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¨STATE OF THE ART OF BIOLOGICAL THICKNESS IN DEEP MARGIN RESTORATIONS¨

Trabajo de titulación previo a la obtención del título de Odontólogo

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Resumen

Hoy en día, la técnica de elevación del margen gingival es parte de una posible rehabilitación conservadora y predecible para el reemplazo y mejor adaptación de las restauraciones subgingivales. Sin embargo, la invasión del espacio biológico puede provocar patologías en los tejidos circundantes y reabsorción ósea. Por lo tanto, el objetivo de este estudio es revisar el estado del arte con respecto al ancho biológico de los dientes naturales y dientes con elevación profunda del margen (DME). Este estudio se realiza a través de una revisión narrativa de la literatura, buscando en las bibliotecas bibliográficas de Science Direct y PubMed. Los artículos fueron seleccionados en base a criterios de inclusión y exclusión. De la búsqueda inicial se obtuvieron 90 artículos, de los cuales se seleccionaron 37. Los resultados de estos artículos indican que mientras el ancho biológico sea de 3 mm, se puede realizar una penetración de hasta 0,5 mm sin repercusiones a largo plazo. Por lo tanto, este procedimiento se puede realizar de forma segura siempre que se asegure el manejo adecuado del ancho biológico y la cooperación del paciente. Los profesionales de la odontología pueden abordar con eficacia los casos de elevación profunda de los márgenes y garantizar la salud bucal.

Palabras clave**:** EMD, margen profundo, espesor biológico, reubicación del margen cervical

Abstract

Today, the technique of gingival margin elevation is part of a possible conservative and predictable rehabilitation for the replacement and improved adaptation of subgingival restorations. However, the invasion of the biological space can lead to pathologies within the surrounding tissues and bone resorption. Therefore, the aim of this study is to review the state of the art regarding the biological width of natural teeth and teeth with deep margin elevation (DME). This study is conducted through a narrative review of the literature, searching the bibliographic libraries of Science Direct and PubMed. Articles were selected based on inclusion and exclusion criteria. From the initial search, 90 articles were obtained, of which 37 were selected. The results of these articles indicate that as long as the biological width is 3mm, a penetration of up to 0.5mm can be performed without long-term repercussions. Therefore, this procedure can be safely performed as long as appropriate management of the biological width and patient cooperation are ensured. Dental professionals can effectively approach cases of deep margin elevation and ensure oral health.

Keywords*:* DME, deep margin, biological thickness, cervical margin relocation

Índice de contenido

1. Introduction

Dentists over the years have sought new conservative approaches to restore teeth and improve periodontal regeneration, optimizing and maintaining the quality of dental treatment, making it more aesthetic and avoiding marginal leakage [1,2]. Preserving the biological width is fundamental to favor periodontal health, which is defined as the dimension of the space occupied by healthy gingival tissues above the alveolar bone [3–6].

The biological width is not always constant and can vary according to factors such as tooth location, tooth type, and appearance [4,5]. The average clinical dimension is 3 mm in healthy conditions, allowing restoration margins to be placed within the sulcus up to 0.5 mm [3–5].

Different materials used to restore teeth need to have a close relationship with a healthy periodontium [5]. Currently,the repositioning of the cervical margin has been employed to prevent restoration margins from invading the biological width and causing periodontal attachment loss and bone resorption [2,7,8].

Deep margin elevation (DME), also known as the "open sandwich technique," "margin elevation technique," and "proximal box elevation," is a reliable, conservative, and predictable non-surgical technique used to favorably move the gingival margin cervically, avoiding complications such as bone loss, black triangles, papilla atrophy, dental ankylosis, or inadequate crown-root ratio [2,5,6,9–11].

The aim of this literature review is to review the state of the art regarding the biological width of natural teeth and teeth with deep margin elevation (DME) by discussing concepts and the specific structure of the biological width from various radiographic and histological perspectives.

2. Material and methods

Information from indexed scientific articles published in databases such as PubMed and Science Direct in the last 5 years was analyzed. The quality of the articles was evaluated based on the definition of the topic, selection of inclusion and exclusion criteria, and literature review. The search was conducted using the Boolean operator "AND" with keywords DME, Deep Margin, Biological Width and Cervical margin relocation. The inclusion criteria were articles published in English, Spanish, and Portuguese. As for the exclusion criteria, works that did not correspond to the topic, technical reports, course materials, monographs, incomplete articles and animal experiments were discarded.

The search yielded a total of 90 articles, out of which 14 were excluded due to being incomplete, 5 were discarded as monographs, and 26 were analyzed based on titles and abstracts that were not related to the topic. In the end, 37 articles were used for this literature review study. The reviewed articles were collected and stored using

Zotero, which allowed for the elimination of duplicate references, and Microsoft Excel 2016 was used as a tool for data organization.

3. Results

Due to the difficulty involved in restoring teeth with cervical caries, different protocols have been developed over time to remove subgingival carious lesions and perform restorations that allow us to rehabilitate teeth while maintaining a natural appearance and preserving harmony with the surrounding tissues. The following points will be addressed to achieve an appropriate protocol.

3.1. Clinical method to observe biological width

In healthy teeth, to measure the biological width, the entirety of the keratinized tissue must be taken into account, and this value is subsequently subtracted from the depth of the sulcus [5]. When the biological space is located above the crest of the bone and is attached to a healthy tooth at the tissue level, the attached gingiva zone is measured from the base of the sulcus to the mucogingival junction. On the other hand, if the biological width is found below the crest (periodontal compromise), the attached gingiva zone is measured from the crest of the bone to the mucogingival junction. If the mucogingival junction is located above the crest of the bone, there is no attached gingiva, only a zone of unattached keratinized tissue, which would yield a negative result [12].

The dimensions of the supracrestal tissue attachment are not constant and can vary due to factors such as tooth type, tooth position, tooth location in the alveolus, tooth appearance, surface, gingival biotype, and alveolar bone type [5,13].

3.2. Periodontal aspect and effects of biological width invasion

In addition to separating dental structures, the function of the biological width is to act as a protective biological barrier, isolating the pathogenic biofilm from the underlying periodontal ligament and alveolar bone [4,5,13,14]. Obtaining a healthy periodontium after rehabilitating the tooth ensures proper restoration margin configuration, aiming to achieve suitable contour, avoid marginal discrepancies, maintain the properties of the materials used, and promote treatment success [4,5,13,14].

Furthermore, it should be considered that there are characteristic signs of biological width invasion, including gingival inflammation, bleeding and/or suppuration on probing, localized hyperplasia, gingival recession, pocket formation, gingivitis, and clinical attachment loss [4,5,13,14]. Douglas de Oliveira et al. [4] mention in their article that a clear indication of biological width invasion in patients with a thick biotype is periodontal pockets, while in a thin biotype, it is gingival recessions.

3.3. Biological Width Loss Indicators

- Probing Depth - Increased probing depth indicates the presence of a periodontal pocket, which cannot be used as a reference point and is not clinically relevant. The measurement should be taken at the crestal bone level when the patient has pockets [12].
- Osseous Sounding - The value is determined by taking into account the measurement obtained from periodontal probing, with the bone structure serving as the limit. This value is then subtracted from the sulcus depth measurement. If the result is less than 2mm, it can be diagnosed as an invasion of the biological width. In this case, the periodontal health should be evaluated in terms of bleeding on probing and marginal bone level through radiographs to assess the efficacy and success of the DME technique [5].
- Subgingival Margin of the Restoration - When the biological width is altered, the body attempts to recreate the space between the alveolar bone and the margin to allow for tissue insertion, which leads to bone loss [12].

3.4. Biological Width in Deep Margin

The goal of restoring a tooth through restorations is to achieve an emergence profile and correct contact point in each clinical situation. This is a key point to consider for relocating margins [11].

3.5. DME: When and Why?

DME (Deep Margin Elevation) involves the repositioning of the cervical margin, which is a non-invasive pretreatment for restoring deep cavities with cervical margins that extend below the CEJ (Cemento-Enamel Junction), offering the possibility of a gradual relocation of deep margins [9,15]. DME should be performed using restorative materials such as resin and glass ionomer, which need to be placed properly to ensure good marginal seal and to avoid compromising the periodontal ligament [11].

The purpose of performing the deep margin elevation technique is to facilitate impression-taking, placement of the rubber dam during cementation, and cementation of the inlay [8,15]. Bresser et al. [8] confirm that indirect restorations with DME have a good survival rate up to 12 years of evaluation.

3.5.1. Techniques

The elevation of the gingival margin can be achieved using different materials, but the use of composite with absolute isolation and metal matrices is the basis for proper technique management. To execute the technique correctly, it is necessary to locate the lesion borders and identify the crestal bone through radiographs and osseous sounding to ensure the success of the restoration [6,7,16].

Venuti describes two different techniques: anatomical, which is performed with well-adapted matrices, and non-anatomical, which is manually reconstructed or uses Teflon to reduce capillarity and maintain the seal [17].

3.5.2. DME Protocol

First, the extent of the carious lesion, its proximity to the pulp, and the distance between the future margin and the crestal bone should be evaluated. This can be determined through probing depth, osseous sounding, and radiography.

Steps:

- Removal of carious lesion in its entirety, if necessary, referral to relevant areas will be made.
- Complete isolation of the working field with a rubber dam isolating the necessary teeth for proper cavity protection [6,11,18,19].
- Placement of a curved stainless steel matrix to isolate the margins precisely and achieve a perfect seal, ensuring intimate contact with the cavity margins. The biologic width should not be violated by the matrix. Sufficient dental substance should be maintained on the vestibular, lingual, or palatal walls to stabilize the matrix. The rubber dam must not interfere between the margin and the matrix [6,11,16,18–21].
- If necessary, the use of magnification can be implemented as an alternative for the correct execution of the treatment, such as a digital microscope [6,22].
- Subsequently, the cavity is conditioned, dried with cotton rolls to decrease sensitivity and ensure dentinal sealing. Although adhesives with high filler content are preferred, a dentin adhesive agent can also be applied, followed by light curing (20 seconds) [6,8,9,17–19,21].
- Deep margin elevation is performed with flowable composite, conventional resin, or a combination of both, using increments of 1 to 1.5mm. The geometry is corrected, and undercuts are eliminated. As a final step, light curing is done [6,8,9,17–19,21,23]. Glass ionomer modified with resin can also be used following the manufacturer's instructions and light curing (30 seconds) [21,24].
- Excess material is removed to prepare the margins and composites to avoid the adherence of dental plaque [6–9,18,19,23,25].
- As subgingival caries, many of them usually extend beyond the CEJ, therefore, for the reconstruction of the coronal destruction, it is indicated to perform indirect restorations. During the cementation appointment, the area is cleaned and dried before cementation [15,19]. Indirect restorations help reduce polymerization shrinkage, tooth stress, prevent fractures, and avoid microleakage [8,15,21,26].

3.5.3. Advantages and Limitations

The technique has the advantage of avoiding surgery and the absence of a postoperative period, as well as potential complications related to crown lengthening [6].

Margin Placement Guidelines

It is necessary to consider the health of the tissue to determine an appropriate margin guide for the restoration and perform the DME technique. There are rules to follow based on sulcus measurements.

- Rule 1: If the cavity margin is 1.5mm or less, isolation with a rubber dam should be performed, and the margin should be relocated.
- Rule 2: If the cavity margin is greater than 1.5mm and 2mm above the crestal bone, another technique should be used.
- Rule 3: If the cavity margin is greater than 1.5mm and less than 2mm from the crestal bone, another technique should be used.
- Rule 4: If the margin is located below the bone level, another technique involving osteotomy should be performed [11,12,20].

Periodontal Phenotype

Barootchi et al. suggest that the trajectory of the gingival margin is associated with specific phenotypic characteristics of the tooth site. The periodontal phenotype affects the healing time of the gingival margin, and it is necessary to respect tissue recovery before placing permanent restorations [27,28].

Marginal Adaptation

The location of the cervical margin influences marginal seal regardless of the type of adhesive used. Adhesion should be focused on enamel since dentin, due to its organic component and permeability, can affect the seal [29]. In addition, exposing the furcation area, increasing the crown-root ratio, and exposing the root surface can increase the risk of caries [17].

Da Silva et al. stated in their article that nanofiltration and microleakage would be determined by the presence of enamel at the gingival margins, along with the application of phosphoric acid to achieve a proper hermetic seal [10].

Zardoni et al. mentioned in their study that material quality is essential because low-quality material will generate greater short-term microleakage compared to high-quality materials. Moreover, the possibility of improper light curing, inadequate isolation, or matrix placement will affect the success of the restoration, preventing the DME from being carried out correctly [6].

Ismail et al. evaluated under scanning electron microscopy and digital microscopy that regardless of the technique used, microleakage of the deep margin elevation was not affected over time [30]. Meanwhile, Senol et al. concluded that microleakage would be maintained if it is performed above the amelocemental junction [31].

Fracture Resistance

Zhang et al. found in their study that gingival margin elevation increases the fracture resistance of ceramic crowns and can reduce marginal microleakage below the CEJ [32]. On the other hand, Grubbs et al., in their study comparing different materials for gingival margin elevation, suggested that any material could be suitable [33].

The loss of dental structure will negatively affect the restoration process. However, the amount of remaining tissue must be considered for proper rehabilitation and the forces applied during mastication [34,35].

3.5.4. DME Procedure Results

Evaluation of Gingival Health

It is necessary for the dentist to assess the adaptation of the restoration and check for microleakage through clinical observation and probing. Bleeding on probing, inflammation, and other signs must be taken into account to ensure periodontal health [14,23].

Scotti et al. [15] conducted a study on restoration sealing in patients with gingival margin elevation using Micro-CT. They found that nanohybrid and bulk-fill composites can maintain sealing over time.

Histological

Bertoldi et al. conducted a histological study of the gingival margin, confirming that subgingival restorations are compatible with gingival health and favor results in reconstructive dentistry [36,37].

3.5.5. Other Techniques to Correct Biological Width

- Crown lengthening: It is used to achieve margins in a healthy dental structure and helps maintain the biological width when the space is greater than 2mm.
- External bevel gingivectomy: It is performed if there is sufficient attached gingiva and no need for bone correction.
- Internal bevel gingivectomy: It is performed when the depth of the periodontal pocket is shallow, with or without the need for bone correction.
- Apically repositioned flap with or without bone reduction: It is indicated for multiple teeth requiring crown lengthening within a single quadrant.
- Orthodontic extrusion: It is performed when crown lengthening could compromise the patient's aesthetics and the prognosis of the supporting bone [5,9,11,17,20].

4. Discussion

The topic of biological width and deep margin restorations in dentistry can be discussed. Biological width and proper management of the restorative margin are

crucial to achieve long-term aesthetic and functional outcomes in patients with periodontal disease or those requiring dental restorations [6,8,9,15,18,19,23,25,29].

Biological width refers to the distance from the gingival margin to the alveolar bone level. It is essential to maintain a proper balance between the restorative margin and the surrounding gingival tissue to prevent periodontal problems and achieve adequate tissue health and aesthetics [11].

When a dental restoration with a deep margin, meaning near or below the level of the alveolar bone, is performed, several issues can arise. One of the main challenges is maintaining the biological width. If the restorative margin is placed too close or invades the biological space, chronic irritation of the periodontal tissues occurs, leading to inflammation, gingival recession, and ultimately, bone loss [2,8,29].

When the restorative margin is located below the level of the alveolar bone, the restoration becomes a plaque and bacteria accumulation site. This hinders proper oral hygiene and can result in periodontal disease. Additionally, placing a deep margin can compromise the stability of the gingival tissues, leading to an aesthetically undesirable appearance due to gingival recession [4,5,13,14].

Aldakheel et al. [14] cited in their article that periodontal tissue inflammation had a higher prevalence in teeth that underwent pre-DME treatment compared to teeth without DME in a 1-year follow-up. They also associated DME with increased bleeding on probing, indicating compromised periodontal health, highlighting the importance of the distance between the alveolar crest and the restoration margins.

To avoid these issues, it is crucial to carefully assess the patient's periodontal status before planning and performing restorations with deep margins. In some cases, prior periodontal procedures such as soft tissue augmentation or guided bone regeneration may be necessary to correct the position of the gingival margin and create an adequate biological width. Additionally, using appropriate restorative materials and proper cementation or bonding techniques is advisable to minimize irritation to the periodontal tissues. The use of materials with low toxicity and high biocompatibility is essential to ensure the health of the gingival tissues and prevent adverse reactions [4,5,13,14].

In summary, biological width and proper management of the restorative margin are crucial aspects in the planning and execution of dental restorations. As dentists, it is our responsibility to evaluate and treat the periodontal health of patients and work closely to achieve lasting aesthetic and functional outcomes. By maintaining an adequate biological width and avoiding deep margin restorations, we can preserve periodontal health and improve the quality of life for our patients.

5. Conclusion

In conclusion, biological width is a critical factor in the placement of subgingival restorations, and its proper consideration is essential to ensure long-term treatment

success. Neglecting the biological space can lead to complications, including inflammation, bone resorption, and loss of the dental restoration.

With appropriate management of the biological width and patient cooperation, dental professionals can effective address cases with deep margins and ensure optimal oral health for their patients. Additionally, maintaining good oral hygiene and regularly visiting the dentist are important to ensure gum health and the longevity of the restoration.

Ultimately, it is advisable for dental professionals to stay updated on the latest techniques and materials available to provide the best possible care to their patients.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare no conflict of interest.

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