

Biologic Width – Considering Periodontium in Restorative Dentistry

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ABSTRACT

A satisfactory understanding of the relationship between periodontal tissues and restorative dentistry is supreme to safeguard satisfactory form, function, esthetics, and comfort of the teeth and its supporting structures. The tooth and its supporting structures shall be considered as one biologic unit. Most of the dental surgeons are not aware of the important relationship, specific concepts such as biologic width, its maintenance and applications of crown lengthening in cases of biologic width violation. In the case of extensive caries, sub-gingival perforation and post and core placement in endodontic therapy, the concept of biologic width gains its importance. Biologic width is essential for the preservation of periodontium, which ultimately decides the success of restorative procedures. This article reviews the anatomy, categories, evaluation, violation, methods to correct the violation of biologic width and its relationship to periodontal health and restorative dentistry.

Keywords: Biologic width, Crown lengthening, Periodontal health, Restoration

INTRODUCTION

The concept of the biologic width (dentogingival unit) was first commenced by a research conducted by Gargiulo, Wentz, and Orban in which the distance between the apical end of the gingival sulcus and the crest of the alveolar bone was measured on several cadaver specimens.^{1,2} Later on, the term 'biologic width' was introduced by Cohen to describe the space over the tooth surface, occupied by the connective tissue and epithelial attachments and this parameter being equivalent to the distance between the bottom of the gingival sulcus and the alveolar bone crest.³ The dentogingival unit is important for the health of the gingiva, and invasion on it may cause disruption and apical migration of the attachment apparatus. The biological width is considered to be essential for maintaining healthy gingiva, especially in the case of teeth which needs restoration.⁴ Periodontal tissues form the main infra-structure for good esthetics, proper functioning, and comfort of the dentition.⁵ Biological width acts as a barrier to prevent entry of microorganisms into the periodontium.⁶ Satisfactory understanding of the relationship between periodontal tissues and restorative dentistry is necessary to ensure adequate form, esthetic and functions, and comfort of the dentition.⁷ If there is restoration of a tooth without considering biological width, it results in poor periodontal response and failure of restoration.⁸ Many clinicians are not unable to utilize the concept of biologic width in a practical manner even though there is an increased emphasis on the perio-restorative interface in restorative dentistry.⁸ Hence, the purpose of this paper is to

describe the biologic width anatomy, categories, evaluation, violation, methods to correct the violation of biologic width and its relationship to periodontal health and restorative dentistry.

ANATOMY OF THE BIOLOGIC WIDTH

The dimension of the space that the healthy gingival tissue occupies the alveolar bone is called the biologic width.⁹ [Figure 1] The term biological width was based on the work of Gargiulo *et al.*, who described the dimensions and relationship of the dento-gingival junction in humans. Measurements were done from the dento-gingival components of 287 individual teeth from 30 autopsy specimens. Gargiulo *et al* established that there is a precise proportional relationship between the alveolar crest, the connective tissue attachment, the epithelial attachment, and the sulcus depth. Gargiulo *et al* reported the following mean dimensions: A sulcus depth of 0.69 mm, an epithelial attachment of 0.97 mm, and a connective tissue

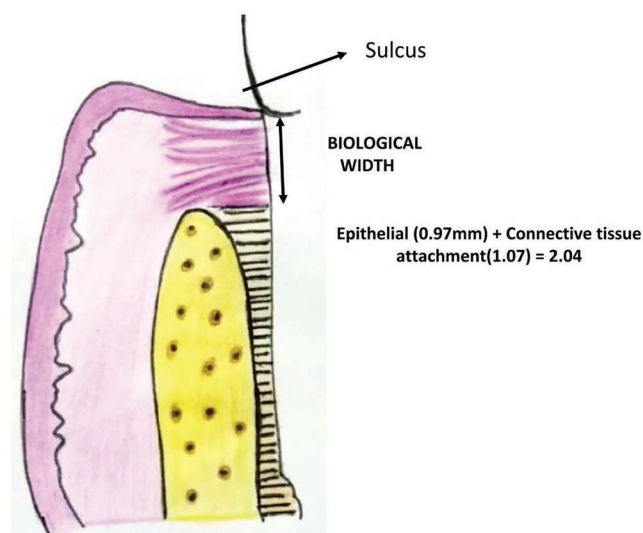


Figure-1: Anatomy of biological width

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attachment of 1.07 mm. Based on this, the biologic width is commonly stated to be 2.04 mm, which represents the sum of the epithelial and connective tissue measurements.⁹ In 1977, Ingber *et al.* described "Biologic Width" and credited D Walter Cohen for first coining the term.¹⁰ The dimension of biologic width is not constant always, it depends on the area of the tooth in the alveolus, differ from tooth to tooth, and also from the appearance of the tooth. It has been shown that 3 mm between the preparation margin and alveolar bone maintains periodontal health for 4 to 6 months.¹¹ This 3 mm aggregate on an average for supra-crestal connective tissue attachment (1 mm), junctional epithelium (1 mm) and for gingival sulcus (1 mm). This allows for adequate biologic width even when the restoration margins are placed 0.5 mm within the gingival sulcus.¹² According to Nevins and Skurow when subgingival margins are indicated, the dentist should not disrupt the junctional epithelium or connective tissue apparatus during tooth preparation and during impression taking. According to the authors, subgingival margin extension should be limited to 0.5-1.0 mm because violating this, it is impossible for the clinician to detect where the sulcular epithelium ends and the junctional epithelium begins.¹³

MARGIN PLACEMENT AND BIOLOGIC WIDTH

According to Ingber *et al.*, (1977) there is a requirement of minimum 3mm from the restorative margin to the alveolar crest for an adequate healing and restoration of the tooth.¹⁰ Maynard and Wilson in 1979 divided the periodontium into three-dimensions, a) Superficial physiologic: Representing the free and attached gingiva surrounding the tooth. b) Crevicular physiologic: Representing the gingival dimension from the gingival margin to the junctional epithelium. c) Sub-crevicular physiologic: consisting of the junctional epithelium and connective tissue attachment. This sub crevicular physiologic dimension is analogous to the biologic width described (Gargiulo *et al.* 1961), These all three dimensions have influence in making decisions during restorative phase.¹⁴ From the alveolar crest to the crown margin a minimum 3.0 mm distance is necessary.¹³

A clinician has three options for margin placement: i) Supragingival, ii). Equigingival, and iii) subgingival locations

Supra-gingival margin

It has the least impact on the periodontium. Due to the marked contrast in opacity and color of traditional restorative materials against the tooth, the margin location has been applied in areas where aesthetics are not required. Nowadays with the advent of more translucent restorative materials and resin cements, there is more ability to place supragingival margins in esthetic areas.⁷

Advantages of supragingival margin¹¹

1. Preparation of the tooth and finishing of the margin is effortless.
2. Authentication of the marginal integrity of the restoration

is very easy.

3. Duplication of the margins with impressions that past the finish line without damage or deformation is the easiest with supragingival margins.
4. Finishing and fitting of the restoration and removal of excess material are easiest.
5. There is the least irritation to the periodontal tissue.

Equigingival margin

Due to the thought that equigingival margin favours more plaque accumulation than supragingival or subgingival margins, and therefore result in greater gingival inflammation, equigingival margins was traditionally not desirable. There was also the matter, an even minor gingival recession would create an unsightly margin display. Now these concerns are not valid today, because the restoration margins can be esthetically integrated with the tooth and restorations can be finished easily to provide a smooth, polished interface at the gingival margin. From a periodontal viewpoint, both supragingival and equigingival margins are well tolerated.⁷

Subgingival margin

Due to caries or any tooth deficiencies, and/or to mask the tooth/restoration interface, restorative considerations will periodically dictate the placement of restoration margins beneath the gingival tissue crest. Forced entrance into biologic periodontal space by clinicians for additional retention will lead to iatrogenic periodontal disease with early loss of restoration. If the restoration margin is placed far away below the gingival tissue crest, restoration will impinge on the gingival attachment which leads to inflammation which is worsened by the patient's as they are unable to clean this area. Many Investigators have correlated that sub gingival restorations promotes more qualitative and quantitative changes in the micro flora, increased plaque index, increased gingival index, increased pocket depth, increased recession and increased gingival fluid.^{15,16}

EVALUATION OF BIOLOGIC WIDTH VIOLATION

a) Clinical method

If a patient experiences or complains of tissue discomfort when the margin levels of restoration are being determined, with the help of suitable periodontal probe, indicating that the margin extends into the attachment leading to biological width violation. During restorative preparation, if the apical margin is placed within the biologic width (i.e., too close to the bone), there is likely to develop a zone of chronic inflammation. There is also bleeding on probing, localized gingival hyperplasia with a minimal bone loss, pocket formation, gingival recession clinical attachment loss and alveolar bone loss, the sign of biological width violation.¹¹ One of the theories proposed is that there is meager space for a "normal" length of junctional epithelium to develop; the junctional epithelium is short, fragile, and does not exert a proper sealing effect of the dentogingival unit.¹⁷ The area is easily impaired by mechanical oral hygiene practices, the chronic inflammation is readily induced or may persist. Other authors believe that if the subgingival restorative

margin is deeply placed i.e., close to the crest of alveolar bone, prejudice (impairs / hampers) the maintenance of proper plaque control, promoting certain inflammatory changes which are not good to a healthy periodontal environment.¹⁸ Subgingivally placed restoration margins and gingival hyperplasia is most frequently found in altered passive eruption.¹¹

Bone sounding:

The level of the alveolar crest must be determined preceding to any considerations regarding aesthetic crown lengthening so as to determine the feasibility, surgical aspects, and treatment sequence. The biologic width can be done following the administration of a local anesthesia, a measuring instrument (probe) is utilized to puncture and penetrate the mucosa until contact is made with the underlying bone (referred to as "sounding to the bone") and subtracting the sulcus depth from the resulting measurement. If this distance is less than 2 mm at one or more locations, biologic width violation may be confirmed. This measurement should be performed on the teeth having healthy gingival tissues and should be repeated on more than one tooth to ensure accurate assessment, and reduce individual and site variations. During this periodontal evaluation, bone sounding assists in determining the level of the alveolar crest and thus the need for osseous contouring^{10,19}

b) Radiographic evaluation

Radiographic interpretation can be very helpful to the clinicians in identifying interproximal violations of biologic width. However, radiographs are not diagnostic on the mesio-facial and disto-facial line angles of teeth, because of tooth superimposition.²⁰ H. Sushama and Gouri have described a new innovative, parallel profile radiographic (PPR) technique to measure the dimensions of the dento gingival unit (DGU). The authors assume that the PPR technique could be used to measure both length and thickness of the DGU with accuracy, as it was simple, concise, non-invasive, and a reproducible method.¹⁹

CATEGORIES/PROFILES OF BIOLOGIC WIDTH TO PREVENT BIOLOGIC WIDTH VIOLATION

Based on the total dimension of attachment and the sulcus depth following bone sounding measurements, Kois proposed three categories of biologic width namely:

1) Normal Crest, 2) High Crest and, 3) Low Crest.^{21,22} [Figure 2] [Table 1]

Normal crest patient

It occurs in almost 85% of patients. 3.0 mm is the mid-facial measurement and the proximal measurement is in the range of 3.0-4.5 mm. The margin of a crown shall generally be placed no closer than 2.5 mm from the alveolar bone. In this the gingival tissue seems to be substantial for a long term. Therefore, a crown margin which is placed 0.5 mm subgingivally tends to be well-tolerated by the gingiva in such patients.⁸

High crest patient

High Crest is a rare finding and occurs in approximately 2% of the patients. This is seen mostly in a proximal surface adjacent to an edentulous site due to the collapse of interproximal papilla following tooth removal. Usually, it is not possible to place an intra-crevicular margin because the margin will be very close to the alveolar bone, resulting in a breach of biologic width that will eventually lead to chronic inflammation. The mid-facial measurement is > 3.0 mm and the proximal measurement is also >3.0 mm.⁸

Low-crest patient

It occurs in almost 13% of patients. Generally, the Low Crest patient has been illustrated as more vulnerable to recession secondary to the placement of an intra-crevicular crown margin.

When retraction cord is placed consecutive to the crown preparation; the attachment apparatus is frequently injured. As there is healing of injured attachment apparatus, it tends to alleviate back to a normal crest position that ultimately results in gingival recession. The mid-facial measurement

| | Normal Crest | High Crest | Low Crest |
|------------------------|--------------|------------|-----------|
| Mid-facial measurement | 3 mm | <3 mm | >3 mm |
| Proximal measurement | 3-4.5 mm | <3 mm | >4.5 mm |

Table-1: Dimensions of attachment and sulcus depth following bone sounding.



Figure-2: Categories of biological width

is < 3.0 mm and the proximal measurement is <4.5 mm.⁸ All low crest patients do not react in an equivalent way to an injury to the attachment as some low crest patients are prone to gingival recession while others have a quite stable attachment apparatus, depending on the depth of the sulcus.²³

IMPORTANCE OF DETERMINING THE CREST CATEGORY

When preparing anterior teeth for indirect restorations, it is must for the clinicians to know in detail about the Crest category. Determination of the crest category allows the clinicians to determine the excellent position of margin placement. It also helps the clinician to inform the patients of the probable long-term effects of the crown margin on gingival health and esthetics.⁸ If the sulcus is in the deeper range, the clinicians can forecast that an intra-crevicular crown margin placed in this unstable low-crest patient would result in the gingival recession. However, if the sulcus is in the shallow range, the clinician may treat this stable low-crest patient like a Normal-Crest patient. An intra-crevicular margin can be placed with a feasible intention of long-term stability and esthetics.^{8,10,19,20}

Based on the sulcus depth the following three rules can be used to place intra-crevicular margins:

- If the probing depth of sulcus is 1.5 mm or less, the restorative margin can be placed 0.5 mm below the gingival tissue crest.
- If the probing depth of sulcus more than 1.5 mm, the restorative margin should be placed in half the depth of the sulcus.
- If the probing depth of sulcus is greater than 2 mm, gingivectomy may be executed to lengthen the tooth and create a 1.5 mm sulcus.^{21,24}

CORRECTION OF 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, thus moving the margin away from the bone. Correction of Biologic Width Violation can be achieved by two methods:

- Surgical Crown Lengthening

b) Orthodontic Extrusion

a) Surgical Crown Lengthening: [Fig.3]

Indications for Surgical crown lengthening²⁵

- Inadequate clinical crown for retention due to large caries, sub-gingival caries or fracture of the tooth, perforations in root or root resorption within the cervical 1/3rd of the root in teeth with adequate periodontal attachment.
- Restorations which violate the biologic width.
- Placement of sub gingival restorative margins.
- Short clinical crowns.
- Teeth with excessive occlusal wear or incisal wear.
- Teeth with inadequate inter occlusal space for proper restorative procedures due to supraeruption.
- Unequal, excessive, or unesthetic gingival levels for esthetics.
- In conjunction with tooth requiring hemisection or root resection.

Contraindications for Surgical crown lengthening²⁵

If there is need of excessive bone removal in case of deep caries or fracture.

- Tooth with an increased possibility of furcation involvement.
- Unaesthetic outcomes after Post-surgery.
- Non-restorable teeth.
- Unreasonable compromise of esthetics
- Tooth with inadequate crown root ratio (2: 1 ratio is preferred ideally).
- Unreasonable compromise on adjacent alveolar bone support.

CROWN LENGTHENING PROCEDURES [FIG 4]

After performing an analysis of the individual case with concern to crown-root alveolar bone relationships, the proper treatment approach for crown lengthening is decided. The proper treatment approach for crown lengthening procedures are as follows:

- External bevel gingivectomy: Gingivectomy is a very successful and anticipated surgical procedure done for reconstruction of biologic width; however, it can be only used in situations with hyperplasia or pseudo pocketing (> 3 mm of biologic width) and presence of adequate amount of keratinized tissue. When attached gingiva is

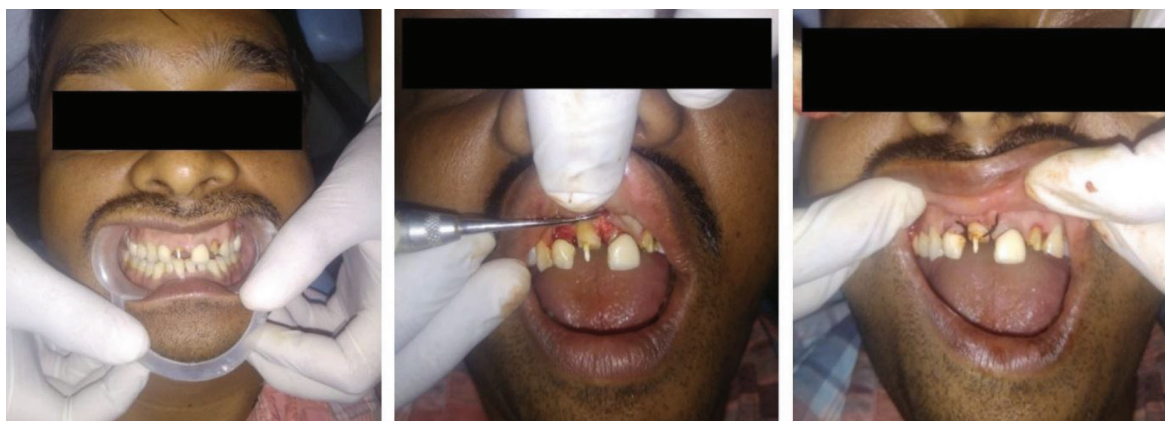


Figure-3: Surgical crown lengthening

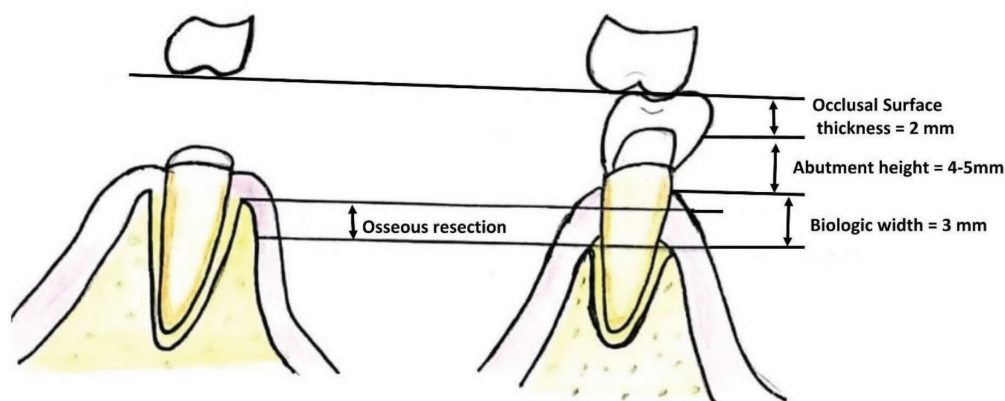


Figure-4: Explanation of Crown Lengthening

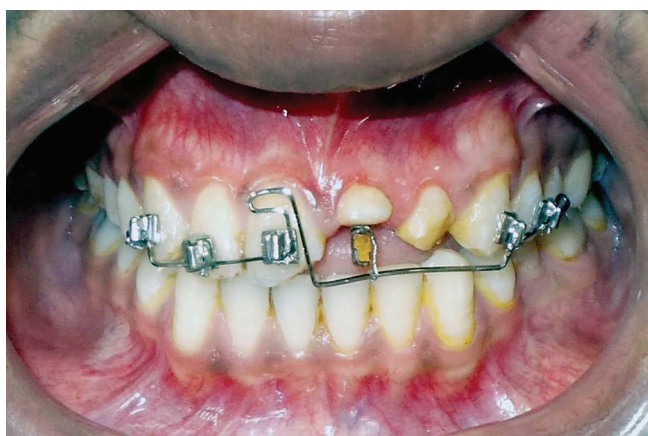


Figure-5: Orthodontic Extrusion

more than adequate and there is no bone involvement, in such case method of eliminating excessive pocket depth and or of exposing additional coronal tooth structure is done by external-bevel gingivectomy.²⁶

- 2) Internal bevel gingivectomy: For reduction of excessive pocket depth and for exposing additional coronal tooth structure in the absence of a sufficient zone of attached gingiva (with or without the need for correction of osseous abnormalities) requires a surgical procedure, in which the flap must always be internally beveled so as to expose the supporting alveolar bone.⁷

APICAL REPOSITIONED FLAP SURGERY

It is indicated in the crown lengthening of multiple teeth in a quadrant. Apical repositioned flap surgery should never be used during surgical crown lengthening of a single tooth in the esthetic zone.

Apical repositioned flap surgery can be done by following methods:

- a) Apically repositioned flap without osseous resection: This procedure is done when there is a biologic width of more than 3 mm on multiple teeth, and there is no adequate width of attached gingiva.
- b) Apical repositioned flap with osseous reduction: This technique is used when biologic width is less than 3 mm, there is no adequate zone of attached gingiva. The alveolar bone is reduced by the process called ostectomy followed by osteoplasty, to expose the required tooth

length in a scalloped fashion, and for following the desired contour of the overlying gingiva. As a general rule, at least 4 mm of sound tooth structure must be exposed, because soft tissue will proliferate coronally to cover 2-3 mm of the root so that leaving only 1-2 mm of supra-gingivally located sound tooth structure. Complications after crown lengthening can be Poor esthetics (black triangles), Root hypersensitivity, root resorption and transient mobility.^{27,28}

Orthodontic procedures

Orthodontic extrusion can be performed in two ways [Fig. 5]²⁹

Slow

This is done by applying low orthodontic force, the tooth eruption is slow, bringing the alveolar bone, and gingival tissue along with it. The tooth is extruded until the bone level has been drifted coronal to the optimal level by the amount that needs to be removed surgically for correcting the biologic width violation. Stabilization of the tooth is done in this position and then treated with appropriate surgical procedures to correct the bone and gingival tissue levels.

Rapid The tooth is erupted to the desired amount for several weeks (with supracrestal fibrotomy performed weekly in an intentional to prevent the tissue and bone from succeeding the tooth). Then the tooth is stabilized minimum for 12 weeks prior to surgical correction.

Forced tooth eruption

Heithersay and Ingber were the first to suggest the use of "forced eruption" to treat "non-restorable" or previously "hopeless" teeth.³⁰ Forced tooth eruption should be done in the cases where conventional crown lengthening via ostectomy cannot be achieved as in anterior area, as ostectomy will lead to a negative architecture, and there is also a removal of bone from the adjacent teeth which can eventually compromise the function of these teeth. Forced tooth eruption is contraindicated where there is an inadequate crown-to-root ratio, lack of occlusal clearance for the required amount of eruption and possible periodontal complications.³¹

Techniques of forced tooth eruption

Orthodontic brackets are bonded to the affected tooth and

adjacent teeth and are combined with the help of an arch wire. Power elastic is tied from the bracket to the arch wire which pulls the tooth coronally.

Starr, gave two concepts of forced eruption: Forced eruption with minimal osseous resection, and forced eruption combined with fibrotomy. Frank et al. described forced eruption of multiple teeth.³² Fibrotomy is performed with a scalpel at 7-10 day intervals to detach the supracrestal fibers so that preventing the crestal bone form following the root in a coronal direction. Fibrotomy in case of forced tooth eruption the crestal bone, and the gingival margin are restored at their pre-treatment location. The tooth gingiva interface at adjacent teeth is unaltered.³³ Forced tooth eruption with fibrotomy is contraindicated in angular bone defects and ectopically erupted teeth.

CONCLUSIONS

The overall health of periodontal tissue is solely dependent on properly designed restoration. Incorrectly placed restorative margins and poorly adapted restorations violate the biologic width. Properly designed restorations play a vital role in maintaining the overall health of the periodontal tissues. Incorrectly positioned restoration margin and improper restoration violate the biologic width. Clinicians regularly encounter cases in daily practice such as extensive caries, subgingival perforation and post and core placement in endodontic therapy, fractured teeth etc. In this type of cases concept of biologic width gain its importance. Clinicians should be aware of the important relationship, specific concepts such as biologic width, its maintenance and applications of crown lengthening in cases of biologic width violation. Biologic width is essential for the preservation of periodontium which ultimately decides the success of restorative procedures. Patient cooperation, motivation and regular maintenance visits, plays an important role in the success of restorations and maintenance of periodontal health.

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