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PERIODONTAL ASPECTS FOR ACHIEVING SUCCESSFUL FIXED PROSTHODONTIC TREATMENT

ПАРОДОНТОЛОШКИ АСПЕКТИ ЗА ПОСТИГНУВАЊЕ НА УСПЕШЕН ФИКСНО ПРОТЕТИЧКИ ТРЕТМАН

Bojadzieva Dimovska M.[1,2], Dashtevski B.[1], Mijoska A.[1], Stavreva N.[1], Bajraktarova Valjakova E.[1]*

[1] Department of Prosthodontics, Faculty of Dentistry - Skopje, "Ss. Cyril and Methodius" University in Skopje, University Dental Clinical Center "St. Panthelejmon", Skopje, Republic N. Macedonia, [2]PHO „Vita Dent", Gevgelija, Republic N. Macedonia, *Author for correspondence

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-

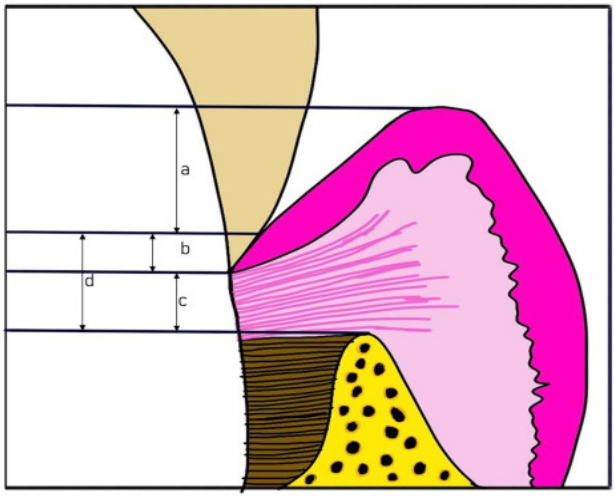

Figure 1. *Schematic representation of biological width components: a) Gngival sulcus of 0.69 mm, b) Epithelial attachment of 0.97 mm, c) Connective tissue attachment of 1.07 mm, d) Biological width (b+c)*[12]

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.).

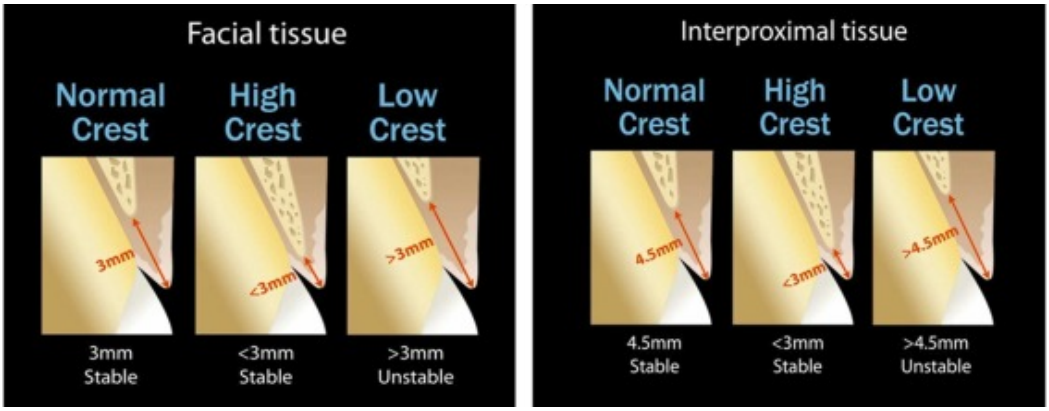

Figure 3. *Categoriesof Biological Width*[19]

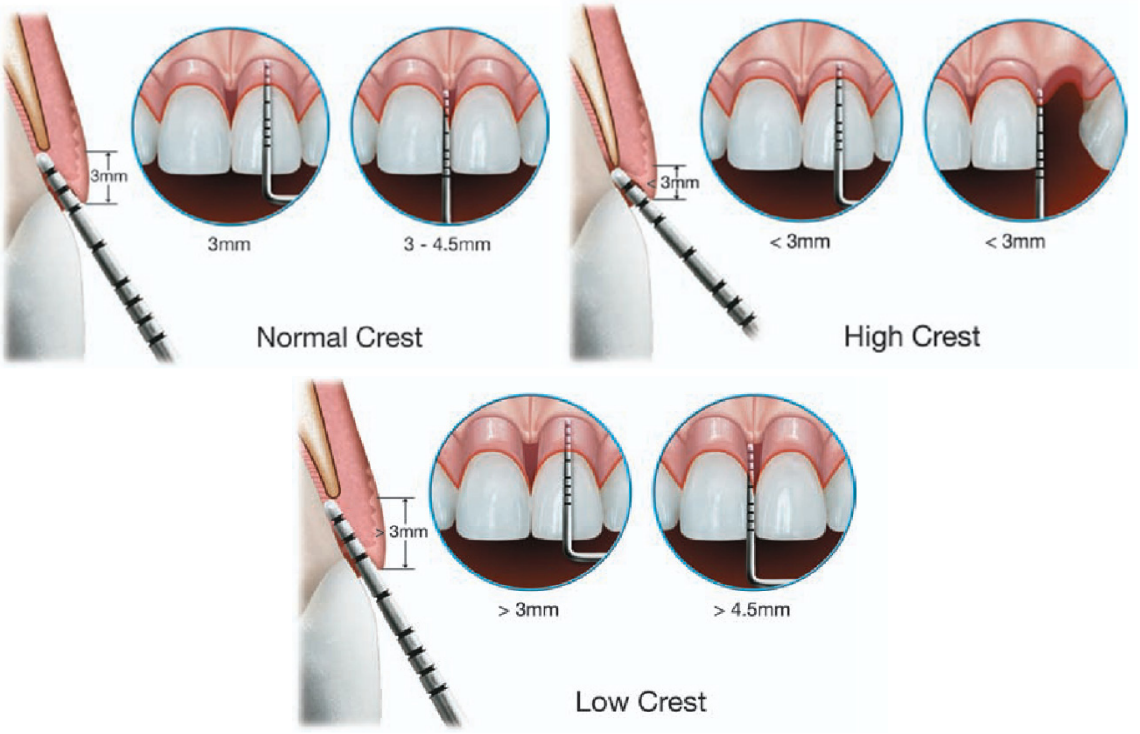

Figure 4. *a) Normal Crest, b) High Crest, c) Low Crest*[16]

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:

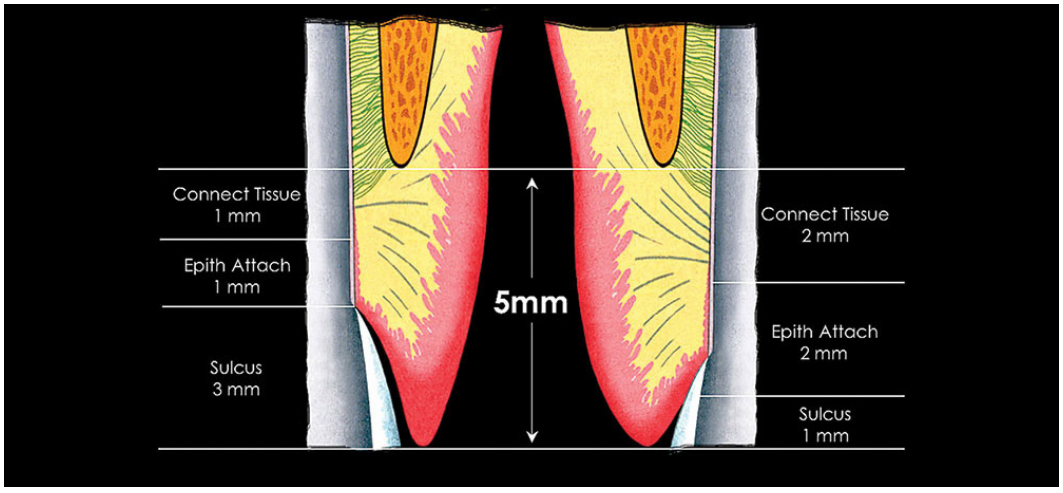

Figure 4. ***Variations in Biological Width in the Low-Crest patient*** *(the total height of gingiva above the alveolar bone is 5 mm)*

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

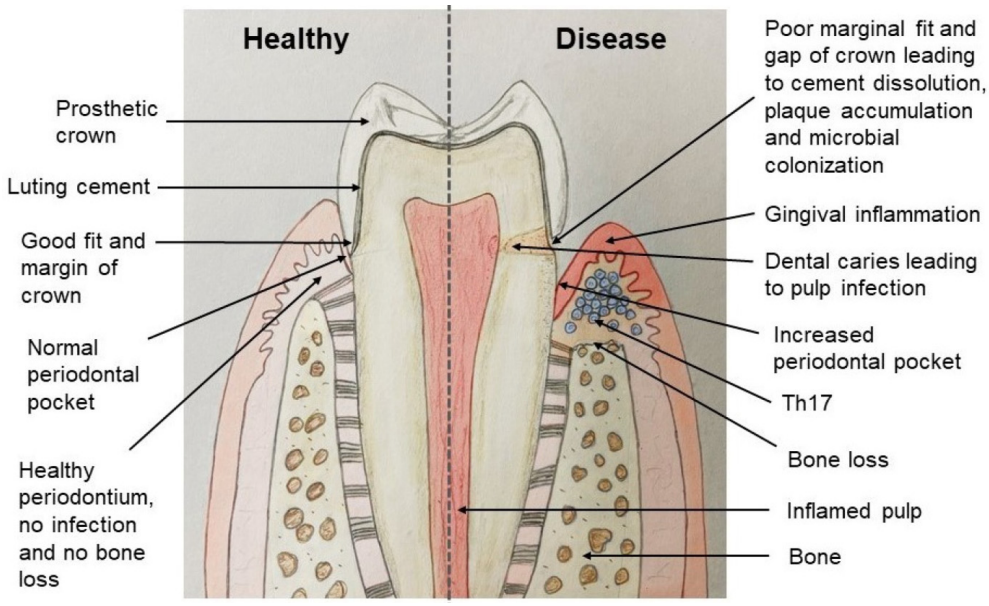

Figure 6. *Good marginal fit of the crown and a poor marginal fit leading to consequence[6]*

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

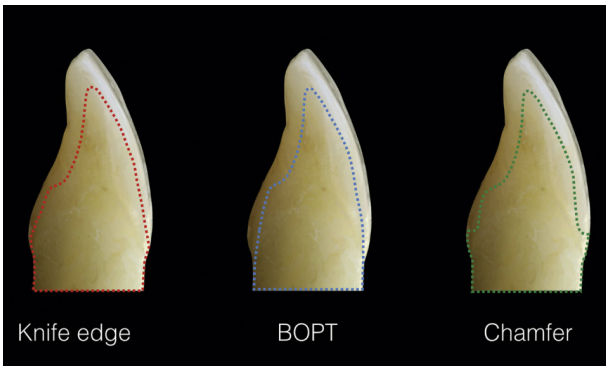

Figure 7. *Types of preparation[56]*

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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