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RESEARCH ARTICLE

BIOLOGIC WIDTH VIOLATION – A WAKE UP CALL LITERATURE REVIEW

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ABSTRACT

There exists a close relationship between the periodontium and the margins of a restoration. The dimension of the space that the healthy gingival tissue occupies above the alveolar crest is known as the biologic width. Maintaining this area is paramount for prevention of gingival inflammation and secondary periodontal involvement of the tooth. Many a times, the general dentist is not aware of the appropriate dimensions of the biologic width area and the significance of the same when preparing the tooth to recieve a prosthesis. This may lead to inadvertent violation of this healthy zone of gingiva and transform it into an unhealthy, sometimes painful zone. Hence the purpose of this article is to describe the biologic width anatomy, evaluation of its dimension and correction of its violation by different methods.

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INTRODUCTION

The relationship between periodontal health and the restoration of teeth is intimate and inseparable. Maintenance of gingival health constitutes one of the keys for tooth and dental restoration longevity. (Felippe *et al*., 2003)The tooth, the pulp tissue within it, and its supporting structures should be viewed as one biologic unit. The periodontium and pulp have embryonic, anatomic, and functional interrelationship. In this context, the biologic width functions as a barrier against the entrance of microorganisms into the internal medium of the periodontal ligament and into the gingival and osseous connective tissue. An adequate understanding of the relationship between periodontal tissues and restorative dentistry is paramount to ensure adequate form, function, esthetics, and comfort of the dentition. While most clinicians are aware of this important relationship, uncertainty remains regarding specific concepts such as the biologic width. Despite an increased emphasis on the perio-restorative interface in restorative dentistry, many clinicians have been unable to utilize the concept of biologic width in a practical manner. (Robbins, 2007) Therefore the aim of this literature review is to summarize the importance of the biologic width and factors to be taken into consideration on its violation.

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Normal biologic width anatomy

The dimension of the space that the healthy gingival tissue occupies above the alveolar bone is called the biologic width (Figure 1). (Gargiulo *et al*., 1961) Biologic width is essential for — the preservation of periodontium and removal of irritation that might damage the periodontium. The dimension of biologic width is not constant, it depends on the location of the tooth in the alveolar, varies from tooth to tooth, and also from one surface of the tooth to another. This term was based on the work of Gargiulo *et al*., who described the dimensions and relationship of the dentogingival junction in humans. (Gargiulo *et al*., 1961) reported in 1961 a certain uniformity of the dimension of some components of biologic width. Measurements made from the dentogingival components of 287 individual teeth from 30 autopsy specimens established that there is a definite proportional relationship between the alveolar crest, the connective tissue attachment, the epithelial attachment, and the sulcus depth.

They reported the following mean dimensions

- Mean depth of the histologic sulcus is 0.69 mm,
- Mean junctional epithelium measures 0.97 mm (0.71-1.35 mm),

- Mean supraalveolar connective tissue attachment is 1.07 mm (1.06-1.08 mm).

The total of the attachment is therefore 2.04 mm (1.77 to 2.43 mm) and is called the biologic width (Vacek *et al*., 1994; Mishkin and Gellin, 1993) essential for preservation of periodontal health and removal of irritation that might damage the periodontium. In 1977, Ingber *et al*. described "Biologic Width" and credited D.Walter Cohen for first coining the term. (Ingber *et al*., 1977)

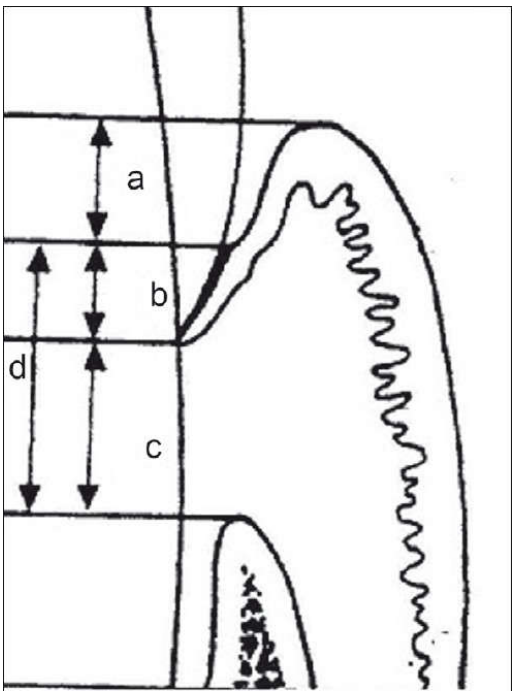

Figure 1. (a) Histological sulcus (0.69 mm), (b) Epithelial attachment (0.97 mm), (c) Connective tissue attachment (1.07 mm), (d) Biologic width (b+c)

Nevin and Skurow defined biologic width as the sum of the combined supracrestalfibers, the junctional epithelium and the sulcus. This was over 3mm when measured from the crest of bone. Vacek and colleagues found that the biological width increased anteroposteriorly (1.07 to 2.08mm) and that 15% of restoration that impinge in the biologic width had a biologic width of less than2.04 mm. Koisand Spear pointed out that the dentogingival complex is 3.0mm facially and 4.5mm to 5.5mm interproximally. They noted that the height of interdental papilla can only be explained by increased scalloping of the bone. Tarnow and colleagues found that for the gingival tissue to assume complete filling of the interdental space, the distance from the contact point to alveolar crest should not exceeded 5 mm to 5.5mm.Greater distance result in significant loss of alveolar height. (Tarnow *et al*., 1992)

Margin placement and biologic width

Maynard and Wilson (1979) Divided the periodontium into three-dimensions, all of which affect decision-making during restorative therapy: (Maynard and Jr, Wilson, 1979)

- Superficial physiologic: Represents the free and attached gingival surrounding the tooth.
- Crevicular physiologic: Represents the gingival dimension from the gingival margin to the junctional epithelium.
- Subcrevicular physiologic: Is analogous to the biologic width described (Gargiulo *et al*. 1961), consisting of the junctional epithelium and connective tissue attachment.

There are three different types of margin placement

- Supra-gingival margin
- Equi- gingival margin
- Sub-gingival margin

Supragingival margins

Supragingival margin means the margin is located away from gingival margin. It has the least impact on the periodontium. This margin location has been applied in non-esthetic areas due to the marked contrast in color and opacity of traditional restorative materials against the tooth. With the advent of more translucent restorative materials, adhesive dentistry, and resin cements, the ability to place supragingival margins in esthetic areas is now a reality. The supragingival margins are least irritating to the periodontal tissue. (Khuller and Sharma, 2009)

Equigingival margins

The use of equigingival margins traditionally was not desirable because, they were thought to favor more plaque accumulation, and hence result in greater gingival inflammation and that any minor gingival recession would create an unsightly margin display. These concerns are not valid today, not only because the restoration margins can be esthetically blended with the tooth but also because restorations can be finished easily to provide a smooth, polished interface at the gingival margin. From periodontal tissue health wise, both the above described restorative margins are well tolerated by periodontal tissue.

Subgingival margins

Restorative considerations will frequently dictate the placement of restoration margins beneath the gingival tissue crest because of caries or tooth deficiencies, and/ or to mask the tooth/restoration interface. Invasion of biologic periodontal space for additional retention will cause iatrogenic periodontal disease with a premature loss of restoration. Restorative margin placement within the biologic width is detrimental to periodontal health and acts as a plaque retentive factor. When the restoration margin is placed too far below the gingival tissue crest, it will impinge on the gingival attachment apparatus and a constant inflammation is created and made worse by the patient's inability to clean this area. Body attempts to recreate room between the alveolar bone and the margin to allow space for tissue reattachment. This is more likely to occur in areas where the alveolar bone surrounding the tooth is very thin in width. Highly scalloped, thin gingiva is more prone to recession than a flat periodontium with thick fibrous tissue. The more common finding with deep margin placement is that bone level appears to remain unchanged; however, gingival inflammation develops and persists on the tooth restored. (Waerhaug, 1978) Add on to above disadvantage is, that this type of margin is not accessible for finishing and polishing which act as a niche for bacterial growth and cause gingival inflammation. (Frank *et al*., 2002) If the margin must be placed subgingivally,

The factors to be taken into account are

- Correct crown contour in the gingival third.
- Correct polishing.

- Rounding of the margins.
- Sufficient zone of the attached gingival.
- No biologic width violation.

Categories of biologic width

Kois proposed three categories of biologic width based on the total dimension of attachment and the sulcus depth following bone sounding measurements: (Kois, 1994)

• Normal crest. • Low crest. • High crest.

Normal crest patient 85%

In the Normal Crest patient, the mid-facial measurement is 3.0 mm and the proximal measurement is a range from 3.0 mm to 4.5 mm. (Figure 2a). In these cases, the gingival tissue tends to be stable for a long term. The margin of a crown should generally be placed no closer than 2.5 mm from alveolar bone. Therefore, a crown margin which is placed 0.5 mm subgingivally tends to be well-tolerated by the gingiva, and is stable long term in the Normal Crest patient.

High crest patient 2%

This is seen more often in a proximal surface adjacent to an edentulous site. In the High Crest patient, the mid-facial measurement is less than 3.0 mm and the proximal measurement is also less than 3.0 mm (Figure 2b). In this situation, it is commonly not possible to place an intracrevicular margin because the margin will be too close to the alveolar bone, resulting in a biologic width impingement and chronic inflammation.

Low crest patient 13%

In the Low Crest patient group, the mid-facial measurement is greater than 3.0 mm and the proximal measurement is greater than 4.5 mm. (Figure 2c) Traditionally, the Low Crest patient has been described as more susceptible to recession secondary to the placement of an intracrevicular crown margin. When retraction cord is placed subsequent to the crown preparation; the attachment apparatus is routinely injured. As the injured attachment heals, it tends to heal back to a Normal Crest position, resulting in gingival recession. However, the Low Crest attachment is actually more complex because all Low Crest patients do not react the same to an injury to the attachment. Some Low Crest patients are susceptible to gingival recession while others have a quite stable attachment apparatus. The difference is based on the depth of the sulcus, which can have a wide range. For example, If patient A is bone sounded and the mid-facial distance from the gingival crest to the alveolar crest is 5.0 mm, while patient B is bone sounded and the measurement is again 5.0 mm. By definition, both of these patients are Low Crest.

However, they are not the same. Patient A has a 3.0- mm sulcus and a 2.0- mm attachment (i.e, epithelium and connective tissue). In contrast, Patient B has a 1.0- mm sulcus and a 4.0- mm attachment (ie, epithelium and connective tissue). (Figure 2d) Patient A has 3.0 mm of unsupported tissue from the base of the sulcus to the gingival crest. This amount of unsupported gingival tissue does not tend to be stable, and this patient is susceptible to gingival recession.

However, Patient B has a more substantial attachment apparatus (4.0 mm) and a significantly shallower sulcus (1.0 mm). This patient is much less susceptible to gingival recession. Patient A is classified as an Unstable Low Crest because the patient is more susceptible to gingival recession. Patient B is classified as a Stable Low Crest because this patient reacts more like a Normal Crest patient and is not as susceptible to gingival recession.

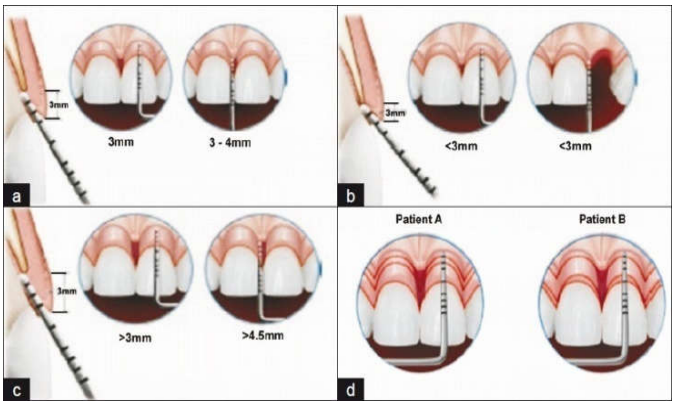

Figure 2. (a) Normal crest showing biologic width on labial and interproximal site, (b) High crest showing biologic width on labial and interproximal site. (c) Low crest showing biologic width on labial and interproximal site, (d) Pateint A- Low crest unstable; and, Patient B-. Low crest stable

Based on the determination of crest type the following rules for margin placement should be followed:

Margin placement — Rules (Orkin *et al*., 1987**)**

- If the sulcus probes 1.5 mm or less, the restorative margin could be placed 0.5 mm below the gingival tissue crest.
- If the sulcus probes >1.5 mm, the restorative margin can be placed in half the depth of the sulcus.
- If the sulcus is >2 mm, gingivectomy could be performed to lengthen the tooth, and create a 1.5 mm sulcus. Then the patient can be treated as per rule 1.

Evaluation of biologic width violation

Encroachment of biologic width becomes of particular concern when considering the restoration of a tooth that has fractured or been carious near the alveolar crest. Also, esthetic concerns often require hiding of restorative margins below the gingival margin that is pushing them down into the gingival sulcus leading to the violation of biologic width. Bone loss and gingival recession occur as the body attempts to recreate room between the alveolar bone and the margin to allow space for tissue reattachment. This is more likely to occur in areas where the alveolar bone surrounding the tooth is very thin. This fragile tissue recedes leading to the gingival recession. (Khuller and Sharma, 2009)

Clinical method

If a patient experiences tissue discomfort when the restoration margin levels are being assessed with a periodontal probe, it is a good indication that the margin extends into the attachment and that a biologic width violation has occurred.

A sterilized periodontal probe is pushed through the anesthetized attachment tissue from the sulcus to the underlying bone, if the distance is less than 2 mm at one or more location a diagnosis of biologic width violation can be confirmed. This assessment should be completed circumferentially around the tooth to evaluate the extent of problem (Figure 3). The biologic violation can occur in patients in whom margins are placed more than 2mm. This statement is in reference to the fact given by Vaceketal in 1994 who proposed that the biologic width dimensions extend in the range of 0.75mm to 4.3 mm. (Vacek *et al*., 1994) Thus according to this information, biologic width assessment should be performed for each patient to determine whether they need additional biological width in excess of 2 mm for restoration to be in harmony with their periodontal health.

Figure 3. Bone sounding to check for biologic width violation

The signs of biologic width violation are: (Jorgic-Srdjak *et al*., 2000) (Figure 4)

- Chronic progressive gingival inflammation around the restoration.
- Bleeding on probing.
- Localized gingival hyperplasia with minimal bone loss.
- Gingival recession.
- Pocket formation.
- Clinical attachment loss.
- Alveolar bone loss.
- Gingival hyperplasia (most frequently found in altered passive eruption and subgingivally placed restoration margins).

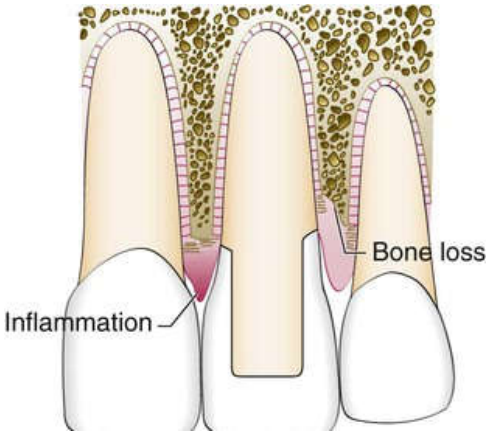

Figure 4. Diagrammatic signs of biologic width violation

Radiographic method

Radiographic interpretation can identify interproximal violations of biologic width. However, on the mesiofacial and distofacial line angles of teeth, radiographs are not diagnostic because of tooth superimposition. Parallel profile radiographic technique has been devised which could be used to measure both length and thickness of the dentogingival unit with accuracy. (Galgali and Gontiya, 2011)

Correction of biologic width violation

Biologic width violations can be corrected by either surgical crown lengthening or orthodontic extrusion of the tooth, thus moving the margin away from the bone.

Surgical crown lengthening

Surgery is the more rapid of the two treatment options. It is also preferred if the resulting crown lengthening will create a more pleasing tooth length. In these situations, the bone should be moved away from the margin by the measured distance of the ideal biologic width for that patient, with an additional 0.5 mm of bone removed as a safety zone. (Kois, 1996)

Indications: (16)

- Inadequate clinical crown for retention due to extensive caries, subgingival caries or tooth fracture, root perforation, or root resorption within the cervical 1/3rd of the root in teeth with adequate periodontal attachment.
- Short clinical crowns.
- Placement of sub gingival restorative margins.
- Unequal, excessive or unaesthetic gingival levels for esthetics.
- Planning veneers or crowns on teeth with the gingival margin coronal to the cemeto enamel junction (delayed passive eruption).
- Teeth with excessive occlusal wear or incisal wear.
- Teeth with inadequate interocclusal space for proper restorative procedures due to supraeruption.
- Restorations which violate the biologic width.
- In conjunction with tooth requiring hemisection or root resection.
- Assist with impression accuracy by placing crown margins more supragingivally.

Contraindications: (Jorgic-Srdjak *et al*., 2000)

- Deep caries or fracture requiring excessive bone removal.
- Post surgery creating unaesthetic outcomes.
- Tooth with inadequate crown root ratio (ideally 2:1 ratio is preferred)
- Non restorable teeth.
- Tooth with increased risk of furcation involvement.
- Unreasonable compromise of esthetics.
- Unreasonable compromise on adjacent alveolar bone support.

Gingivectomy can be done in the case of: (Smukler and Chaibi, 1997)

- Hyperplasia or pseudopocketing (>3 mm of biologic width).
- Presence of adequate amount of keratinized tissue.

Apically repositioned flap: (Heithersay, 1973**)**

This procedure is done without osseous reduction when there is no adequate width of attached gingiva, and there is a biologic width of >3 mm on multiple teeth. The alveolar bone can be reduced (no adequate attached gingiva and biologic width < 3mm) by ostectomy and osteoplasty, to expose the required tooth length in a scalloped fashion, and to follow the desired contour of the overlying gingiva. As a general rule, at least 4 mm of sound tooth structure must be exposed, so that the soft tissue will proliferate coronally to cover 2-3 mm of the root, thereby leaving only 1-2 mm of supragingivally located the sound tooth structure.

Orthodontic technique

Forced eruption should be considered in the cases where traditional crown lengthening via ostectomy cannot be accomplished as in anterior area, as ostectomy would lead to a negative architecture, and also remove bone from the adjacent teeth, which can compromise the function of these teeth. Orthodontic crown lengthening can be slow or rapid. In the slow technique, by applying low orthodontic force, the tooth is erupted slowly, bringing the alveolar bone, and gingival tissue along with it. The tooth is extruded until the bone level has been carried coronal to the ideal level by the amount that needs to be removed surgically to correct the biologic width violation. The tooth isstabilized in this position and then treated with surgery to correct the bone and gingival tissue levels. In the rapid technique, the tooth is erupted the desired amount over several weeks (with supracrestal fibrotomy performed weekly in an effort to prevent the tissue and bone from following the tooth). Then the tooth is stabilized for at least 12 weeks prior to surgical correction. Fibrotomy is performed with a scalpel at 7-10 day intervals to sever the supracrestal fibers, thereby preventing the crestal bone form following the root in a coronal direction (Felippe *et al*., 2003)

Conclusion

In dentistry the area of biological width along with sulcus, around natural teeth or an implant is sometimes called *Bermuda Triangle or Devil's Triangle*. It extends from gingival crest, with tooth/implant on one side and biological width on the other side. Like the Bermuda triangle, this biological width area is most exploited and misused area in dentistry, by almost all the dentists irrespective of their specialty. (Sharma *et al*., 2012) Hence, this region should be evaluated prior to treatment planing of the restorative phase. Periodic maintainence of the restored area and patient education is a key for the long term success of any restorative therapy.

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