

Biologic width-A Review

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Abstract

Replacement of missing, damaged or unaesthetic tooth by dental prostheses helps the patient to rehabilitate structure and function of the lost tissues. During delivery of the prostheses, the overall health of the oral tissues, including the periodontium, must be considered. The gingival tissues must be healthy and it is of paramount importance to respect the biologic width of the tissues. The biologic width varies among different individuals and at different sites of the same individual. Instead of following a mean value, each patient should be examined to determine the biologic width. In case violation of biologic width is anticipated, appropriate measures should be adopted to maintain the dimensions of the biologic width.

Key words: Biologic width; Crown lengthening; Margins; Orthodontic extrusion.

Introduction

Dental prostheses are used for the restoration of damaged, unaesthetic, or dysfunctional tooth, or to replace one or more missing natural teeth.¹ While prostheses serve to cater optimal quality of life to the individual, faulty prostheses, on the other hand, contribute to detriment the periodontium.² Tooth and prostheses related factors have been introduced as a separate category in the recent American Academy of Periodontology (AAP) Classification of Periodontal and Peri-implant Diseases and Conditions as other conditions affecting the periodontium under Periodontal Diseases and conditions.³

Localised dental-prosthesis-related factors predisposing to periodontitis include:⁴

- a) Restoration margins placed within the supracrestal attached tissues
- b) Clinical procedures related to the fabrication of indirect restorations
- c) Hypersensitivity/toxicity reactions to dental materials

Dental prostheses should be fabricated harmonising with the natural hard and soft tissues. Infringement of the periodontal tissues results in loss of the supporting tissues. The dimension of the soft tissue, which is attached to the portion of the tooth coronal to the crest of the alveolar bone, termed biologic width⁵, should be preserved. Histologically, the biologic width is composed of the junctional epithelium and supracrestal connective tissue attachment. The AAP 2017 has replaced the term supracrestal tissue attachment and the term biologic barrier has been suggested.⁶ Maintenance of biological width is essential for the optimal periodontal health, which again is dependent on the properly designed restorations.⁷

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Definitions of Biological Width:

Khuller N and Sharma N (2009)⁸ defined BW as the dimension of the soft tissue, which is attached to the portion of the tooth coronal to the crest of the alveolar bone.

Nevin and Skurow (1984)⁹ defined it as the sum of the combined supracrestal fibers, the junctional epithelium and the sulcus.

World Workshop on the classification of Periodontal and Peri implant diseases and conditions (2018) defined it as a commonly used clinical term to describe the apico- coronal variable dimensions of the supracrestal attached tissues.

The concept of biologic width must be clear as many clinicians are unable to practically implement it.¹⁰ In dentistry, the area of biological width is sometimes called Bermuda Triangle or Devil's Triangle.^{11,12}

History

Gottlieb was the first to describe the “epithelial attachment”.¹³ The “gingival crevice” or sulcus was defined by Orban and Mueller¹⁴. The connective tissue was described as three-dimensionally oriented fibers firmly connecting tooth structures to the adjacent gingiva by Feneis.¹⁵ Marfino, Orban and Wentz¹⁶ were the first to demonstrate that gingival connective tissue attachment and junctional epithelium compose the attachment of gingiva to tooth. Sicher¹⁷ described the dentogingival junction as epithelial and connective tissue attachments to the teeth.

Historically Walter Cohen first coined the term “biologic width” and in 1977, Ingber et al. described the biologic width.¹⁸ In 1961, Garguilo et al.¹⁹ evaluated the average vertical dimensions of the biological width. From 30 autopsy specimens, 287 individual teeth were studied and the alveolar crest, the connective tissue attachment, the epithelial attachment, and

the sulcus depth were measured. They reported the mean sulcus depth of 0.69 mm, epithelial attachment of 0.97 mm, and connective tissue attachment of 1.07 mm. The biologic width was calculated to be 2.04 mm. Thus, on average, it is essential to maintain 3 mm distance from the bone crest to the cement-enamel junction in healthy teeth or until the end of the preparation or the margin of restoration in restored teeth.²⁰

Vacek et al²¹ reported variations in the dimensions of the supracrestal gingival tissue between teeth and in different sites within the same tooth. They evaluated 171 cadaver tooth surfaces and observed mean measurements of 1.34 mm for sulcus depth, 1.14 for epithelial attachment, and 0.77 mm for connective tissue attachment. The connective tissue attachment was the most consistent measurement. Vacek and colleagues found that the biological width increased anteroposteriorly and 15% of restoration that impinge the biologic width had a biologic width of less than 2.04 mm.

The dimensions advocated by different authors to maintain a healthy gingiva are shown in Table 1.

Table 1: Minimum biologic width advocated by various authors

Authors	Minimum requirement
Ingber et al (1977) ¹⁸	3 mm
Rosenberg and colleagues (1980 and 1999) ²²	3.5 to 4 mm
Weinberg and Eskow (2000) ²³	3.5 to 4 mm
Nevins & Skurow (1984) ⁹	3.0 mm
Wagenberg and colleagues (1989) ²⁴	5 to 5.25 mm
Palomo and Kopczyk ²⁵	1 mm

Interproximal Biologic Width is similar to that of the facial surface but the total dentogingival complex is different. According to Kois and Spear, the dentogingival complex is 3.0mm facially and 4.5 mm to 5.5 mm interproximally.²⁶ The height of interdental papilla was explained

by increased scalloping of the bone. Spear suggested that additional 1.5 to 2.5 mm of interproximal gingival tissue height is seen only in the presence of adjacent teeth. In the absence of the adjacent tooth, the interproximal gingival tissue be 3.0 mm.²⁶ Tarnow and colleagues found that the distance from the contact point to alveolar crest should not exceeded 5 mm to 5.5 mm for the gingival tissue to completely fill the interdental space. Greater distance resulted in significant loss of alveolar height.²⁷ Cho et al also found that the number of papillae that filled the interproximal space also decreased as the interproximal distance between the teeth increased.²⁸

Importance of biologic width

The components of the biologic width serve for adhesion of the junctional epithelium and insertion of the connective fibers to the dental structure.⁵ They create a barrier in the periodontium and prevent microbial penetration. If it is impinged, the microorganisms gain access to deeper tissues and cause destructive inflammation. The restorations with rough surface aid in retention of the biofilm and the inability of the patient to clean deep areas further aggravates the biofilm accumulation. As a consequence, gingival inflammation, loss of clinical attachment, bone loss, gingival recession, increasing vertical bone resorption and increasing the horizontal component can be seen.²⁹

Violation of biologic width results in:³⁰

- a) Crestal bone loss
- b) Gingival recession with localized bone loss
- c) Localized gingival hyperplasia with minimal bone loss
- d) A combination of three

Tooth supported/retained restorations and their design, fabrication, delivery, and materials can be associated with plaque retention and loss of

clinical attachment. However, according to the available evidence, it is not possible to determine if the negative effects is due to dental plaque biofilm, trauma, toxicity of dental materials, or a combination of these factors.⁴

Optimal restoration margins located within the gingival sulcus do not cause gingival inflammation if patients are compliant with self-performed plaque control and periodic maintenance. Localized inflammation that does not respond to adequate measures of plaque control may be a sign of dental material hypersensitivity.⁴

Evaluation of Biologic Width Violation

1. Clinical method

The presence of discomfort during examination of restoration margins indicates biologic width violation. The clinical signs of biologic width violation are:

- a) Chronic progressive gingival inflammation around the restoration
- b) Bleeding on probing
- c) Localized gingival hyperplasia with minimal bone loss
- d) Gingival recession
- e) Pocket formation
- f) Clinical attachment loss
- g) Alveolar bone loss
- h) Gingival hyperplasia

Encroachment of restoration into biologic width initiates crestal bone resorption. This occurs to allow space for establishment of a minimum biologic width.³¹

2. Radiographic evaluation

Radiographs are useful non-invasive tools in the assessment of biological width encroachment. Their use is only limited to interproximal areas. Parallel profile radiographic (PPR) technique has been introduced to measure the dimensions

of the dento gingival unit (DGU).³² It is used to measure both length and thickness of the DGU.

3. Bone sounding

After application of local anesthesia, the area is probed till the bone is felt. Then, the sulcus depth is measured and subtracted. If the distance is less than 2 mm, biologic width violation can be confirmed.³³ The transulcular periodontal probing was described by Jardini and Pustiglione.³⁴ The following considerations must be considered for bone sounding:

1. The gingiva must be healthy.
2. The measurement should be repeated on more than one tooth to ensure accurate assessment, and reduce individual and site variations.

Factors influencing the biologic width^{5,35-37}

- a) Location/inclination of the tooth in the socket
- b) Different teeth
- c) Site of the tooth
- d) Gingival biotype
- e) Keratinised tissue

Categories of biologic width:³⁵

There are three categories of biologic width

1. Normal crest patient

The maximum number of individuals, i.e., 85% of the individuals have normal crest patient. The gingival tissues are stable for a long-term. In these cases, when the crown margin is placed 0.5 mm subgingivally, it is tolerated well by the gingiva.

2. High crest patient

It is seen in 2% of the individuals and is found in a proximal surface adjacent to an edentulous site. If the margins are placed subgingivally in these cases, the margins will be closer to alveolar bone and biologic width is violated.

3. Low crest patient

It is seen in 13% of the individuals. If the margins are placed subgingivally in these cases, there might be two types of reaction based on the depth of the sulcus. If the attachment apparatus is thick and the sulcus is shallow, it is less susceptible to gingival recession and if the attachment apparatus is narrow with deeper sulcus, it is more susceptible to gingival recession.

Dimensions of periodontium

Maynard and Wilson³⁸ categorised the periodontium into three-dimensions

- Superficial physiologic: It represents the free and attached gingiva surrounding the tooth.
- Crevicular physiologic: It represents the gingival dimension from the gingival margin to the junctional epithelium.
- Subcrevicular physiologic: It is analogous to the biologic width and consists of the junctional epithelium and connective tissue attachment.

Types of margin

Margins can be placed in three ways:

Supragingival margin

This margin type is easy for preparation of the tooth and finishing of the margin. The impression can be taken easily with proper duplication of the margins. The margins are mainly given in non-esthetic areas owing to the color and opacity contrast present in restorative materials. If translucent restorative materials are used, they can also be given in esthetic areas. They are the least irritating to the periodontal tissue.

Equigingival margin

The restoration and the tooth margin can be blended easily. Tooth preparation and finishing is easy and it gives a smooth, polished interface at the gingival margin. But, traditionally, it was

said to favour accumulation of plaque giving rise to gingival inflammation.⁵

Subgingival margin

Subgingival margins should be given if dental caries or tooth deficiencies extend apically beyond the gingival crest.³⁹ It is also used for optimal esthetic output. But, too far placement of the subgingival margin will impinge on the periodontal apparatus. Constant inflammation occurs and the condition is aggravated by the patient's inability to clean this area. Biologic width violation will lead to gingival recession and bone loss. Thin alveolar bone increases the risk of alveolar bone loss and thin gingiva increases the risk of gingival recession.⁵ The more common finding with deep margin placement is unchanged bone level but gingival inflammation will develop and persist on the restored tooth.⁴⁰ This type of margin is not accessible for finishing and polishing which acts as a niche for bacterial growth.⁴¹ To prevent these complications, the contour should be proper, polishing of the restoration should be done and biologic width must be respected. The amount of attached gingiva should also be taken into account.

Margin placement⁴²

1. If the sulcus probes 1.5 mm or less, the restorative margin could be placed 0.5 mm below the gingival tissue crest.
2. If the sulcus probes >1.5 mm, the restorative margin can be placed in half the depth of the sulcus.
3. 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.

In a study done by Valderhaug and Birkeland⁴¹, 114 patients with 329 total crown restorations were evaluated. 59% of the crowns were located

subgingivally at the beginning of the study period and after 5 years, only 32% of the crown margins remained below the gingival margin.

Waerhaug stated that subgingival restorations are plaque-retentive areas and are inaccessible to scaling instruments. They will continue to accumulate plaque even after adequate supragingival plaque control measures are carried out. Later, he demonstrated that gingivitis and attachment loss was associated with sub marginal restorations in monkeys and dogs.⁴³ Clinical and histological observations of human teeth was done by Drago and Williams⁴⁴. They demonstrated that compared to shoulder preparations, compromised healing was associated with gingival bevel crown margins. Orkin et al.⁴² demonstrated that subgingival restorations had a greater chance of bleeding and gingival recession than supragingival restorations. Stetler and Bissada⁴⁵ demonstrated 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. Keratinised gingiva should be carefully evaluated before placing subgingival restorations.

Flores-de-je-Coby et al⁴⁶ demonstrated that subgingival margins demonstrated increased plaque, gingival index scores, and probing depths. More spirochetes, fusiforms, rods, and filamentous bacteria were found to be associated with subgingival margins.

Method to correct biologic width violation

The biologic width has inter-personal and intra-personal variability. There is no magic number which can be recommended and each site of each patient must be evaluated before coming to a definite conclusion.⁴⁷ In case a biologic width is violated, the following procedures should be considered:

1. Surgical crown lengthening:
 - Gingivectomy
 - Apically positioned flap (APF)
 - APF with osseous reduction
2. Orthodontic procedure
 - Forced eruption
 - Forced eruption combined with fiberotomy
 - Orthodontic Extrusion associated with Supracrestal Fiberotomy and Root Planing (OEFRP):

Surgical crown lengthening

As the term indicates, it is used to lengthen the crown. Various measures are:

Gingivectomy

External bevel gingivectomy is both successful and predictable surgical procedure and is indicated in hyperplasia or pseudopocket along with presence of adequate amount of keratinized tissue.⁴⁸ Internal bevel gingivectomy is carried out if reduction of excessive pocket depth and exposure of coronal tooth is required in absence of sufficient zone of attached gingiva.⁸

Apically positioned flap (APF)

Apically positioned flap is recommended when crown lengthening of multiple teeth in a quadrant or sextant of dentition is required and there is a biologic width of more than 3 mm. Pocket reduction can be done at the same surgery. It should not be done for during surgical crown lengthening of a single tooth in the esthetic zone.

APF with osseous reduction

It is the most common procedure for clinical crown lengthening. It is done in inadequate zone of attached gingiva and biologic width less than 3 mm. Detailed evaluation should be done before carrying out osseous reduction as it compromises periodontal support of the tooth, causes furcation involvement, poor crown-to-

root ratio and gingival recession. It should not be done during surgical crown lengthening of a single tooth in the esthetic zone. In such cases, forced eruption should be considered to prevent negative architecture.

Orthodontic procedures

Forced eruption

In forced eruption, tooth is intentionally moved in a coronal direction using gentle continuous force. The force stretches gingival and periodontal fibers resulting in a coronal shift of gingiva and bone.⁴⁹ It was first advocated by Heithersay⁴⁹ for teeth with horizontal fractures. Orthodontic extrusion was advocated in anterior area where surgical crown lengthening cannot be accomplished. It minimizes gingival recession and loss of bone support on adjacent teeth.^{50,51}

Orthodontic extrusion requires an activation period of 4-6 weeks and 6-8 weeks retention period for tooth to become stabilized in its new position. Additional surgical crown lengthening may be required after forced eruption. The contraindications are inadequate crown-to-root ratio, lack of occlusal clearance and periodontal complications.

Forced eruption with fiberotomy

Combination of orthodontic extrusion and severance of supracrestal fibers, termed supracrestal fiberotomy is also used for crown lengthening. If fiberotomy is performed during the forced tooth eruption procedure, the crestal bone, and the gingival margin are retrieved at their pretreatment location. Thus, the tooth-gingiva interface at adjacent teeth is unaltered. Fiberotomy is performed once every 7-10 days during the phase of forced tooth eruption.²⁷

Orthodontic Extrusion associated with Supracrestal Fiberotomy and Root Planing (OEFRP): It is a flapless technique for crown lengthening after orthodontic extrusion. The OEFRP procedure must be carried out every 2

weeks during the entire extrusive orthodontic phase.⁵²

Complications after crown lengthening⁵

- a) Poor aesthetics due to ‘black triangles’
- b) Root hypersensitivity
- c) Root resorption
- d) Transient mobility of the teeth

Conclusion

The study of the periodontal-prosthetic relationship is necessary for the ultimate success of the prostheses. The maintenance of the normal structure of the biological tissues should be done and the concept of biologic width must be followed at each procedure. The periodontal health is an important key for the longevity of dental prostheses.

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