularity. Lateral cephalometric radiographs are used to assess the relationships of viscerocranium to the cranial base.

According to Mitchell[2] and Cobourne[12] the results achieved with orthodontic appliances and the extent of facial harmony depend on the patient's age, the duration of the orthodontic treatment, and the degree of overjet correction.

Zorko[15] emphasizes that the dental arches are under constant pressure from surrounding structures. These include forces generated by mastication, tongue and lip pressure both at rest and during speech and swallowing-as well as forces from tooth eruption. The purpose of orthodontic appliances is to modify the natural system of pressure on dental arches[3].

Nanda[3] highlights that the goal of treatment is the correction of skeletal, dental and soft tissue irregularities, as well as maintaining the stability of results, after the appliance is removed. Since therapeutic approaches affect craniofacial structures differently, appliances selection should correspond to the underlying etiology of malocclusion. Due to the wide range of clinical manifestations of class II division 1 malocclusion, treatment must be individualized.

Mitchell[2] and Graber[7] note that mandibular growth is most pronounced during puberty and early adolescence, which is advantageous for correction class II division 1 malocclusion. Children with increased vertical skeletal proportions and a posteriorly roteted mandible have a poorer prognosis regarding incisal stability. This is due to the worsening anteroposterior discrepancy during growth, an increase in the height of the lower facial third and difficulty in achieving lip competence. In patients whose growth is complete and who present skeletal class II malocclusion, successful treatment with orthodontic appliance alone is challenging as noted by Mitchell[2].

Interceptive therapy is a phase of orthodontic treatment aimed at identifying and eliminating potential irregularities early. Although effective, it may not always produce high-quality final results, as also stated by Špalj[22]. However its benefits include reducing irregularities, eliminating harmful habits, enabling proper tooth eruption, guiding jaw and facial growth, and enhancing the patient's self-confidence.

Interceptive therapy begins during the deciduous or early mixed dentition stage, with the goal of enabling normal growth and development of the dentofacial complex when possible, achieving complete correction of the malocclusion. According to Špalj.[22] 50% of children benefit from interceptive therapy.

Noar[14] notes that the severity of malocclusion depends on the duration and intensity of the harmful habit. Persistent habits-such as digit sucking can lead to open bite, proclination of upper anterior teeth and lateral cross-bite, due to negative pressure by the habit. In children under the age of 6 treatment focuses on eliminating such habits, including digit sucking, tongue thrusting, and mouth breathing.

The Vestibular Plate and myofunctional exercises are considered part of the interceptive therapy in the correction of class II division1 correction. Proponents of early treatment follow the principle of promoting favorable developmental changes while suppressing unfavorable ones[15].

Zorko[16] emphasizes the use of the vestibular plate as an appliance for treating class II division 1 malocclusion in the deciduous and early mixed dentition stages (3-9 years), for correcting the parafunctions. This is used alongside myotherapy which targets the tonus of m. orbicularis oris[16].

Proffit[9] states that treatment of maxillary protrusion in early mixed dentition is indicated only when maxillary incisors erupt with diastemas, cause aesthetic concerns or are at risk of trauma. He further explains that maxillary protrusion in children without skeletal discrepancy is often the result of parafunction habits, which must be eliminated before orthodontic treatment begins.

Phulari[5] and Couburne[12] recommend early treatment of Class II division 1 malocclusion-typically between the ages of 8 and 10-due to the availability to maximize growth potential, reduce the risk of dental trauma, and simplify the overall treatment. However, potential drawbacks include prolonged treatment duration, the need for retention during the transition from mixed to permanent dentition, and economic considerations.

Correcting class II division 1 malocclusion using mobile appliances and teeth tipping is only feasible when the severity of the class II malocclusion expression is mild, highlights Couburne[1].

Mitchell[2] identifies three primary approaches to addressing class II skeletal discrepancy: growth modification, orthodontic camouflage, and surgical correction.

The findings of the Mitchell[2] align with the conclusions of Phulari[5] who explains that growth modification aims to restrict maxillary growth and stimulate mandible development. Headgear appliances are used to influence maxilliary growth both horizontally and vertically depending on the direction of the applied force.

Functional therapy has proven effective in reducing overjet in growing patients with more pronounced degree of skeletal class II. When crowding is present, correction in the anteroposterior plane can be achieved using functional appliances, followed by extractions and fixed appliances to achieve final dental alignment[2].

According to Nanda[3] Functional appliances utilize muscle forces to counteract unfavorable orofacial muscle activity. These devices enable modification of orofacial growth by directing the mandible mesially, based on the construction bite. The construction bite uses the stretching forces of the muscles, which are transmitted through the appliance to the teeth and jaws. This mechanism inhibits vertical maxillary growth and tooth eruption minimizing downward mandibular rotation[3].

Coubourn[12], highlights that the optimal time forusing functional appliances, is during adolescent peak of growth. In girls this typically begins around age 10 with the at approximately 11.5 years. In boys, growth starts between 11 and 12 years, peaking 14 and 15 years. Treatment is less effective if initiated during late mixed or early permanent dentition[12].

Literature findings suggest that patients with posterior rotation respond less favorable than those anterior mandibular rotation. The latter group typically presents with increased overbite a reduced lower facial third and a decreased angle between the Frankfurt and mandibular plane. While the ability to predict orofacial growth patternsand treatment response to functional devices remains limited, the use of Cone Beam Computed Tomography (CBCT) and three-dimensional imaging has enhanced clinicians' ability to assess and forecast treatment more accurately.

Fleming and Lee[24] report that, during treatment with functional appliances, the height of the lower third of the face increases due to a combination of natural growth and the anterior inclination of the occlusal plane. This vertical dimension increase is one reason why functional therapy is often avoided in patients with an increased gonial angle[24].

According to the literature functional appliances promote forward growth of the retruded and underdeveloped mandible. These appliances position the mandible in a more protrusive state initiating adaptive changes in the teeth, jaws and TMJ, ultimately resulting in the correction of malocclusion. The therapeutic effect of functional appliances include skeletal, dentoalveolar, and soft tissue modifications that can be estimated with cephalometric analysis.

Correction of the mandible in anteroposterior direction is proportionally dependent on the degree of the initial intermaxillary discrepancy. This is evidenced in cephalometric recordings by the forward movement of the Pogonion forward by 1-3mm, and correction of the ANB value, as noted by Fleming and Lee[24].

Functional appliances achieve overjet reduction through various mechanisms, including retroclination of maxillary incisors, proclined mandibular incisors, distal tipping of maxillary teeth, mesial eruption of mandibular teeth, restriction of maxillary growth, and anterior repositioning of the mandible via remodeling of the glenoid fossa, as described by Cobourne[12] andKoli[18].

Recent molecular level research has shed light on the process of enhanced cellular growth and genetic activity in the condyle cartilage cells. Stimulated cartilage cells signal the differentiation of mesenchymal stromal cells into chondrocytes in the articular layer, leading to cell division and remodeling the condyle.

Lee[24] further notes that the effects of functional appliance are more dental than skeletal occurring in ratio 2:1.

An improvement in the Class II relationship was observed following functional treatment, primarily due to dentoalveolar changes: the correction of the upper incisor position and proclination of the lower anterior teeth. Skeletal changes were also noticed: there was a constriction of the maxillary growth combined with a more protruded position of the mandible says Zelderloo et all.[25].

Given that the functional appliance increases the vertical dimension of the face through molar extrusion, Fleming and Lee[24] recommend the use of extraoral traction with an increased gonial angle when correcting Class II division 1 malocclusion. Extraoral traction helps to control vertical dimension while emphasizing sagittal correction In patients with a reduced lower facial third and increased overbite, eruption of the buccal segment contributes positively to malocclusion correction. The presence of a pronounced curve of Spee is reduced by a posterior disocclusion that favors extrusion in the buccal segment and reducing overbite[24].

The stability of the reduced overjet directly depends on the balance of soft tissues which is one of the determining factors. By the end of the treatment, lip competence should be achieved, with the lower lip covering the incisal third of the upper incisors.

Mitchell's[2] analysis alligns with the findings of Phulari[5] emphasizing that the decision to resolve crowding through tooth extraction significantly affects the facial profile. In patients with an increased nasolabial angle, a prominent nose and a retrognated mandible, extracting teeth and retroclination of the maxillary frontal segment, does not lead to an improvement in facial aesthetics.

Overjet can be corrected either by the distalization of maxillary molars or through extraction. The severity of protrusion of the maxillary anterior segment, as along with the degree of arch crowding, are key factors that determine the need for extraction. Most often, the first maxillary premolar is extracted, as noted by Nanda[3].

The Andresen activator has been successful in correction sagittal and vertical irregularities, with the greatest

effect observed during the late mixed dentition phase from 10 to 12. The success is attributed to the repositioning of jaw growth due to the skeletal pubertal peak in growth.

Combining of an activator with a headgear results in a retrusion of the upper incisors, distalization of maxillary molars, and mesial movement of mandibular molars.

Cephalometric analysis following bionator therapy demonstrated an increase in the height of the face dimensions, both anterior and posterior, a forward movement of point B on the mandible and an increase in the SNB angle The most favorable results are observed when the appliances if used during the pubertal peak, resulting in mandibular elongation, an increased gonial angle, posterior rotation of the condyle, and reverse shift of the caput mandibule, states Oshagh[26].

A study by Almeida-Pedrin and Osor[19] compared the effect of the bionator and headgear with anterior plate bite. The finding showed that the headgear restricts forward growth, while the bionator promotes mandibular protusion, indicating a significant favorable impact on both appliances of the antero-posterior relation of the maxilla and the mandible.

The mandible appear more pronounced by an average of 2mm-in the group treated with a headgear. Disarticulation the occlusion to minimize adaptive changes in the dentoalveolar complex is consider to significantly facilitate the treatment of II/1 malocclusion.

Twin-Block devices are most effective during the peak growth of late mixed and early permanent dentation. According to Koli[18] the class correction is achieved through a combination of skeletal (40%) and dental (60%) changes.

Mudgil[21] notes that twin-block therapy results in mandibular elongation and an increases in the SNB angle. The rapid reduction in overjet is due to the dentoalveolar changes. The appliance also effect the inclination of mandibular incisors, retroclination of maxillary incisors, eruption of lower molars and their mesialisation, as well as the distalization of maxillary molars. One common side effect, tipping of the mandibular incisors, is mitigated by placing acryling materials on the incisal edges Post- treatment changes in soft tissues include facial convexity, an increase in the mentolabial angle, and the lower lip and the soft Pogonion are moved in anterior direction, concludes Mudgil[21].

Greber[7] points the role of Frankel regulator, in eliminating functional irregularities of the tongue and lips. The resulting changes in soft tissues lead to gradual skeletal and dentoalveolar adaptation. The best results are achieved in early mixed dentition, when intensive growth of the alveolar bone is used and initial removal of functional irregularities before their complete manifestation[7].

The Frankel appliance is designed to alter the biomechanical conditions of the periodontal functional matrix of the maxilla and mandible. Grabel[7] attributes mandibular underdevelopment to an imbalance between retractor and protractor muscles. By positioning the mandible, such that the periodontal tissue of the mandibular condyle are exposed to biomechanical stimulus, growth is stimulated promoting forward relocation of the mandible in anterior direction.

Functional appliances can be combined with headgear, to restrict maxillary growth. The direction of the mandible growth toward the front and down is mainly due to the eruption of the molars.

Growth modification in skeletal class II malocclusion is achieved using headgear orthopedic appliances that apply intra-oral action and extraoral anchorage. The intermaxillary force transmitted through the labial arc on the maxillary dental arc creates orthopedic pressure that inhibits the both vertical and horizontal growth of the maxilla, thereby contributing to the correction of the skeletal II class, Nanda[3].

Extraoral traction reduces the forward growth of the maxillary dentition to establish proper occlusion. Nanda[3] emphasizes the headgear therapy restricts anterior and downward maxillary growth while allowing the the mandible to grow forward, thereby correcting the second class.

The extrusive component of the cervical headgear is particularly effective in reducing overbite in patients with a deep bite. For hyperdivergent patients, a high-pull headgear configuration is used to control vertical extrusive forces[3].

In addition to the skeletal effect, the appliance also induces significant dental changes, as noted by Staley[13]. The direction of force depends on the type of extraoral anchorage used. Cervical anchorage produces a horizontal component - distalization and extrusion of the upper molars, while parietal anchorage exerts force- distalization and the intrusion of maxillary molars.

In patients with an open bite extrusion of molars, must be avoided. Conversely, in patients with a low mandibular plane angle molar extrusion is a desired effect. The application of force in these patients is above the resistance center, producing extrusion and distal movement points out Staley[13].

Headgear can be used independently or in combination with fixed or removable appliances. The treatment outcome depends on the intensity of the force that can cause orthodontic (distalization, intrusion, extrusion) and orthopedic changes (inhibition of maxillary growth). According to Nanda[3] the optimal force for orthodontic tooth displacement is 1.5 N (150 gr) per side. If the second molars have erupted the applied force should be increased.

Greber[7] and Proffit[9] both emphasize that inhibition of maxillary growth is achieved by applying force that com-

press the sutures between maxilla and zygomatic bones, pterygoid and frontal bones. It is indicated the application of a minimum force of 2.5N (250 gr) on each side to inhibit maxillary growth. The skeletal effect of headgear therapy is achieved only if therapy is started during the pubertal growth peak, and improve the benefit by wearing the appliance at night when the secretion of growth hormone is greatest.

Expansion of the dental arches and correction of crowding are importan components of class II malocclusion. In Class II division 1 malocclusion, correction is often achieved through distalization of the molars, to create a space within the dental arch. Several appliances can achieve thus without the need for tooth extractions, including headgear, the pendulum appliance, the herbst appliance, and the Jasper Jumper.

The Hilgers Pendulum is an orthodontic device designed for distalization of maxillary first permanent molars, correction of dental II class and the derotation of molars, Nanda[3].

Almuzian et al.[27] applied moderate and continuous forces using such appliances, achieving molar distalization 4 to 5 mm for 3-4 months thus correcting the crowding and the second class.

The optimal timing for maxillary first distalization is prior to the eruption of the maxillary second molar indicates the authors[27]. Intraoral molar distalization leads to anchorage loss in the incisor or premolar region (or both) in various amounts depending on choice of distalization unit[28].

Lip bumper as an intramaxillary appliance for distalization, according to Almuzian[27] is a passive, fixed functional orthodontic appliance that operates through a labial arch technique, which affects the balance between cheeks, lips and tongue, activates the m. orbicularis oris and transfers forces from the perioral muscles to the molars.

The force that creates the tongue muscles from the lingual side pushes the teeth labial and thus corrects their position to increase the perimeter of the mandibular dental arch with passive lateral and anterior expansion and the distalization of molars, states Almuzian et al.[27]. In class II/1 malocclusion lip bumper is placed in the middle third of the incisors for labial inclination of the mandibular front. The reciprocal force exerted by the lips is transmitted through the arch to the molars and results in their distalization and extrusion. Graber[7] notes that changes in the balance of soft tissue cause proclination of lower incisions, an increase in inter-canine width, and a buccal inclination of molars.

Patients with a lip bumper should be monitored to prevent impaction of second molars during their eruption.

Researchers have concluded, that the spontaneous dental compensation in the mandibular dental arch generated by maxillary enlargement does not affect the basal structures of the mandible. Lip bumper therapy has been shown significantly increase the mandibular transverse basal dimension. Starting from the fact that transversal growth ends first, the condition for the amplification of therapy with lip-bumper is the early beginning of treatment, Vanasrdall[29].

The Herbst fixed functional orthopedic appliance developed according to Kingsley's "bite jumping" principles applies force to the molars pushing the jaws of each other. The force vector moves the mandible forward, and the maxilla backward is the conclusion of the Almusian etal[27]. The continuous 24-hour activity makes the Herbst appliance potentially the most efficient functional fixed appliance in the modification of the mandible growth, notes Proffit[9].

For the optimal effective treatment, Fleming and Lee[24] recommend construction the appliance based on an edge-to-edge construction bite[24].

Quad helix is a flexible modification of the transverse arch, whose application in late mixed and early permanent dentition makes it suitable for expanding the maxillary dental arch by slowly opening the palatal suture and derotation of the molars.

The effects observed by Phulari[5] are primarily dentoalveolar than skeletal, caused by light forces. The extraoral activation of the arch results in the extension of the maxillary arch from 2 mm to achieving hypercorrection, i.e. the palatal tubers of the upper teeth occlude with buccal tubers of the lower teeth. The combination of lateral cross-bite and bad habit of digit sucking is the best indication for this appliance[5]. The construction of the appliances positions the arch away from the palatal mucosa of the for 1-1.5 mm, thus avoiding the irritation of the palate as a side effect. After removing the appliance, the effectirritation disappears, but it can last up to a year.

The amplification of the treatment Proffit[9] is most effective when the appliance is used before adolescence, when medial palatal sutura is not ossified or there is only a small initial intermediation, so it does not require extensive microfracturation to separate the palatal parts[9].

The four helixes are bent in a plane parallel to the occlusal plane, not parallel to the palate. Upon activation, a horizontal vector force is created when the helixes are activated, with more translation movement of the molars, than only an inclination - Staley[13].

The correction of a skeletal maxillary constriction manifested by a narrow palate is achieved by the forced palatal expansion.

According to Špalj[23], the average upper limit for forced expansion is 16 years, and after that age the skeletal effect of the appliance decreases. For this purpose, hyrax-screw is applied, which is fixed on a metal frame of the maxillary first permanent molars and premolars or the first deciduous molars[23].

Transversal expansion of the palate, as a side effect, extrudes the side teeth and opens the bite, points out Ngan[33]. These side effects are desirable in patients with deep bite but not in patients with vertical growth. Placing acrylic plate on the occlusal surfaces prevents extrusion of the teeth from the buccal segment. The expansion of the maxillary arch does not only correct the skeletal crossbite but also the crowding. Each millimeter of maxillary expansion results in a 0.7 mm increase in the perimeter of the maxillary arch, which can be seen as a protrusion of the front teeth[33].

Orthodontic camouflage is achieved through the used of fixed appliance, translatory retraction of maxillary incisors and the proclination of the mandibular labial segment.

Comprehensive orthodontic treatment is an attempt to establish an ideal occlusion by repositioning all or almost all of the teeth. Therapy with removable appliances is not able to completely position the teeth; it is achieved only with devices that can cause translatory movements.

Elastic bands is used as intermaxillary and intramaxillary. Power chains are intramaxillary chains that connect the same dental arch attachments applying force for distalizing of canines and the retraction of incisors notes Demirovic[31]. Modules, elastic ligatures, and power chain generate force that is not constant it rapidly diminishes as soon as the material absorbs water from the mouth[31].

The elastic force of class II elastics is applied diagonally between the mandibular posterior segment and maxillary front teeth and creates a force that possesses a vertical and horizontal component. When the force does not pass through the center of resistance causes mesiopalatal rotation and expansion, according to Nanda[30].

The vertical component highlights Nanda[30] causes extrusion of maxillary canines and incisors and the mandibular buccal segment. The excessive use of elastic ligatures of large diameter causes the anterior rotation of the occlusal plane, extrusion of the mandibular molars and maxillary incisors resulting in deep bite and anterior rotation of the mandible. The magnitude of the vertical component increases when the mouth opens.

In hyperdivergent patients, excessive use of elastic long-diameter rubber may result in molar extrusion and anterior rotation of the mandible, increased face height. Nanda[30] avoided these undesirable effects on the vertical component by reducing its action or by increasing the action of the horizontal component and placing the ligature diagonally between the mandibular second molar and the maxillary lateral incisor.

The elimination of the protrusion of mandibular incisors and the recession of the labial gingiva Nanda[30] achieves this by reducing the time and magnitude of force[30].

Surgical correction associated with orthodontic therapy is the most appropriate approach in a strongly manifested skeletal class II malocclusion, to achieve aesthetic harmony and stable occlusion, as stated by Mitchell[2].

The study of Oh et al.[32] examines the stability of the results achieved 10 years after the end of orthodontic treatment. The changes observed, in most of the respondents, were not greater than 1mm in the length and width of the dental arches. Oh et al.[32] concluded that the presence of a fixed mandibular retainer affects the stability of the achieved results in the mandibular arch.

As McNamara underlines, the goal of all therapeutic regimens is to correct existing problems in the hard and soft tissues and to attain a normal relationship which remains after all appliances have been removed. Since specific therapeutic techniques affect craniofacial structures in different ways, the variety available should correspondent to the variety of true etiologies[34].

Conclusion

A thorough review of the literature provides comprehensive insight into the etiological factors that accurately guide us to the morphological variations of this malocclusion and the manner of its formation.

The data gathered from the literature review helped us to determine the impact of etiological factors on the clinical manifestations of class II division 1 malocclusion and the changes of the aesthetic of the person.

By searching the literature, we have determined the diagnostic methods: anamnesis, clinical trials, cephalometric analysis, which accurately described class II division 1 malocclusion, determined dental and skeletal changes in the orofacial region and thus helped determine the treatment plan for class II/1 malocclusion.

Through the conducted search of the data obtained from the literature we have indicated the treatment plan appropriate for the patient's age and the degree of expression of class II/1 malocclusion.

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SUBJECTIVE EVALUATION OF THE OBTAINED AESTHETICS AFTER LASER-ASSISTED CROWN LENGTHENING IN THE FRONTAL MAXILLARY AREA

СУБЈЕКТИВНА ЕВАЛУАЦИЈА НА ДОБИЕНАТА ЕСТЕТИКА ПО ЛАСЕРСКИ АСИСТИРАНО ПРОДОЛЖУВАЊЕ НА КЛИНИЧКАТА КОРОНКА ВО ФРОНТАЛНАТА МАКСИЛАРНА ОБЛАСТ

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Abstract

Introduction: Crown lengthening in the frontal aesthetic areas involves the removal of misaligned gingival tissue and the restoration of its margins to meet aesthetic standards. The use of lasers can significantly simplify this procedure. Giving the growing demand for aesthetically pleasing smiles and the benefits offered by laser technology, this study aimed to assess the aesthetic impact of laser-assisted crown lengthening in the upper frontal region. **Material and method:** The study involved 35 participants. To fulfill the study's AIM, a comprehensive questionnaire was developed to collect subjective evaluations of the aesthetic results from patients who received prosthetic restorations. Additionally, a portion of the questionnaire was completed by the dentists who performed the procedures to evaluate the aesthetic outcomes. **Results:** Over ninety percent of participants indicated that the restorations led to an improved aesthetic effect. A significant number of patients reported a notable enhancement in aesthetics, while an equal proportion of clinical practitioners assessed the improvements as either significant or moderate. **Conclusion.** The findings of this study suggest that the use of lasers in clinical crown lengthening procedures results in a substantial enhancement of aesthetics, as perceived by both patients and dentists. **Keywords:** aesthetics, aesthetic effect, crown lengthening, laser-assisted crown lengthening.

Апстракт

Вовед. Процесот на продолжување на клиничката коронка во фронталните естетски зони вклучува отстранување на неправилно поставеното гингивално ткиво и враќање на неговите маргини во согласност со естетските стандарди. Употребата на ласери значително го олеснува овој процес. Со зголемената желба на пациентите за естетски привлечни насмевки и предностите што ги нуди ласерската технологија, оваа студија имаше за цел да ја процени естетската вредност на ласерски асистираното продолжување на клиничката коронка во горната фронтална регија. **Материјали и методи.** Студијата вклучи 35 испитаници. За да се исполни целта на истражувањето, беше изготвен детален прашалник со кој се собираа субјективни евалуации за естетските резултати од пациентите што добија протетски реставрации. Дополнително, дел од прашалникот беше пополнет од стоматолозите што ги изведуваа интервенциите за да ја проценат естетската вредност на добиените резултати. **Резултати.** Повеќе од деведесет проценти од испитаниците изјавија дека реставрациите довеле до подобрен естетски ефект. Значителен број од нив пријавиле забележливо подобрување на естетиката, додека идентичен процент на стоматолози го оцениле подобрувањето како значително или умерено. **Заклучок.** Резултатите од оваа студија укажуваат дека употребата на ласери при продолжување на клиничката коронка резултира со значително подобрување на естетиката, како што е перцепирано и од пациентите и од стоматолозите. **Клучни зборови:** естетика, естетски ефект, продолжување на клиничка коронка, ласерски асистирано продолжување на клиничка коронка.

Introduction

Clinical crown lengthening in aesthetic zones typically requires the removal of misaligned gingival tissue and the reshaping of the gingival margins to align with aesthetic expectations. However, in certain cases where it is essential to excise the alveolar bone ridge near the cementoenamel junction, as merely removing the gingival tissue may not adequately preserve the desired length over time. Some studies suggest that minimally invasive techniques

for crown lengthening, those that avoid flap elevation and incorporate osteotomy, are as effective as those that utilize mucoperiosteal flap lifting, while also presenting fewer complications[1].

A comprehensive understanding of gingival form, position, and contour are essential to understanding gingival architecture. The gingival margin is crucial in determining the shaping the gingiva as observed from the anterior view of the tooth. Several factors influence this architecture , with the primary consideration being that the gingival margins of the central incisors should be aligned at the same level, forming an arch that follows the contours of the enamel-cementum junction. Moreover, the gingival margins of the canines should match the level of the central incisors. It is also important that the gingival margins of the lateral incisors are approximately 1.0 to 1.5 mm shorter than those of the canines and central incisors. This configuration results in a variation in the heights of the gingival margins, which contributes to its overall shape. The contour of the gingiva is defined as the portion of the gingival architecture that runs parallel to the tooth surface. If the gingival shape is altered without proper contouring, it may result in a relapse of the condition[2].

Osteotomy is often required to achieve an optimal aesthetic outcome during crown lengthening procedures. In addition to traditional rotary instruments, this procedure can also be done by using piezoelectric ultrasonic devices or laser technology. The piezoelectric device is particularly advantageous as it can excide bone tissue while preserving the integrity of the root surface, making it a potentially ideal choice for crown lengthening without necessitating osteotomy.

As laser technology becomes more prevalent, its application in these procedures is expected to become essential. Laser assisted interventions offer numerous advantages for patients, including a reduction in postoperative complications, a shortened recovery period, minimized trauma during the procedure, and often the possibility of performing the interventions without anesthetics. Furthermore, lasers enhance the visibility of the surgical field by decreasing bleeding, which is crucial for efficient intervention. The establishment of sterile conditions during and after the surgery, the likelihood of complications and infections is significantly reduced[3].

The primary indications for undertaking clinical crown lengthening include the presence of short clinical crowns, the necessity for additional tooth structure to support mechanical restorative interventions, and biological factors aimed at preserving the biological width and preventing subsequent attachment loss around the restored tooth. In addition to providing sufficient dental structure for effective and biologically appropriate restorations, crown lengthening is also performed for aesthetic enhancement[4].

To achieve optimal aesthetic results, it is recommended to conduct procedures in a gradual manner, particularly when utilizing laser technology. Typically, the most favorable results are obtained by initially treating one half of the dental arch, thereby establishing ideal gingival contours-such as contour height and smooth transitions of angles-before proceeding to the opposite side. This approach not only allows for the completion of the entire procedure within a single visit but also eliminates the necessity of re-treating previously laser-treated tissue that may have dried out due to vaporization. The objective of various crown lengthening procedures can include:

- Revealing adequate, robust, and healthy tooth structure in instances of deep fractures located in the subgingival area or the presence of carious lesions in that same region.
- Enhancing the stability, retention, and longevity of different types of restorations.
- Ensuring the correct positioning of the marginal edges of restorations while preserving the biological width.
- Achieving improved aesthetics for patients with irregular gingival margins and excessive gingival overgrowth[5].

It is essential to recognize that this procedure is not only feasible but also delivers satisfactory results in terms of both functionality and aesthetics when performed according to the designated therapeutic plan. The increasing number of patient inquiries regarding clinical crown lengthening, along with the significant advantages that lasers provide for this type of procedure, has motivated to pursue their combined application.

Our objective was to evaluate the achieved aesthetic effects by patients undergoing laser-assisted clinical crown lengthening of the frontal teeth, as well as their appropriate restorative care.

The aesthetic evaluation of a smile is significantly influenced affected by the vertical positioning and angulation of the upper anterior teeth. This influence, however, can be perceived differently by various groups, including the general population, dental students, practitioners of dental medicine, and specialists in other areas of dentistry. The ultimate goal of dental treatment encompasses not only the restoration of normal anatomical and morphological characteristics and functions of the teeth but also the enhancement of aesthetic appeal for patients. Beauty, as a concept, resists quantification due to its dependence on a variety of factors and its variability across different cultures, nationalities, and religious traditions.

The aesthetic harmony between the teeth, lips, and gingival tissue may be disrupted by gingiva that is healthy yet inadequately positioned. As such, the aesthetics of the gin-

giva are heavily influenced by the contour progression, known as the gingival zenith, from the central incisor to the canine, which should ideally follow a parabolic curve[6].

In conventional aesthetic crown lengthening procedures, the gingiva is surgically reshaped with a scalpel, while bone is removed using a rotary instrument by creating full-thickness mucoperiosteal flap. This method is often intensive, requires suturing, and is often perceived as intimidating, particularly for patients with dental anxietyA laser is an apparatus that generates concentrated light aimed at a specific point over considerable distances. The primary distinction between laser light and conventional light lies in the properties of laser light, which is characterized as monochromatic, coherent, and parallel. In contrast, ordinary white light comprises multiple colors, with waves that are neither synchronized nor parallel, resulting in refraction of its rays[8]. These three fundamental attributes enable the application of lasers in the fields of medicine and dentistry. The advantages of utilizing lasers are extensive, with the most notable being precision and enhanced therapeutic outcomes compared to traditional dental procedures. However, a comprehensive understanding of this therapeutic instrument is essential to mitigate potential side effects and to maximize the intended benefits. The 2940 nm wavelength of this laser corresponds to the peak absorption in water molecules, which is significantly greater-fifteen times higher than that of the carbon dioxide laser and 20,000 times higher than the Nd:YAG laser[9]. Additionally, the laser light produced is optimally absorbed by hydroxyapatite. Consequently, it can be inferred that this laser type is effective not only in the removal of dentin and enamel with minimal and mild side effects, such as thermal damage to the dental pulp, but also in treating soft tissues within the oral cavity, making it suitable for clinical crown extensions[10]. Based on its effective absorption in both water and hydroxyapatite, numerous studies have demonstrated the efficacy of this laser in ablating hard and soft tissues during interventions, as well as its bactericidal properties, which contribute to reduced or absent pain sensations during clinical applications, thereby highlighting the numerous benefits associated with this laser technology. Research into its various potential applications continues, reflecting an increasing interest among dental professionals worldwide.

Aim

Considering the increasing demand for aesthetically pleasing smiles among patients, coupled with the significant benefits of utilizing laser technology for dental crown extensions, this study aims to evaluate the aesthetic effects of prosthetic rehabilitation. This assessment is based on perspectives of both the patients who received laser-assisted crown extensions in the upper anterior region and the clinicians involved in the treatment process.

Material and methods

The research sample consisted of 35 respondents, including 13 males (37.14%) and 22 females (62.86%). The average age of participants was 31 years. The study was carried out across four private dental practices, employing a total of 10 dentists, located in Skopje (two practices), Bitola, and Gevgelija, within the Republic of North Macedonia. Among the dentists involved, three were specialists: two in orthodontics and one in periodontology. The research was conducted from August to November 2022.

Each participant received an indication for tooth crown lengthening and provided verbal consent to partake in the study. To achieve the aim of this study, a comprehensive questionnaire was utilized to identify the motivations for these interventions, the types of prosthetic restorations applied, and the patients' subjective evaluations of the aesthetic outcomes. Additionally, part of the questionnaire was completed by the dentists who performed the procedures, focusing on the used lasers and their assessments of the aesthetic results of the prosthetic restorations.

Statistical analysis was performed utilizing the software Statistics 7.1 (SPS 7.1), which is specifically designed for statistical processing. In the context of descriptive statistics, the following analytical methods were applied:

1. For numerical data series, the standard deviation (±Stand.dev.) and the 95.00% confidence interval (±95.00% CI) were established, alongside the determination of the minimum and maximum values of the parameters analyzed;
2. For non-numerical data series, the percentages representing the structure were calculated.

Results

The total number of participants in this study is 35, each of whom underwent laser-assisted clinical crown lengthening. The data analyzed from the entire sample indicated that the average age of the participants is 31.142 ± 6.049 years, with the youngest patient being 20 years old and the oldest at 44 years. Following the data analysis, it is evident that the examined group is predominantly composed of females (62.86%) compared to males (37.14%).

Patients identified aesthetic reasons as the most prevalent motivation for this intervention, representing 77.14% of cases, followed by prosthetic needs at 11.43% and orthodontic considerations at 8.58%. The least frequent reasons were associated with various periodontal diseases, which accounted for 2.85% (Table 1.).

Table 1. Reasons for performing laser-assisted crown lengthening

Reasons	No	%
Aesthetic	27	77.14 %
Orthodontic	3	8.58 %
Prosthetic	4	11.43 %
Periodontal	1	2.85 %

Table 2. Lasers used for laser-assisted crown lengthening

Laser type	No	%
Diode	16	45.71 %
Er:YAG	19	54.29 %
CO_2	0	0 %

Table 3. Type of restoration

Type of restoration	No	%
Metal-ceramic	3	8.57%
Metal-free	10	28.57%
Porcelain veneers	7	20%
Composite veneers	15	42.86%

In everyday dental practice, a variety of laser devices with different wavelengths are available, each affecting tissues in unique ways. The E r :YAG laser was the most commonly used for laser-assisted clinical crown extension, utilized in 54.29% of cases, while diode lasers accounted for the remaining 45.71%. No other types of lasers were reported among the participants in this study (Table 2.).

Upon analyzing the data, it was observed that a significant majority of the participants, specifically in 57.14%, prosthetic devices were done, whereas 42.86% had received composite restorations, including composite veneers (Table 3.). Regarding the types of prosthetics, metal-free crowns were the most prevalent, being utilized by 28.57% of the subjects, which accounts for 50% of those with prosthetic restorations. Porcelain laminates were reported in 20% of the subjects, representing 35% of individuals with prosthetic restorations, while metal-ceramic products were found in 8.57% of the subjects, equating to 15% of those with prosthetic restorations.

More than 90% of the respondents in the survey indicated that the restorations implemented after the intervention contributed to a better aesthetic result. In contrast, 5.72% of the participants felt that the restorations did not result in any noticeable change in aesthetic quality. Additionally, one individual, making up 2.86% of the subjects, mentioned that the aesthetic restoration applied to the tooth subjected to the intervention led to a worsening of its aesthetics (Table 4.).

Table 4. Influence of restorations on the aesthetic effect

Influence	No of subjects	%
Improved aesthetic effect	32	91.42 %
Worsened aesthetic effect	1	2.86 %
No influence on aesthetics	2	5.72 %

Table 5. Staging of aesthetic effect by the respondents

Staging	No	%
considerably improved aesthetics	18	56.25 %
moderately improved esthetics	12	37.5 %
satisfactory improved aesthetics	2	6.25 %

Table 6. Staging of the aesthetic effect by clinicians

Grading	No	%
significantly improved aesthetics	14	43.75 %
moderately improved aesthetics	14	43.75 %
satisfactorily improved aesthetics	4	12.5 %

For those respondents who subjectively felt that their aesthetic appearance had improved due to the restorations applied to their teeth following the laser-assisted crown lengthening procedure in the anterior maxillary region, an additional question was posed regarding the level of aesthetic improvement. The majority, representing 56.25%, indicated a significant enhancement in aesthetics. A smaller proportion, at 37.50%, reported a moderate improve-

ment, while only 6.25% stated that their improvement in aesthetics was minimal or satisfactory (Table 5.).

The evaluation of the aesthetic outcomes achieved by the patients was conducted by the clinicians, relying on their subjective assessments. Consequently, an identical proportion of clinical doctors reported observing a significant improvement in aesthetics as well as a moderate enhancement, with both categories representing 43.75% of the total. In contrast, twice as many doctors, in comparison to the patients' self-assessments, indicated that the aesthetic improvement was merely satisfactory, accounting for 12.50% of the overall number of clinicians.

Discussion

This study investigates the types of prosthetic devices used for the teeth involved in this intervention. A key aspect of this research is the evaluation of the aesthetic effects achieved through the laser procedure in combination with prosthetic restoration.

While the existing literature provides comprehensive information on the aesthetic outcomes associated with clinical crown lengthening and highlights the various benefits of utilizing lasers in these procedures, there is insufficient information regarding the aesthetic impact of combining these two elements, specifically in the context of laser-assisted clinical crown lengthening of teeth.

Comparing the findings of this study with other similar research endeavors presents significant challenges. This complexity arises mainly from the limited number of participants in most published studies, coupled with the diverse variations in research methodologies and criteria employed across different investigations. Furthermore, the subjective influences of both patients and physicians contribute to this difficulty. Additionally, there is a notable scarcity of published data on this topic within the national context.

The aesthetic technique for extending the clinical crown of teeth may be carried out using either traditional surgical methods with a scalpel or laser technology. The advantages of employing lasers for such procedures are notable, including their accuracy, the ability to sterilize the treatment area, a bloodless surgical and recovery process, the absence of sutures, diminished pain and swelling, and a more favorable prognosis for the results. Furthermore, laser procedures are significantly more efficient than conventional surgical methods.

The impairment of biologic width is correlated with long-standing chronic gingival inflammation, often resulting in spontaneous tissue regrowth within approximately three months[11]. Enhanced soft tissue regrowth is particularly evident in groups that received laser gingivectomy and electrocautery gingivectomy. According to Antenucci's findings, the application of laser techniques in soft tissue management optimizes the health and healing processes of oral tissues in a manner that is minimally invasive[12].

The assessment of aesthetic results in restorations is inherently subjective, which undermines the reliability of this study, especially given the lack of objective measures. However, since aesthetic values are personal and significantly influenced by patient needs, the study retains its importance if patients themselves recognize a positive outcome. In conclusion, dental lasers are established as a safe, rapid, and effective treatment modality that delivers outstanding results for gummy smiles. As marketing strategies improve, these treatments are gaining greater acceptance among patients[13].

Numerous research efforts have explored the various aesthetic factors influencing patients who desire enhancements in their smile aesthetics. Despite significant advancements in this area, there remains a considerable focus on studies involving female participants, who tend to exhibit a greater concern for aesthetic outcomes. It is essential to consider patients' perspectives to mitigate the risk of dissatisfaction with orthodontic interventions[14,15].

Conclusion

Based on the analysis of the collected data, several conclusions can be drawn regarding the aesthetic evaluation of the achieved following the laser-assisted extension of the clinical crown. It is noteworthy that over ninety percent of the examined sample indicated that the restorations applied after the intervention contributed to a significant improvement in their aesthetic results. Moreover, a substantial portion of the respondents assessed their aesthetic enhancement as considerable.

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INFLUENCE OF SERUM ADIPONECTIN CONCENTRATION ON GINGIVAL HEALTH IN FEMALE PATIENTS WITH INCREASED BMI

ВЛИЈАНИЕ НА СЕРУМСКИТЕ КОНЦЕНТРАЦИИ НА АДИПОНЕКТИН ВРЗ ГИНГИВАЛНО ЗДРАВЈЕ КАЈ ПАЦИЕНТКИ СО ЗГОЛЕМЕН ВМІ

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Abstract

Relationship between circulating adiponectin levels and gingival health in women with high BMI

Chronic periodontal disease is an inflammatory condition characterized by a shift in the microbial ecology of subgingival plaque biofilms and the progressive host-mediated destruction of tooth-supporting structures. There has been considerable interest in drawing connections between periodontal inflammation and other chronic conditions. Although anti-inflammatory mediators, antagonize the pro-inflammatory activities, the balance between pro- and anti-inflammatory mediators is shifted towards inflammation. Recent data point out that inflammation is associated with lower levels of adiponectin. Adiponectin is adipocytokine secreted by the fat tissue that is involved in the energy homeostasis and the regulation of the metabolism of fat and carbohydrates and exhibits anti-inflammatory effect. The levels of circulating adiponectin are inversely related with body mass index and tend to be lower in obese subjects. The aim of our study was to determine connection between serum levels of adiponectin and gingival inflammation in obese women. **Materials and methods**: The study included 45 women, aged 21- 60 years with BMI range 25.8 – 50.2 kg/m^2. The study group was selected from the participants in the project MONODIET run at the Institute of Pathophysiology and Nuclear Medicine, at the Medical faculty in Skopje. The presence of endocrinologic disorders, pregnancy, lactation, hormonal or antilipidemic drugs were exclusion criteria. Adiponectin levels were determined by competitive radioimmunoassay and gingival inflammation was estimated clinically using the criteria proposed by Sillness Loe. The statistical analysis of the data was performed with Pearson's correlation and two sample unpaired t-test. The probability level <0.05 was considered statistically significant. **Results:** The adiponectin levels ranged from 3.3 ng/ml to 28.07 ng/ml. The mean value was 10.58+/- 4.7 ng/ml. The adiponectin levels showed negative correlation (r -0.7643, p<0.02, r-0,7776, p<0.002).) with gingival inflammation and bleeding as well.The results from our study showed inverse correlation between adiponectin and gingival inflammation and bleeding. In accordance with the obtained results we concluded that the lower levels of adiponectin lead to stronger clinical expression of gingival inflammation and bleeding. **Keywords:** Adiponectin, serum, BMI, gingiva, inflammation.

Апстракт

Хроничната пародонтална болест е воспалителна состојба која се карактеризира со промена во микробната екологија на биофилмовите на субгингивалниот плак и прогресивно уништување на структурите што го потпоруваат забот со посредство на домаќинот. Постои значителен интерес за поврзување помеѓу пародонталната инфламација и други хронични состојби. Иако антиинфламаторните медијатори ги антагонизираат проинфламаторните активности, рамнотежата помеѓу про- и антиинфламаторните медијатори е насочена кон воспаление. Неодамнешните податоци покажуваат дека воспалението е поврзано со пониски нивоа на адипонектин.Адипонектинот е адипоцитокин што се лачи од масното ткиво, кој е вклучен во енергетската хомеостаза и регулирањето на метаболизмот на мастите и јаглехидратите и покажува антиинфламаторно дејство. Нивоата на циркулирачки адипонектин се обратно пропорционални со индексот на телесна маса и имаат тенденција да бидат пониски кај обезни лица. Целта на нашата студија беше да се утврди врската помеѓу серумските нивоа на адипонектин и гингивалната инфламација кај дебели жени. **Материјали и метод:** Студијата опфати 45 испитаници од женскиот пол на возраст од 21- 60 години со вредност на BMI од 25.8 до 50.2 kg/m^2. Пациентките со ендокрини, метаболни пореметувања , бременост, лактација како и хиперлипидемија беа исклучени од студијата. Кај сите пациентки беше одреден БМИ, серумското ниво на адипонектин и клинички беше одреден индексот на гингивална инфламација по Sillness Loe. Адипонектинот беше одредуван на Институтот за патофизиологија и нуклеарна медицина со помош на компетитивна радиоимуноесеј метода . За статистичката анализа беше користен Pearson-овиот тест за корелации и Студентов t-тест за независни примероци. Степенот на веројатност <0.05 се сметаше за статистички сигнификантен. **Резултати:** Серумските вредности на адипонектин се движеа во распон од 3.3 ng/ml до 28.07ng/ml. Средната вредност изнесуваше 10.58+/- 4.7 ng/ml. Pearson-овиот тест за корелации покажа статистички значајна негативна корелација со индексот на гингивална инфламација и гингивално крвавење (r -0.7643, p<0.02, r-0,7776 p<0.002). Добиените резултати ни дозволуваат да заклучиме дека намалените нивоа на адипонектин кај пациентите учествуваат во клиничкото потенцирање на гингивалната инфламација и крвавење. **Клучни зборови:** адипонектин, серум, BMI, гингива, инфламација.

Introduction

Periodontal disease is a multifactorial condition characterized by the destruction of periodontal tissues due to an inflammatory response to bacterial plaque accumulation. Its pathogenesis involves the activation of the host immune responses, which leads to the release of pro-inflammatory cytokines such as interleukin-1β (IL-1β), interleukin-6 (IL-6), and tumor necrosis factor-alpha (TNF-α). These mediators contribute to tissue degradation and alveolar bone loss[1]. Chronic inflammation in periodontal disease has also been associated with systemic conditions such as diabetes, cardiovascular disease, and obesity[2].

Recent research has highlighted the role of adipokines-bioactive molecules secreted by adipose tissue-in modulating inflammatory responses within periodontal tissues. Among these, adiponectin has garnered significant attention due to its anti-inflammatory properties and potential influence on periodontal health[3].

Adiponectin is a 30 kDa protein composed of 244 amino acids, structurally characterized by a collagen-like domain and a globular domain. It circulates in the blood in three forms: low-molecular-weight (LMW), medium-molecular-weight (MMW), and high-molecular-weight (HMW) oligomers. The HMW form is considered the most biologically active and is closely associated with insulin sensitivity and anti-inflammatory effects[4]. Adiponectin exerts its effects through two primary receptors, AdipoR1 and AdipoR2, which are widely expressed in various tissues, including the liver, skeletal muscle, and immune cells[5].

Adiponectin has been shown to inhibit the production of pro-inflammatory cytokines such as TNF-α and IL-6, which are elevated in periodontal disease while promoting the secretion of anti-inflammatory cytokines like IL-10, thus modulating the overall inflammatory response[6]. Additionally, Adiponectin influences the activity of osteoblast and osteoclast activity, contributing to bone remodeling. Studies suggest that adiponectin can inhibit osteoclasts genesis and reduce bone resorption, which is beneficial in preventing alveolar bone loss in periodontal disease[7].

Adiponectin plays an important role in improving insulin sensitivity, which is particularly relevant given the bidirectional relationship between diabetes and periodontal disease. Improved glycemic control may reduce the severity of periodontal inflammation and vice versa[8].

Emerging evidence also indicates a significant association between adiponectin levels and periodontal disease. Studies have shown that adiponectin exerts anti-inflammatory effects by inhibiting the expression of pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α) and interleukins (IL-1β, IL-6, IL-8) in periodontal ligament cells. In addition, adiponectin has been shown to counteract the stimulatory effects of periodontal pathogens like Porphyromonas gingivalis, thereby reducing the production of matrix metalloproteinases (MMP-1 and MMP-3) involved in tissue degradation[9].

Therefore, the aim of our study was to investigate the correlation between serum levels of adiponectin and gingival bleeding and gingival inflammation in women with high BMI

Material and methods

The study included 47 women, aged 21- 60 years with BMI values ranging from 25.8 to50.2 kg/m2. The study group was selected from the participants in the MONODI-ET project conducted at the Institute of Pathophysiology and Nuclear Medicine, at the Faculty of Medicine in Skopje. The presence of endocrinologic disorder, pregnancy, lactation, hormonal or antilipidemic drugs were exclusion criterium.

In all patients, BMI, serum adiponectin levels, and the gingival inflammation and gingival bleeding index were clinically assessed according to theSilness and Löe index.

All participants met criteria to have plaque index not higher than1 according to Green-Vermilion index.

Adiponectin levels were measured at the Institute of Pathophysiology and Nuclear Medicine using a competitive radioimmunoassay method. RIA is based on the competitive binding of a radiolabeled antigen (tracer) and an unlabeled antigen (from the sample) to a limited number of specific antibodies. The amount of radiolabeled antigen bound to the antibody is inversely proportional to the concentration of the unlabeled antigen in the sample.

For statistical analysis, Pearson's correlation test and Student's t-test for independentsampleswere used. A p-value<0.05 was considered statistically significant.

Results

The adiponectin levels among participants ranged from 3.3 ng/ml to 28.07 ng/ml. The mean value was 10.58+/- 4.7 ng/ml.

Table 1. Statistical comparation between levels of gingival inflammation and circulating levels of adiponectin

Inflammation		t	p
Index1	20,3 ng/ml.		
Index2	14,7 ng/ml.	2,39	0,0413
Index3	8,6 ng/ml.	3,48	0,0245

The results obtained from our study are presented in the following tables and graphics

Table 1 presents inflammation-related indices and their corresponding values of circulating adiponectin values. The columns include measured values (in ng/ml) and statistical data.

- **Index 1:** The measured value is 20.3 ng/ml.
- **Index 2:** The measured value is 14.7 ng/ml, with a t-value of 2.39 and a p-value of 0.0413. The p-value suggests a statistically significant difference at the 0,05 significance level.
- **Index 3:** The measured value is 8.6 ng/ml, with a t-value of 3.48 and a p-value of 0.0245. The lower p-value indicates a stronger statistical significance compared to Index 2.

Table 2. Statistical difference between levels of gingival bleeding on probing and circulating levels of adiponectin

G bleeding		t	p
Index 1	18,6 ng/ml.		
Index 2	12,3 ng/ml.	1,58	0,0493
Index 3	9,5 ng/ml.	2,89	0,059

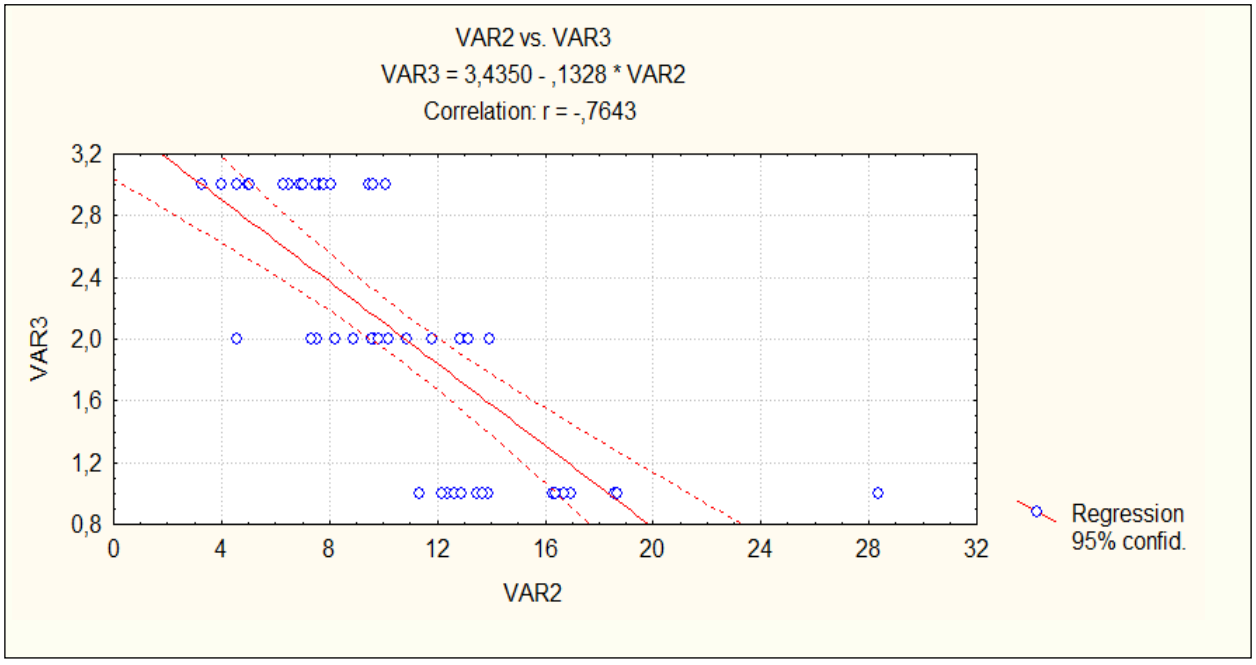
The statistical values (t and p) represent the results of a comparison, between different conditions or groups compared to the first group. A p-value below 0.05 generally indicates statistical significance, meaning the observed differences are unlikely due to random variation.

The table 2 presents data related to G bleeding and includes measured values of adiponectin serum levels, along with statistical parameters (t-value and p-value).

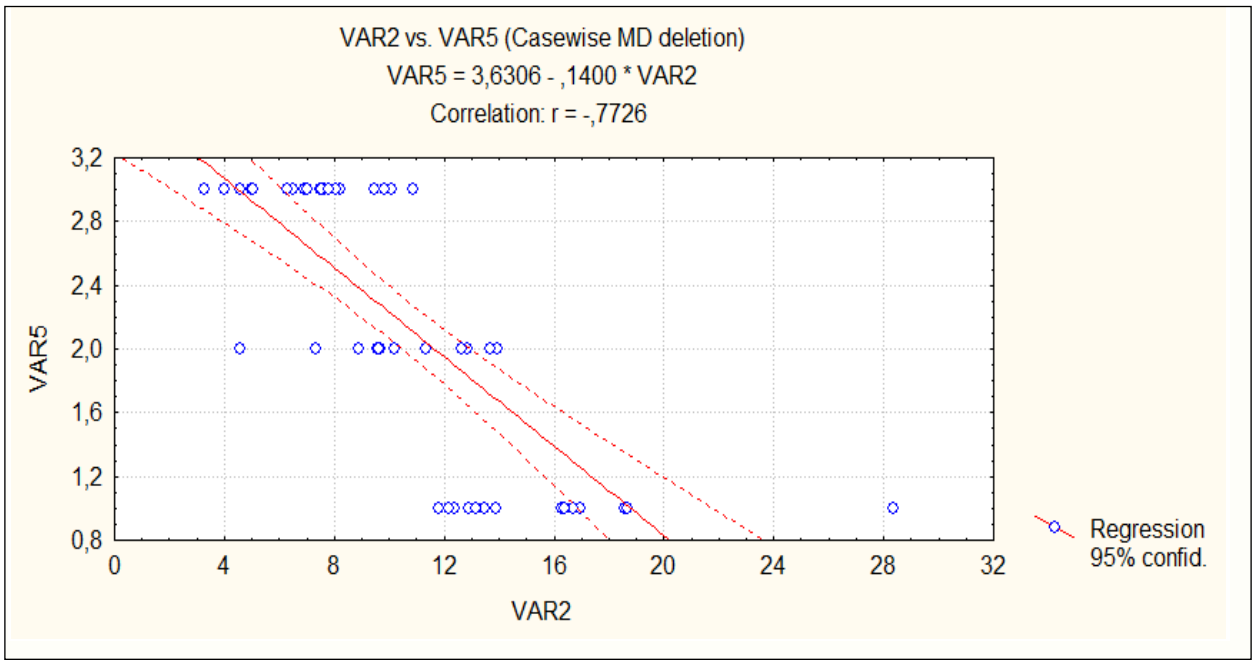
- **Index1:** The concentration is 18.6 ng/ml.
- **Index2:** The concentration is 12.3 ng/ml, with a t-value of 1.58 and a p-value of 0.0493. The p-value is close to the 0.05 threshold, indicating a statistically significant difference.
- **Index3:** The concentration is 9.5 ng/ml, with a t-value of 2.89 and a p-value of 0.059. The p-value is slightly above 0.05, suggesting that the difference is not statistically significant at the conventional level but may still indicate a trend toward significance.

Graph1 illustrates the relationship between adiponectin (VAR2) and gingival bleeding (VAR3) based on a regression analyses Correlation (r =-0.7643): The negative correlation coefficient (-0.7643) indicates a strong inverse relationship between adiponectin and gingival bleeding.

The graph 2 shows the relationship between adiponectin and gingival inflammation based on a regression analyses. This indicates that as adiponectin levels increase, gingival inflammation decreases. Correlation (r = -0.7726) The negative correlation coefficient (-0.7726)



Graph 1. Correlation between gingival bleeding and adiponectin



Graph 2. *Correlation between gingival inflammation and adiponectin*

suggests a strong inverse relationship between adiponectin and gingival inflammation.

Discussion

Periodontal disease arises from the interactions between periopathogenic bacteria and the host defense system. Bacterial products such as LPS, antigen, penetrate the gingival tissue triggering the inflammatory response. As a result of this interaction, inflammatory mediators such as cytokines, chemokines, adipokines, and arachidonic acid metabolites are released, which play an important role in disease progression and tissue destruction[10,2].

Adipokines are biologically active molecules produced by the adipose tissue. Adipokines such as adiponectin play an important role in periodontal inflammation.

Adiponectin possesses anti-inflammatory properties that may protect against periodontal inflammation by counteracting the effects of periodontal pathogens and their associated inflammatory responses[11,12].

The aim of our study was to assess the effect of adiponectin on gingival inflammation. Regarding gingival inflammation, our findings demonstrated that lower serum levels of adiponectin were associated with severe inflammation, while higher levels of adiponectin correlated with reduced inflammation (Table 1).

The negative correlation coefficient (-0.7726) indicates a strong inverse relationship between adiponectin and gingival inflammation. Higher adiponectin levels were associated with lower levels of gingival inflammation. Given adiponectin is an anti-inflammatory protein, this graph supports the hypothesis that higher adiponectin levels might help reduce gingival inflammation. The strong inverse correlation suggests that adiponectin could play a protective role in periodontal health (Graph 2.)

Adiponectin mediates its protective effects through several mechanisms, including:

Inhibition of Pro-inflammatory Cytokines: By suppressing the production of TNF-α and interleukins, adiponectin reduces the inflammatory response within periodontal tissues. Studies demonstrate that adiponectin is synthesized by oral epithelial cells and can modulate inflammatory responses induced by P.gingivalis lipopolysac charide. Adiponectin was found to downregulate pro-inflammatory cytokines such as IL-1β, IL-6, and IL-8, while upregulating anti-inflammatory mediators like IL-10[9].

Similar results were observed for gingival bleeding (Table 2, Graph 1). Higher adiponectin levels are associated with lower levels of gingival bleeding. Adiponectin, known for its anti-inflammatory properties, appears to have a protective role in reducing gingival bleeding. The strong inverse correlation suggests that higher adiponectin levels may contribute to better periodontal health by reducing bleeding in the gums.

Our findings align with previous research. For example, studies by Yamaguchi et al[6] also reported an inverse correlation between adiponectin levels and inflammatory markers in periodontal disease, reinforcing its protective

role in periodontal health. Similar results were observed by Fairlin P et al[13]., who demonstrated that higher adiponectin concentrations in gingival fluid were linked to reduced gingival inflammation and improved periodontal outcomes.

The same results were obtained for gingival bleeding (Table 2, Graph 1). Higher adiponectin levels are associated with lower levels of gingival bleeding. Adiponectin, known for its anti-inflammatory properties, appears to have a protective role in reducing gingival bleeding. The strong negative correlation suggests that higher adiponectin levels may contribute to better periodontal health by reducing bleeding in the gums. A study by Duzagac et al.[14] found that patients with chronic periodontitis had significantly lower serum adiponectin levels compared to healthy controls, suggesting a protective role of adiponectin in periodontal health.

Conversely, another study by Furugen et al.[15] reported elevated adiponectin levels in gingival crevicular fluid (GCF) of patients with periodontitis, indicating a localized anti-inflammatory response.

These findings highlight the complex role of adiponectin in periodontal disease, which may vary depending on the site of measurement (systemic vs. local) and the stage of the disease.

Thus, our study, together with previous research, supports the hypothesis that adiponectin is a significant modulator of gingival inflammation and bleeding, highlighting its potential as a biomarker for periodontal health.

Conclusion

Adiponectin plays a pivotal role in modulating inflammation and bone metabolism within periodontal tissues. Its anti-inflammatory and bone-protective properties make it a promising target for therapeutic interventions in periodontal disease. Future studies should focus on understanding the precise mechanisms of adiponectin action and exploring its potential in clinical applications for periodontal therapy.

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IMPLANT-PROSTHETIC REHABILITATION USING THE "ALL-ON-FOUR" TREATMENT CONCEPT: A CASE REPORT

ИМПЛАНТО-ПРОТЕТСКА РЕКОНСТРУКЦИЈА НА ПАЦИЕНТ СО КОНЦЕПТОТ "ALL-ON-FOUR": ПРИКАЗ НА СЛУЧАЈ

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Abstract

The "All-on-Four" treatment concept is a contemporary approach to complete implant-prosthetic rehabilitation in edentulous patients, enabling the placement of a fixed prosthetic restoration within 24 hours. Compared to conventional complete dentures, this method offers faster rehabilitation, improved function, enhanced aesthetics, and a notable increase in quality of life. This case report aims to evaluate the clinical success of the "All-on-Four" concept for the immediate restoration of completely edentulous jaws, as well as to document a four-year follow-up after placement of the definitive prosthetic restoration. A 56-year-old patient with advanced periodontitis and severely compromised oral health underwent comprehensive clinical and radiographic evaluation, including 3D imaging (CBCT). The diagnosis revealed generalized chronic periodontitis with alveolar bone resorption and inadequate support for conventional implant placement. Given the patient's good systemic health and absence of contraindications, the "All-on-Four" treatment concept with immediate loading was indicated for both the maxilla and mandible. Four titanium implants (MIS C1) were placed in each jaw, followed by the immediate installation of a provisional fixed prosthesis. Follow-up evaluations were conducted at 1, 3, and 6 months, proceeding to the fabrication and placement of a definitive metal-ceramic prosthetic construction. The results indicate that the "All-on-Four" concept is a reliable and effective alternative for patients unsuitable for traditional implant therapy, providing excellent functional and aesthetic outcomes, a favorable long-term prognosis, and substantial improvements in overall quality of life. **Keywords:** "All-on-four" treatment concept,implant-prosthetic rehabilitation, immediate loading,quality of life.

Апстракт

Концептот "all-on-four" претставува современ терапевтски пристап за целосна имплантопротетска рехабилитација кај пациенти со тотална беззабост, овозможувајќи фиксна протетска конструкција во рок од 24 часа. Овој пристап нуди брза рехабилитација, подобрување на функцијата, естетиката и квалитетот на животот во споредба со конвенционалните тотални протези. Целта на овој приказ на случај, со употреба на all-on-four" концептот, е да се евалуира успешноста на реконструкцијата на целосно беззабите вилици со фиксна протетска изработка веднаш по имплантирањето како и да се направи следење на пациентката по поставувањето на дефинитивната протетска конструкција, во временски период од 4 години. Импланто-протетска рехабилитација беше направена кај пациентка на возраст од 56 години со напреднат пародонтит и значително влошена орална состојба. По клиничкиот преглед и 3Д радиографска анализа (CBCT), беше утврдена генерализирана хронична пародонтопатија со алвеоларна ресорпција и недоволна коскена поддршка за традиционална имплантолошка терапија. Поради добрата општа здравствена состојба и отсуството на контраиндикации за имплантирање, беше индицирана терапија со all on four концептот за двете вилици со имедијатно оптеретување. Поставени беа четири титаниумски импланти во горна и долна вилица (MIS C1). Контролни прегледи беа извршени по 1, 3 и 6 месеци, по што беше изработена дефинитивна конструкција од металкерамика. Резултатите покажуваат декаовој пристап претставува одлична и сигурна алтернатива за пациенти кои не се подобни за традиционално поставување на импланти, овозможувајќи висок степен на естетско задоволство, функција, одлична прогноза и значително подобрување на квалитетот на животот. **Клучни зборови:** All on four концепт, имплантопротетска рехабилитација, имедијантно оптоварување,квалитет на живот.

Introduction

The rehabilitation of completely edentulous jaws and the restoration of the stomatognathic system remain significant challenges in modern dentistry. The most commonly employed treatment for total edentulism is conventional complete dentures, designed to restore speech, mastication, and aesthetics. However, in patients with severe alve-

olar ridge resorption-particularly those with Class V and VI mandibular resorption[1], problems with prosthesis retention, stability, and support become considerably more pronounced.

Implant-supported overdentures represent an established therapeutic option for the rehabilitation of fully edentulous patients[2]. Within this context, the use of implant-supported fixed prostheses in individuals with advanced alveolar atrophy poses a substantial clinical challenge. Prosthetic design must balance patient expectations with anatomical limitations. Notably, many edentulous patients demonstrate a strong preference for fixed restorations over removable prostheses.

One of the most widely accepted protocols for fixed prosthetic rehabilitation in edentulous jaws is the "All-on-Four" concept. Regarding the number of dental implants utilized, Brånemark and colleagues conducted a 10-year longitudinal study demonstrating higher success rates in patients treated with four implants compared to those with six[3].

Originally developed by Maló and colleagues in the early 2000s[4], the concept is based on the strategic placement of four implants-two placed axially in the anterior region and two distally tilted posterior implants. This angulation, typically around 45 degrees[5], increases the anteroposterior spread, which in turn enhances prosthetic support and occlusal stability, especially in the first molar region, while limiting cantilever length.

Tilted implants offer several biomechanical and anatomical advantages: they permit the use of longer implants (increasing surface area and primary stability), reduce or eliminate cantilevers, expand the prosthetic base, and help avoid critical anatomical structures such as the inferior alveolar nerve, the mental foramen, and the floor of the maxillary sinus. Literature supports the efficacy of this approach, reporting high success rates and a low incidence of complications[6,7].

The objective of this case report was to evaluate the clinical success of immediate fixed prosthetic restoration using the "All-on-Four" treatment concept for the reconstruction of completely edentulous jaws, with a follow-up period of four years post-implantation.

Case presentation

A 56-year-old female patient with a documented history of advanced periodontitis presented for comprehensive oral rehabilitation due to severely compromised oral health (Figure 1). The patient expressed strong desire to restore both masticatory function and facial aesthetics, emphasizing with a clear preference for a fixed prosthetic solution. The patient reported longstanding dissatisfaction with partial removable dentures, which she had been using for several years.

Intraoral examination revealed partial edentulism in both the maxilla and mandibleThe remaining teeth had a poor prognosis, marked by Grade III mobility, periodontal pockets exceeding 6 mm in depth, and generalized gingival recession. Clinical findings, corroborated by cone-beam computed tomography (CBCT), confirmed a diagnosis of generalized chronic periodontitis accompanied extensive alveolar bone resorption and insufficient bone volume for conventional implant placement.

Given the patient's satisfactory general health and absence of contraindications for surgical intervention, full-arch rehabilitation using the "All-on-Four" treatment concept with immediate loading was proposed for both arches.

Figure 1. *Initial intraoral condition*

Surgical Protocol

The procedure was performed under plexus anesthesia using articaine with epinephrine 1:100,000 (Artinibsa 4%). Antibiotic prophylaxis was initiated with a single dose of amoxicillin-clavulanic acid (Alkaloid AD Skopje), administered one hour prior to surgery and continued for six days postoperatively. Corticosteroid therapy (Prednisolone, MERCK Healthcare KGAA, Germany; P&G Health Austria GmbH & CO OG) was prescribed in a tapering dosage (15 mg to 5 mg) from the day of surgery through postoperative day four.

All remaining teeth wereextracted atracumatically to preserve the existing bone structure. Following extractions,

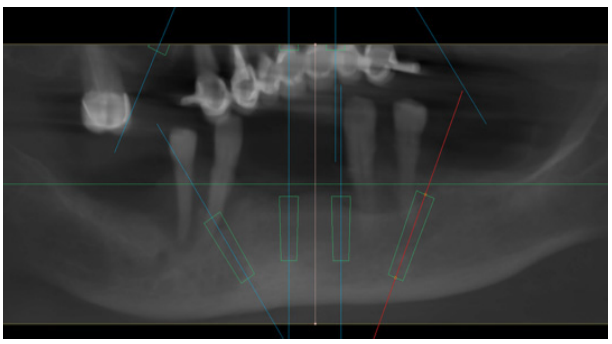

Figure 2. *Marking of four implant positions in the lower arch.*

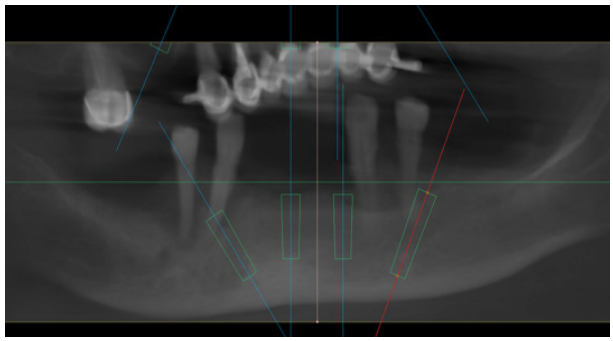

Figure 3. *Marking of four implant positions in the upper arch.*

meticulous curettage of the alveoli was performed to remove residual inflammatory tissue and establish a healthy foundation for implant placement. Full-thickness mucoperiosteal flaps were elevated to allow for osteoplasty and alveolar ridge leveling, thereby optimizing implant stability and ensuring proper prosthetic adaptation. Implant sites were then marked in both arches (Figures 2 and 3).

The anterior implants were placed axially in the lateral incisor/canine region, while the posterior implants were inserted at angulations of 30° to 45°, in the premolar foramen to avoid critical anatomic structures such as the maxillary sinuses and the mental foramen. A total of eight titanium implants (MIS C1) were placed—four in each jaw—with primary stability values exceeding 35 Ncm, thereby allowing for immediate loading.

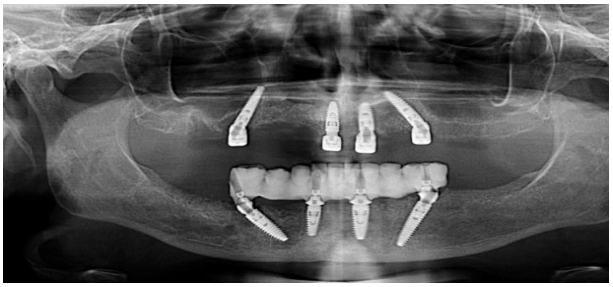

Figure 4. *Final placement of implants in the upper and lower jaw.*

Implants placed in the lower jaw: #45: C1 B+ 4.20 × 13 mm; #42: C1 B+ 3.75 × 10 mm; #31: C1 B+ 3.75 × 11.5 mm; #34: C1 B+ 3.75 × 16 mm

Implants placed in the upper jaw: #15: C1 B+ 3.75 × 16 mm; #11: C1 B+ 3.75 × 10 mm; #21: C1 B+ 3.75 × 10 mm; #24: C1 B+ 3.75 × 13 mm

Multi-unit abutments (MIS, Dentsply Sirona) were immediately connected to correct angulation and provide optimal prosthetic support. Open-tray impression copings were then secured using metal splints and self-curing acrylic resin. Final impressions of both jaws were taken

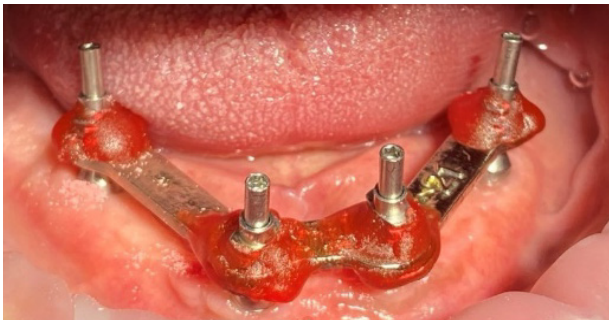

Figure 5. *Placement of transfers stabilized with metal framework and self-curing acrylic in the lower jaw. ??*

Figure 6. *Impression of the lower jaw using hydrocolloid silicone.*

(Figure 5) using hydrocolloid silicone material (Variotime, Kulzer) (Figure 6).

Prosthetic Workflow

Digital planning and design were completed using Exocad software (Figure 7). Upon approval, fabrication of the provisional restoration began.

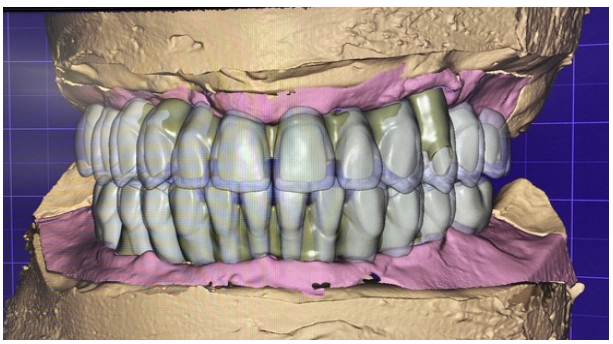

Figure 7. *Digital prosthetic design.*

The temporary restoration (Power Resins Temp, 3BFAB LLC) was 3D-printed using the DentaFab system and screw-retained on the same day, providing immediate restoration of both functional and aesthetics (Figure 8).

Figure 8. *Fabricated temporary restoration.*

Postoperative care management included the continuation of prescribed antibiotic and corticosteroid regimens, supplemented with analgesics (ibuprofen or paracetamol every 6 hours as needed). The patient was advised to perform oral rinse with 0.12% chlorhexidine and adhere to follow a soft diet for 6–8 weeks to minimize implant loading and support proper osseointegration. The initial follow-up appointment was conducted 7 days post surgery, while suture removal scheduled at 14 days. Further evaluations were conducted at 1, 3, and 6 months.

Definitive Prosthetic Rehabilitation

Six months post-implantation, final impressions were obtained, and stone casts were fabricated and scanned with a laboratory scanner. The diagnostic models of the provisional restoration served as reference to preserve established occlusal and aesthetic parameters. The definitive prosthesis was digitally redesigned in Exocad, and the framework was milled from a pre-sintered cobalt-chromium disc (KERA®-DISC, Eisenbacher Dentalwaren) (Figure 9).

Figure 9. *Milled metal framework for tht definitive prosthesis.*

A clinical try-in of the metal framework was performed to verify its passive fit on the abutments, with radiographic verification ensuring accurate adaption. The framework was subsequently veneered with ceramic (GC Initial® MC Classic Line) (Figures 10, 11, 12), achieving excellent aesthetic integration and a natural, lifelike appearance. The definite prosthesis was screw-retained, providing both long-term stability and ease of retrieval for maintenance. A follow-up panoramic radiograph was taken four years post-implantation confirmed the sustained stability of the prosthetic construction and successful osseointegration (Figure 13)

Figure 10.

Figure 11.

Figure 12.

Figure 10, 11, 12. *Definitive prosthesis in situ.*

Figure 13. *Follow-up radiograph four years post-surgery.*

Discussion

Dental implantology represents a major advancement in the treatment of partial and complete edentulism, significantly enhancing both oral health and overall quality of life[8]. In the presented case, four implants were strategically placed in each jaw, with biannual follow-up assessments conducted over a four-year . Throughout this time,no marginal bone resorption was observed, and occlusal contacts remained stable in maximum intercuspation. Implant-supported prosthetic rehabilitations have demonstrated exceptional efficacy in the management of complex edentulous cases[9]. However, such advanced treatments are often associated with increased financial costs when compared to conventional removable dentures. Furthermore, fully edentulous patients may be at risk for certain postoperative complications following implant placement[10].

The introduction of the "All-on-4" treatment concept represents a significant advancement in the prosthetic rehabilitation of edentulous patients. This approach maximizes optimizes the use of residual alveolar ridges in severely atrophied jaws, enabling immediate loading and rapid functional restoration. By minimizing the number of implants and eliminating the need for bone grafting, the "All-on-4" concept reduces surgical complexity, lowers overall treatment costs, and decreases the incidence of prosthetic complications commonly associated with full-arch restorations supported by multiple implants[11].

Compared to conventional removable prostheses, the "All-on-4" protocol delivers superior functional outcomes, enhanced aesthetics, and improved long-term predictability. Fixed implant-supported restorations notably improve patients' self-confidence and social interactions[12]. Conventional dentures often restrict masticatory function-particularly when chewing harder foods-whereas the "All-on-4" system provides complete functional rehabilitation[3].

While the initial financial investment may be higher, the long-term value of the "All-on-4" approach is significantly greater due to reduced maintenance requirements or replacement. Additionally, the elimination off bone augmentation procedures makes this treatment more accessible and cost-effective for a broader range of patients. Clinical evidence supports the use of fewer implants, which still yields highly successful outcomes[13], as confirmed in our case.

The long-term success of the "All-on-4" treatment concept relies heavily on careful patient selection, precise surgical planning, and a prosthetic design that ensures optimal occlusal load distribution[14]. In our case, strategic implant allowed for the cantilever extension to the first molars, achieving maximum occlusal contact without compromising stability-a result that remained consistent over the entire follow-up period[15].

Numerous clinical studies confirm the high success rate of this concept, which involves the placement of four implants-two anteriorly positioned axially and two posteriorly tilted implants. The posterior implants are strategically angulated to increase the anteroposterior spread, thereby enhancing prosthetic support and avoid vital anatomical structures, such as the maxillary sinus of the interior alveolar nerve[16].

Tilted implants provide several biomechanical advantages, including the ability to use of longer fixtures and reduce or eliminate cantilevers, both of which contribute significantly to prosthetic stability. Balshi et al.[17] demonstrated that angled and axially placed implants in the "All-on-4" configuration exhibit equivalent cumulative survival rates, reaching 97.3%.

Our clinical and radiological findings are consistent with these results: four years post-implantation, marginal bone levels remained within physiological limits, suggesting that tilted implants do not adversely affect peri-implant bone stress distribution[18].

Moreover, it is well documented that the longevity of implant-supported prostheses is heavily influenced by the distribution of functional load. Implant failure is often associated with inadequate occlusal design, which can result in excessive stress concentration and subsequent bone resorption. Therefore, occlusal scheme and load distribution are critical parameters for ensuring the long-term success of implant-prosthetic rehabilitation[19].

Conclusion

The presented clinical case highlights the efficacy and long-term stability of the "all-on-four" treatment concept affirming its role as a safe and predictable therapeutic option for patients with advanced periodontal disease and severe alveolar ridge resorption requiring fixed prosthetic rehabilitation. The applied protocol, which included immediate loading with a screw-retained fixed prosthesis, enabled rapid functional restoration and excellent aesthetic results within the first 24 hours of the surgical intervention.

Thanks to accurately established intermaxillary relationships and the controlled distribution of occlusal forces, the patient exhibited no signs of peri-implant inflammation throughout the follow-up period. Regular evaluations over a four-year period confirmed the long-term clinical success of the treatment, with the patient demonstrating optimalfunctional adaptation and reporting a high degree of satisfaction in both functional and aesthetic terms.

The "All-on-Four" treatment concept has thus proven to be a reliable and evidence-based alternative for patients who are not ideal candidates for traditional

implant protocols. Beyond delivering a functionally stable and aesthetically satisfactory fixed prosthetic solution, this approach significantly enhances patients' overall quality of life.

Consequently, the "All-on-Four" concept has become is increasingly regarded as a contemporary gold standard within the discipline of implant prosthodontics.

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