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A Review On Biologic Width: The Key To Restorative And Periodontal Interrelationships

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ABSTRACT
Restoration of the teeth and the periodontium share an inseparable relationship. Biologic Width is the dimension of space that the healthy gingival tissues occupy above the alveolar bone. Incorrectly placed margins of restorations are a common cause of biologic width violation. This can lead to gingival inflammation and bone loss, thereby damaging the periodontal health as well as reducing the life of the restoration. Respecting the biologic width and designing restorations accordingly is crucial. This review aims to cover the significance of biologic width in Periodontics and Implant therapy.

Keywords: Biologic width, Margin placement, Implants

I. Introduction

Periodontal health and tooth restoration share a close relationship. For the long life of the filling, the health of the periodontium is important. In order to improve the esthetics, the tooth/tissue interface must have a sound natural appearance with the gingivasurrounding the restoration in a balanced manner.(1) This article will focus on the concept, evaluation and correction of the nonobservance of biologic width.

Biologic width is identified as the dimension of space that the healthy gingival tissues occupy above the alveolar bone.(1)It can be defined as the junctional epithelium and supracrestal connective tissue attachment surrounding every tooth. (Ingber et al.,1977, Amiri-Jezeh et al., 2006)(10)

Gargiulo, Wentz and Orban in 1961 studied 287 individual teeth from30 cadavers and established that there is aobviouscomparable relationship between the crest of the alveolar bone, the connective tissue attachment, epithelial attachment and the sulcus depth. They found that in an average human, the connective tissue apparatus occupies 1.07mm of space above the alveolar crest, the epithelial attachment below the base of the sulcus occupies 0.97mm and the sulcus depth occupies another 0.69mm. A combination of the connective tissue attachment and epithelial attachment together form the biologic width. Based on this study, the biologic width is generally considered to be 2.04mm.(2)

Another study by Vacek et al. in 1994 evaluated 171 cadaver teeth and observed mean measurements of 0.77mm for connective tissue attachment, 1.14mm for epithelial attachment

and 1.34mm for sulcus depth.[2] Many studies showed that there were significant variations in the epithelial attachment, whereas the connective tissue attachment was relatively constant.[2] In 1977, Ingber et al.reported Biologic Width and also attributed D. Walter Cohen for first framing this term.[3] Biologic width isn't always constant and varies with many factors namely the location of the tooth in the alveolus, it also changes from tooth to tooth and the appearance of the tooth. It is said that 3mm space between the crest of the alveolus and the margin of the preparation can maintain the health of the periodontium for 4-6 months.The 3 mm measurement on an average for supra-crestal connective tissue attachment of 1 mm, junctional epithelium of 1 mm and gingival sulcus of 1 mm, provides adequate biologic width even when the restoration margins are placed 0.5 mm within the gingival sulcus.[4]Positioningrestorative margins within the biologic width can lead to gingival inflammation, clinical attachment loss and bone loss. This is mainly due to inflammatory response to plaque in deep pockets and gingival recession. [2]

In 1984, Nevins &Skurow said that when subgingival margins are necessary, the clinicianshould not disrupt the junctional epithelium or connective tissue apparatus during preparation and taking the impressing. Theyadvocated limiting the extent of subgingival margin to 0.5-1.0 mm as it is impractical for the dentist to detect where the sulcular epithelium ends and the junctional epithelium begins. Theyhighlighted the importance of allowing a minimum of 3.0 mm distance from the crest of the alveolar bone to the crown margin.[2]

Given the vast variability of the epithelia measurements, Walton T suggested a name change of Biologic width to "Biologic barrier" [7]

II. Margin placement & biologic width:

In 1977, Ingber et al., stated thata minimal 3mm from the restorative margin to the alveolar crest is needed for sufficient healing and restoration of the tooth.[4]In 1979, Maynard and Wilson divided the periodontium into three-dimensions as follows [4] :

Superficial physiologic: Representing the free and attached gingival surrounding the tooth.

Crevicular physiologic: Representing the gingival dimension from the gingival margin to the junctional epithelium.

Sub-crevicular physiologic: Combination of the junctional epithelium and connective tissue attachment.

TheSub-crevicular physiologic dimension corresponds to the biologic width described by Gargiulo et al., in 1961.[4]

A clinician is granted with three options for margin placement: Supragingival, Equigingivaland Subgingival

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Supragingival Margin

It has the lowest impact on the periodontium. Its position has been applied in unesthetic areas due to the considerable contrast in color and opacity of conventional restorative materials against the tooth. With the arrival of more translucent restorative materials and resin cements, the ability to place supragingival margins in esthetic areas is now possible. (1)

Equigingival Margin

Conventionally, the use of equigingival marginswas not desirable because they were thought to favour more plaque accumulation than supragingival or subgingival margins, and thus result in greater gingival inflammation. Another concern was that any minor gingival recession could create an unsightly margin display. These concerns are not valid today, not only because the restoration margins can be esthetically merged with the tooth but also because restorations can be finished easily, giving a smooth, polished interface at the gingival margin. From a periodontal viewpoint, both supragingival and equigingival margins are well endured. [2]

Subgingival Margin

The greatest risk occurs here. These margins are not as reachable as supragingival or equigingival margins for finishing procedures. Moreover, if the margin is placed too far below the gingival tissue crest, it will breach the gingival attachment. (1)Restorative considerations mayoftenwarrant thatthe margins be positioned below the gingival tissue crest owing to caries or tooth deficiencies, and/or to conceal the tooth/restoration interface. Infringement into biologic periodontal space for additional retention will lead to iatrogenic periodontal disease along with premature loss of the restoration. Positioning of restorative margin within the biologic width is deleterious to the health of the periodontiumas it acts as a plaque retentive factor. When the restoration margin is positioned too far below the gingival tissue crest, it will encroach on the gingival attachment apparatus and results in a constant inflammation. This is worsened by the inability of the patientto maintain this area due to inaccessibility. Thebody tries to recreate space between the alveolar bone and the margin to permit space for tissue reattachment, leading to bone loss of an unpredictable nature along with gingival recession. This usually occurs in areas where the alveolar bone surrounding the tooth is very thin in width. Anotherregular finding with placing the margin too deep is that even though bone level might appear to remain unchanged, gingival inflammation develops and persists on the restored tooth. Studies haveshown that sub gingival restorations demonstrated more quantitative and qualitative changes in the plaque micro flora, increased plaque index, gingival index, recession, pocket depth and gingival fluid.(3) In 1987, Orkin *et al*. established that subgingival restorations had a higher chance of bleeding and gingival recession than supragingival restorations.(2)In 1980, Waerhaug demonstrated gingivitis and attachment loss associated with sub marginal restorations in monkeys and dogs.(2)In 1987, Stetler&Bissada evaluated the effects of width of keratinized gingiva and subgingival restorations on periodontal health. They found that teeth with subgingival restorations and

narrow zones of keratinized gingiva showed significantly higher gingival index scores than teeth with sub marginal restorations with wide zones of keratinized gingiva. Hence, dentists should consider gingival augmentation for teeth with minimal keratinized gingiva before placing subgingival restorations. (2)

III. Margin placement guidelines

The biologic width requirement can be assessed by using the patient's existing sulcus depth as guidance. The first step in using sulcus depth as a guide in margin placement, is to manage gingival health. Once the tissue is healthy, the following three rules can be used to place intracrevicular margins. (1)

Rule 1 : If the sulcus probes 1.5mm or less, position the restoration margin 0.5mm below the gingival tissue crest. This is in particular important on the facial aspect and will prevent a biologic width infringement in a patient who is at high risk in that regard.

Rule 2 : If the sulcus probes more than 1.5mm, position the margin half the depth of the sulcus below the tissue crest. This places the margin far enough below the tissue so that it will still be enclosed, if the patient is at higher risk of recession.

Rule 3 : If a sulcus greater than 2mm is found, particularly on the facial aspect of the tooth, assess if a gingivectomy can be performed to lengthen the teeth and create a 1.5mm sulcus. The patient can be subsequently treated using Rule 1. (1)

IV. Evaluation of biologic width violation

Clinical Method : If a patient feels tissue discomfort when the restoration margin levels are being evaluated with a periodontal probe, it is a reliable indicator that the margin extends into the attachment and that a biologic width violation has occurred. The signs of biologic width violation are: Chronic progressive gingival inflammation around the restoration, bleeding on probing, localized gingival hyperplasia with minimal bone loss, gingival recession, pocket formation, clinical attachment loss and alveolar bone loss. Gingival hyperplasia is most frequently found in altered passive eruption and subgingivally placed restoration margins. (3)

Bone Sounding : The periodontal probe is used for determining biological width. Under local anesthesia, the biological width can be established by probing to the bone level (referred to as 'sounding to the bone') and subtracting the sulcus depth from the derived measurement. If this distance is less than 2 mm at one or more locations, a diagnosis of biological width violation can be confirmed. This calibration must be performed on teeth with healthy gingivaand must be repeated on more than one tooth to ensure accurate assessment, and reduce individual and site variations. (5)

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In 2000, Koisrecommended three categories of biological width based on the total dimension of attachment and the sulcus depth following bone sounding measurements, namely - normal crest, high crest and low crest. (5)

Normal crest patient

In the normal crest patients, the mid-facial measurement is 3 mm and the proximal measurement variesbetween 3 mm to 4.5 mm. Normal crest occurs approximately 85% of time and results in highly stable gingiva in the long term.

High crest patient

This is an uncommondiscovery and occurs approximately 2% of the time. Seen often in a proximal surface adjacent to an edentulous site. In the high crest patient, the mid-facial measurement is less than 3 mm.

Low crest patient

In the low crest patient group, the mid-facial measurement is greater than 3 mm and the proximal measurement is greater than 4.5 mm. Itappears approximately 13% of the time. Conventionally, a patient with low crest has been described as more susceptible to recession secondary to the placement of an intracrevicular crown margin. (5)

Radiographic Evaluation: Radiographically, interproximal violations of biologic width can be determined. Nonetheless, on the mesiofacial and distofacial line angles of teeth, radiographs aren't diagnostic owing to tooth superimposition. H. Sushama and Gouri depicted a new innovative parallel profile radiographic (PPR) technique to measure the dimensions of the dento-gingival unit (DGU). The authors concluded that the PPR technique could be used to assess both length and thickness of the DGU with accuracy, as it was simple, concise, non-invasive, and a reproducible method. (4)

V. Methods to correct biologic width violation

Biologic width violations can be reformed by either surgically removing bone away from proximity to the restoration margin, or by applying orthodontic forces, extruding the tooth, thereby moving the margin away from the bone. Correction of Biologic Width Violation can be achieved by two methods(4): Surgical Crown Lengthening and Orthodontic extrusion.

Crown Lengthening Procedures

Clinical crown lengthening is done to achieve margins on sound tooth structure, maintenance of the biologic width, access for impression techniques, and esthetics. [8]In order to select the proper treatment technique for crown lengthening, an analysis of the individual case with regard to crown-root- alveolar bone relationships should be done. If thepatient's concern is their small anterior teeth, and the periodontium is of a thin biotype, full exposure of the anatomical crown can be accomplished by a gingivoplasty/gingivectomy (external bevel or internal bevel) procedure.

External bevel gingivectomy

If there is more than sufficient attached gingiva and no bony involvement, excessive pocket depth can be eliminated and additional coronal tooth structure can be exposed by external-bevel gingivectomy. [2]

Internal bevel gingivectomy

Whensufficient width of attached gingiva is not present, reduction of excessive pocket depth and exposure of additional coronal tooth structure with or without the need to correct osseous abnormalities, the flap should always be internally beveledin order to expose the supporting alveolar bone. [2]

Apically repositioned flap

It is indicated in the crown lengthening of multiple teeth in a quadrant. Apically repositioned flap surgery can be done in the following ways[4]:

Apically repositioned flap without osseous resection: Indicated when there is a biologic width of more than 3 mm on numerous teeth, and presence of insufficient width of attached gingiva.

Apical repositioned flap with osseous reduction: Indicated when biologic width is less than 3 mm, there is insufficient width of attached gingiva. Reduction of the alveolar bone is done by the process called ostectomy followed by osteoplasty, so as to expose the required tooth length in a scalloped manner, and for following the desired contour of the overlying gingiva. As a general rule, at least 4 mm of sound tooth structure must be uncovered, as soft tissue will grow rapidly coronally to cover 2-3 mm of the root, leaving only 1-2 mm of supra-gingivally located sound tooth structure. Some complications that can occur after crown lengthening are black triangles, root hypersensitivity, root resorption and transient mobility.

VI. Biologic width and dental implants

Biologic width is a healthy self-restraining zone around an implant. It functions as a mirror for the underlying health of the supporting tissues.It has been suggested that a similar relationship of bone to overlying soft tissues exists around implants, and changes in this relationship may be one of the reasons for early crestal bone loss.[9]

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Structure of biologic width around implants

Kan et al., examined the vertical extension of soft peri-implant tissues in a study of single anterior implants in 45 humans. Implant soft tissues were assessed in allthe patientson the bone on mesial, mid-facial and distal aspects. The mean dimension of biologic widthwas recorded to be 6.17 mm at mesial, 3.63 mm at mid- facial and 5.93 mm at distal sites of implants. (6)

Function of biologic width around implants

It has been suggested that soft tissue around implants form a biological architecture similar to biologic width around teeth and that they serve as a protective mechanism for the underlying bone. (6)

Sanz et al. studied the function of junctional epithelium. Comparative histological study of healthy and infected implant sites in 12 patients suggested that biopsies from implant infection group had significantly higher exodus of inflammatory cells in the sulcular epithelium.(6)

The peri-implant mucosal reaction to plaque accumulation was studied by Zitzmann et al. for three weeks in 12 partially edentulous patients. Two implants sites were selected in each patient and soft tissue biopsies were collected. There was significant increase in density of PMN elastase+ cells which are inflammation markers, within the junctional epithelium after 21 days of plaque accumulation. This accounted for 5.0% in comparison to 3.5% in healthy implant soft tissues.(6)

Chavier and Coublestudied the connective tissues around implants. The biopsies were collected from healthy keratinized peri-implant soft tissues of 32 implants in 8 patients. They were then evaluated for structure and function of the connective tissue. Type I collagen was found to be the principalfiber. (6)

Influence of mucosal thickness on biologic width formation around implants

A certain width of the peri-implant mucosa is needed to enable a proper epithelial-connective tissue attachment and if this soft tissue dimension isn’t available, bone resorption can occur in order tore-establish thejunction with an appropriate biologic width. (6)

Berglundh and Lindheconducted a controlled experiment with 5 dogs (30 implants) and tested the consequence of mucosal thickness on biologic width around implants. At the second stage surgery in test implants, peri-implant mucosa was found to be thinned to about 2 mm, while control implants had the healing abutment connected without tissue thickness adjustment. The test implants on histology revealed that bone resorption was a consistent finding after healing of soft tissue, while the total biologic width wasn’t

statistically significant between the test and control implants. The process of biologic width formation around implants was described by Berglundh et al. in a dog study. The authors observed that the genesis of peri-implant mucosa involved loss of marginal bone. (6)

VII. Conclusion

The proper design and placement of restorations and implants play a vital role in the overall health of the periodontium. As seen in this review, incorrect placement of restorations can result in violations of the biologic width and can further deteriorate the periodontal health.

Regular follow-ups and patient co-operation are also important factors for good maintenance of the restoration as well as the periodontium.

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