RESTORATIVE-PERIODONTAL INTERRELATIONSHIP

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ABSTRACT

A proper understanding of the relationship between periodontal tissues and restorative dentistry is the key to ensuring adequate form, aesthetics and durability of dentition. The literature analyzing the impact of the restorative procedure on periodontal tissues has been researched and it is possible to identify certain factors that are important for the preservation of the periodontium after the restorative procedure, such as restoration contours, roughness, overhangs, contact point and type of material. Special emphasis was placed on the position of the edge of the restoration and its impact on periodontal health. Also, it is necessary to know and understand the concept of biological width, the understanding of which is crucial for everyday practice and the correct approach to any restorative procedure. In the case of neglecting the concept of biological width, the restoration itself can cause more harm than good, which in the worst case leads to tooth loss. Overhanging dental restorations are a problem not only because of their incidence but also due to the fact that clinicians often neglect them even when they are clinically and radiologically obvious. There is much evidence to suggest that bleeding, gingivitis and bone loss are increased in tissues with overhanging restorations.

Keywords: biological width, edge of the restoration, overhangs, gingival and periodontal health

Introduction

The precondition for the success of any restorative treatment is a healthy periodontium. The relationship between restorative dentistry and periodontology is reflected in several ways, both by the edge of the restoration and the outline form of the crown, as well as by the response of the tissue to the preparation. The close relationship between iatrogenic factors and periodontal damage was first recognized by Black.[1]

Preserving periodontal health during and after restoration is a great challenge for dental practitioners because the tooth and its surrounding structures are under the continuous influence of microbiological flora, and the restorative procedure itself can worsen this condition. [2] Emphasis must be placed on the control of bacterial plaque, the contours of the restoration, the sensitivity to restorative materials and the location of the edge of the restoration. [3]

The restorative procedure affects the periodontium in several ways including the type of restorative material and the way it is placed, as well as the contours of the restoration. In the case of subgingivally placed restorations, the surface should be smooth, and the material should resist decay under the influence of plaque, and ideally prevent plaque formation. [2] In the case of gingival inflammation, it is necessary to eliminate the inflammation before the restorative procedure itself. The advantages of this approach are, among other things, that by reducing the size of the gingiva, proper preparation is easier and the risk of trauma to the gingival tissue is reduced. [3]

Any restorative procedure may have a long-lasting effect on the condition of the periodontium. Although most procedures cause periodontal tissue damage, such damage is in most cases reversible.[4] Special attention should be paid to situations in which the integrity of the soft tissue can be easily endangered, such as placement of temporary fillings, dental matrices, interdental wedges and rubber dam. [2]

Dental restorations are often associated with the development of gingival inflammation, especially when they are located subgingivally. Restorations can compromise biological width if placed deep into the sulcus or within the junctional epithelium. This may lead to the development of inflammation and loss of clinical attachment with apical migration of epithelial attachment and its re-establishment at a higher apical level.[1]

Restorative dentistry should have healthy periodontal support structures for its base. Nevertheless, practical situations testify that restorative procedures are usually performed without accompanying supportive periodontal therapy. Many times we place extensive restorations on inflamed and diseased periodontal structures. On the other hand, the longevity and success of the restoration depend on the health of the associated periodontal structures.

This paper presents a review of the literature that in different ways studies the relationship between the edge of the restoration and the gingiva and other periodontal tissues.

Biological width and its significance

The biological width (**Figure 1.)** is defined as the dimension of the soft tissue being attached to the tooth coronally from the crest of the alveolar bone. [5] The term was first introduced by Gargiulo

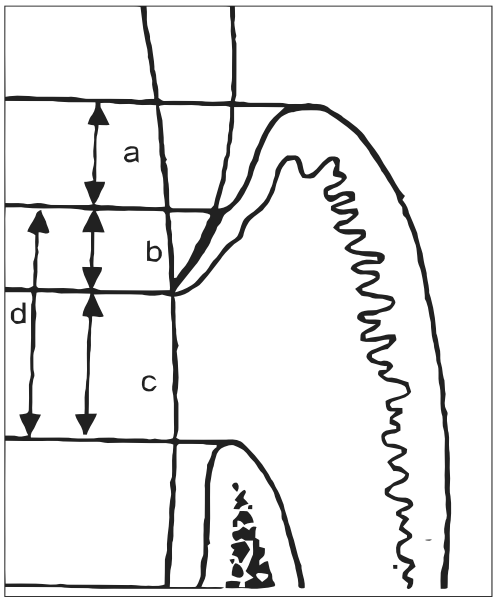

Figure 1. Schematic representation of biological width a) histological sulcus (0.69 mm), b) epithelial attachment (0.97 mm), c) connective tissue attachment (1.07 mm), d) biological width (b + c) (Retrieved from 5)

et al. He defines it as natural protection that develops around the teeth and protects the alveolar bone from infection and disease.[6] Gargiulo claims that the biological width is approximately 2.4 mm, of which 0.69 mm is gingival sulcus, the epithelial attachment is 0.97 mm and the connective tissue is 1.07 mm. The dimension of biological width is not constant and depends on the position of the tooth in the alveoli, as well as on the type of tooth.[2]

Intrusion into the biological width area by cavity preparation, caries, fracture or some restorative material may result in bacterial accumulation, inflammation, increased probing depth, or a combination of these problems. The total dimension of 2.04 mm is accepted as the minimum necessary distance between the edge of the restoration and the crest of the alveolar bone, which allows normal development and preservation of the attachment. This would, however, place the edge of the restoration exactly at the base of the gingival sulcus which would result in unfavorable conditions. A more realistic approach involves providing at least 3 mm from the alveolar crest to a healthy tooth structure, thus providing approximately 1 mm between the attachment and the restoration edge. [7]

If the patient feels discomfort in the gingival area when examining the edges of the restoration with a periodontal probe, it can be considered that the biological width has been compromised, which later leads to gingival hyperplasia, bleeding on probing, recession, bone loss and pocket formation. Biological width can also be estimated by measuring the distance to the bone level using a periodontal probe and subtracting the sulcus depth from the obtained value. If the distance from the base of the sulcus to the bone is less than 2 mm, it is considered that the biological width has been endangered. Disturbance of the biological width in proximal zones can be observed by interpretation of the radiological image.[2]

Reasons for endangering the biological width include attempts to achieve a healthy tooth structure, achieving an adequate length of preparation, previous restorations, existing caries, resorptive defects, traumatic and iatrogenic injuries and incorrect measurement of sulcus depth.[8] Placing the restoration margin in the area of biological width often leads to gingival inflammation, loss of clinical attachment and loss of alveolar bone. Subgingival restoration margin placement should be viewed as a compromise, while supragingival placed restoration edges are preferred. In situations where aesthetics do not play the most important role and where there is an adequate tooth structure, it is recommended to place the edges of the restoration supragingival. The problem arises in situations where setting the edge of the restoration subgingival is necessary. If the gingival sulcus is less than 1.5 mm deep, the dentist "creates" the sulcus himself during the preparation of the cavity to set the edge of the restoration subgingivally. This approach to preparation is usually at the expense of the intact dentogingival unit, resulting in permanent damage to the junctional epithelium and supraalveolar connective tissue. Under normal circumstances, where the depth of the gingival sulcus is 2-3 mm, the edge of the restoration can be placed 0.5 mm into the sulcus.[9]

Importance of the restoration edge position and surface roughness

The position of the restoration edge has a long-term effect on the health of the periodontium, because the accumulation of plaque on the restoration edge is a consistent finding and occurrence, both in research and clinical practice. With restorations whose edges are placed subgingivally, there is a greater accumulation of plaque and a higher frequency of secondary caries and periodontitis. [10] Supragingivally positioned edges of the restoration have a similar impact on periodontal health as unrestored tooth surfaces.[1]

When setting the restoration edge subgingivally, the depth of the gingival sulcus should serve as a guide. If the depth of the sulcus is 1.5 mm or less, the edge of the restoration should be placed 0.5 mm below the gingiva margin. This is particularly important in the frontal area and prevents the destruction of biological width in high-risk patients. If the depth of the sulcus is more than 1.5 mm, the edges should be placed one-half

the depth of the gingival sulcus, while for sulcus depths greater than 2 mm, the possibility of gingivectomy should be considered, which would give a sulcus depth of 1.5 mm and then proceed as in the first situation.[1] When the restoration significantly extends beyond the gingival sulcus, the clinical crown lengthening is suggested.[11]

Roughness in the subgingival zone of restoration largely contributes to the accumulation of plaque and the gradual onset of gingival inflammation. The edge placed subgingivally is difficult for proper finishing, which will later definitely lead to this area becoming a plaque retention place. Marginal adaptation should be optimal because rough restorations and open edges lead to the accumulation of bacterial pathogens and are associated with inflammation of periodontal structures.[9] What is important to note is that the tissue reacts more to the surface roughness of the material than to the composition of that material itself.[3] The surface roughness has also been shown to increase over time.[12] Compared to definitive restorations, temporary restorations have less acceptable contours, adaptation and roughness. Therefore, temporary restorations have a higher potential for plaque accumulation.[8]

Marginal roughness occurs as a result of the following causes:

1. grooves and irregularities present on the polished surface,
2. separating the edge of the restoration and cement from the cervical finish line, exposing the rough surface of the prepared tooth,
3. inadequate marginal adaptations of the restoration (subgingival margins usually have a gap of 20 to 40 μm between the edge of the restoration and the unprepared surface of the tooth),
4. dissolution and fragmentation of cement between cavity and restoration, thus creating space and cracks.

A well-polished and contoured surface of the composite filling does not adversely affect the health of the gingiva. The gingiva shows a weaker inflammatory response to well-polished and contoured restorations than to a cavitated carious lesion.[12]

Contours and contact points of restoration

Proper contours enable adequate maintenance of oral hygiene, create the desired shape of the gingiva and give the appropriate aesthetic effect in visible areas. There are conflicting reports on the adequate contour that is necessary for maintaining the health of the gingiva. Some authors believe that the contour of the crown should follow the true anatomy of the tooth to allow functional simulation and maintenance of gingival health. Others advise that undercontouring is necessary for better periodontal health.[13] The definition of undercontoured and overcontoured restoration is essentially unclear. The results of studies in humans and animals clearly show the connection between overcontouring and gingival inflammation, while undercontouring does not produce a harmful effect on the periodontium.[1]

The emergence profile is the part of the restoration that is in relation to the gingival tissue. The emergence profile of restoration in the aesthetic zone has two aspects: the subgingival form and the supragingival form. The subgingival form should follow the contours of the cement-enamel junction and provide support to the gingival tissue. Increased thickness of proximal subgingival contours leads to increased papillary height, while increased facial contours result in displacement of gingival tissue apically.[9] Flat contours of restoration are always acceptable in areas of the oral cavity where aesthetic requirements are not dominant. When the gingiva comes in contact with a flat uncontoured tooth surface, there is a tendency to develop a thick free gingival margin. This thickening of the gingiva is not pathological, but it requires a method of brushing teeth that will ensure the complete removal of plaque at the point of contact between the tooth and the gingiva. Overcontouring restorations or misplacing contours is a far greater risk of periodontal disease than the

lack of contour, because both, supra and subgingival plaque accumulation, can be increased at contoured edges. The higher the convexity, the harder it is to remove plaque.[3]

The teeth contact in the area is marked as the proximal contact, while the spaces below the contact are marked as embrasures. An embrasure is a V-shaped space that arises apically from the proximal contact, and the interdental space is the physical space between two adjacent teeth, and its shape and volume are determined by the morphology of the tooth. Preservation of the interdental papilla is one of the main concerns during tooth restoration. The absence or loss of the interdental papilla, which eventually leads to the absence or loss of the embrasure, can cause an aesthetic disturbance, phonetic problems and food impaction.[6] In essence, there is no periodontal damage in the case of increased space for the interdental papilla. It is therefore safe to use the minimum proximal contour and place the proximal contacts as occlusal as possible, thus ensuring a good approach to plaque control in the proximal area.[22] Good proximal contact acts as a barrier and prevents food impaction, thus contributing to periodontal health. While the role of deficient proximal integrity may be unclear, open contact leads to food impaction and is often uncomfortable for the patient. It is generally accepted that tight proximal contact is essential for gingival health.[13]

Effect of overhanging restorations on periodontal health

The overhanging restorations have long been considered a contributing factor to gingivitis and loss of periodontal attachment. A close link between iatrogenic factors, such as the existence of overhanging restorations and destructive periodontitis, was observed in the early years of the last century (Black 1912).[14]

The overhanging restorations alter the ecological balance of the gingival sulcus in a way that creates an area that favors the growth of gram-negative anaerobic bacteria and prevents adequate removal of accumulated plaque. It is believed that a change in the composition of the subgingival microbiota over time leads to the loss of periodontal support. The subgingival overhangs result in a change in the microbiota similar to that of adult chronic periodontitis.[15] Studies have shown that a foreign body in the area of biological width, making contact with the alveolar crest, leads to inflammation, bone and occasional root resorption.[16]

A high prevalence of overhanging margins associated with subgingival restorations was found.[17] The presence of overhangs in the wide range of 16% to 71%, as determined by studies, may be due to different definitions of overhangs and different ways of estimating.

Most overhangs on restorations can be successfully reconstructed without replacing the entire restoration.[18] Small supragingival overhangs can be easily removed using a variety of instruments such as periodontal scalers, curettes or files that seek to fragment and remove the overhang. Other devices and methods for removing overhangs on restorations are also recommended, such as diamond burs, curettes, ultrasonic and sonic instruments, chisels, abrasive discs and finishing burs and strips.[14] In the USA, 27 federal states allow dental hygienists the procedure of removing overhangs on restorations.[19]

A study conducted by Sameer et al, which aimed to compare short-term clinical changes in the periodontium after the removal of subgingival amalgam overhang, noted a significant decrease in plaque index.[20] Periodontal destruction caused by overhang is a slow and painless process, so most patients are unaware of it and it rarely occurs because of it. Unfortunately, even some dentists are not aware of the importance of removing overhangs on restorations.

Chemical influence of restorative materials

The health of the gingival tissue that covers the restoration has long been the subject of interest for

many researchers and various authors have determined the irritating effect of certain materials. More than 35 different elements are part of various dental alloys used in practice. Dental amalgam is made up of many components with varying levels of cytotoxicity. Some studies focused on the cytotoxicity of mercury, while others analyzed silver amalgam alloy powder which proved to be less toxic.[23] Although the cytotoxicity of amalgam may be as high as the cytotoxicity of mercury when measured immediately after trituration, it decreases over time. Selenium reduces the toxicity of heavy metals such as mercury, copper, silver, arsenic and cadmium and there is evidence that mercury toxicity can be altered by selenium supplementation.[24] Selenium concentrations of 0.1 to 0.2% in amalgam alloy powder were found to be most effective in reducing the cytotoxic effect of mercury. The release of large amounts of zinc is also one of the factors contributing to the cytotoxicity of amalgams. This may be the explanation for some cases of gingival inflammation in the absence of plaque.[25]

Various authors have investigated the antibacterial activity of amalgam depending on the composition and tested bacteria. The discrepancies in the research most likely exist due to the different sensitivity of the tested bacteria to the materials, and the exact data on the antibacterial effect is difficult to determine due to the complex structure and composition of the amalgam.[26,27] The elemental composition of amalgam acts as an antibacterial agent, unlike composite resins, which do not contain anything that would suppress or prevent the growth and development of microorganisms causing caries. In essence, both triethylene glycol methacrylate (TEGMA) and triethylene glycol dimethacrylate (TEGDMA), which are the main constituents of many composite resins, promote the growth of microorganisms. Copper ions have repeatedly shown that they have the greatest lethal effect on microorganisms.

Composite resin surfaces have been shown to increase sulcus fluid secretion relative to enamel control surfaces. Subgingival composite restorations can cause changes due to direct trauma to periodontal tissues, or they can increase the accumulation of subgingival plaque thus leading to the gradual development of inflammatory changes.[28] Release of various products from composite fillings can initiate an inflammatory response of the gingiva. Ferracane et al have proven that the release of toxic products from composite fillings is greatest during the first days after placement. After that, the cytotoxicity of the restoration gradually decreases.[29] The cytotoxicity mechanism should relate to the short-term release of free monomers during the period of conversion of monomers to polymers. The prolonged release of substances should be a consequence of erosion and degradation that occur over time.[30]

Conclusion

For the complete success of the restorative procedure, it is necessary to preserve the health of the gingiva and other periodontal tissues. Prior to the restorative procedure, it is necessary to analyze the condition of the periodontium and conduct initial periodontal therapy in a situation where the periodontium shows signs of severe inflammation and damage, which will guarantee the longevity of the restoration and the tooth itself. It is necessary to know the concept of biological width to properly approach the restoration procedure, without interfering with the area that can harm the health of the periodontium. There is already many evidence- based studies on how defective restoration and the edge of restoration can have a negative impact to gingiva, so prior knowledge needs to be applied to turn theory into practice.

Declaration of interest

The authors declare no conflicts of interest.

References

1. Sirajuddin S, Narasappa KM, Gundapaneni V, Chungkham S, Walikar AS. Iatrogenic Damage to Periodontium by Restorative Treatment Procedures: An Overview. The Open Dentistry Journal. 2015;9(1):217–22.
2. Puri K, Puri N, Dodwad V, Masamatti SS. Restorative aspects of periodontal disease: an update part 1. Dental Update. 2014;41(6): 545–52.
3. Sood S, Gupta S. Periodontal-restorative interactions: a review. Indian Journal of Clinical Practice. 2013;23(11):707-713.
4. Leon AR. The periodontium and restorative procedures. Journal of Oral Rehabilitation. 1977;4(2):105–17.
5. Nugala B, Kumar BS, Sahitya S, Krishna P. Biologic width and its importance in periodontal and restorative dentistry. Journal of Conservative Dentistry. 2012;15(1):12.
6. Shivakumar A, Kalgeri S, Dhir S. Clinical considerations in restorative dentistry - A narrative review. Journal of the International Clinical Dental Research Organization. 2015;7(2):122.
7. Fugazzotto PA. Periodontal restorative interrelationships: the isolated restoration. The Journal of the American Dental Association. 1985;110(6):915–7.
8. Kois JC. The restorative-periodontal interface: biological parameters. Periodontology 2000. 1996;11(1):29–38.
9. Goldberg PV, Higginbottom FL, Wilson TG. Periodontal considerations in restorative and implant therapy. Periodontology 2000. 2001;25(1):100–9.
10. Fugazzotto PA. Periodontal-restorative interrelationships: ensuring clinical success. Oxford: Wiley-Blackwell; 2011.
11. Reeves WG. Restorative margin placement and periodontal health. The Journal of Prosthetic Dentistry. 1991;66(6):733–6.
12. Gusmão ES, Mg RM, Fl TF, Sc RS, Cimões R, C FB. Effect of Quality of Dental Restorations and Time Elapsed Since Placement on Biofilm Retention. Acta Stomatologica Croatica. 2013;47(4):322–8.
13. Padbury A, Eber R, Wang H-L. Interactions between the gingiva and the margin of restorations. Journal of Clinical Periodontology. 2003;30(5):379–85.
14. Blank LW, Caffesse RG, Charbeneau GT. The gingival response to well-finished composite resin restorations. The Journal of Prosthetic Dentistry. 1979;42(6):626–32.
15. Lang NP, Kiel RA, Anderhalden K. Clinical and microbiological effects of subgingival restorations with overhanging or clinically perfect margins. Journal of Clinical Periodontology. 1983;10(6):563–78.
16. Schatzle M, Lang NP, Anerud A, Boysen H, Burgin W, Loe H. The influence of margins of restorations on the periodontal tissues over 26 years. Journal of Clinical Periodontology. 2001;28(1):57–64.
17. Tal H, Soldinger M, Dreiangel A, Pitaru S. Periodontal response to long-term abuse of the gingival attachment by supracrestal amalgam restorations. Journal of Clinical Periodontology. 1989;16(10):654–9.
18. Vale JDF, Caffesse RG. Removal of Amalgam Overhangs: A Profilometric and Scanning Electron Microscopic Evaluation. Journal of Periodontology. 1979;50(5):245–9.
19. Arneberg P, Silness J, Nordbo H. Marginal fit and cervical extent of class II amalgam restorations related to periodontal condition. Journal of Periodontal Research. 1980;15(6): 669–77.
20. Brunsvold MA, Lane JJ. The prevalence of overhanging dental restorations and their relationship to periodontal disease. Journal of Clinical Periodontology. 1990;17(2):67–72.

21. Sameer A. M. The Impacts of Amalgam Overhang Removal on Periodontal Parameters and Gingival Crevicular Fluid Volume. Pakistan Oral & Dental Journal. 2007;27(1):17–22.

22. Ramfjord SP. Periodontal aspects of restorative dentistry. Journal of Oral Rehabilitation. 1974;1(2):107–26.

23. Kaga M, Seale N, Hanawa T, Ferracane J, Okabe T. Cytotoxicity of Amalgams. Journal of Dental Research. 1988;67(9):1221–4.

24. Kumei Y, Sato A. Evaluation of a new selenium-containing amalgam on mice. Toxicology and Applied Pharmacology. 1982;65(1):177–9.

25. Schmalz G. Biological interactions of dental cast alloys with oral tissues. Dental Materials. 2002;18(5):396–406.

26. Morrier J-J, Suchett-Kaye G, Nguyen D, Rocca J-P, Blanc-Benon J, Barsotti O. Antimicrobial activity of amalgams, alloys and their elements and phases. Dental Materials. 1998;14(2):150–7.

27. Leinfelder KF. Do Restorations Made Of Amalgam Outlast Those Made Of Resin Based Composite? The Journal of the American Dental Association. 2000;131(8):1186–7.

28. Dijken JWV, Sjostrom S, Wing K. Development of gingivitis around different types of composite resin. Journal of Clinical Periodontology. 1987;14(5):257–60.

29. Ferracane J. Elution of leachable components from composites. Journal of Oral Rehabilitation. 1994;21(4):441–52.

30. Bertoldi C, Zaffe D, Generali L, Lucchi A, Cortellini P, Monari E. Gingival tissue reaction to direct adhesive restoration: A preliminary study. Oral Diseases. 2018;24(7):1326–35.

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