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Original article: Practice of Dentists in Respecting the Biologic Width in Fabrication of Prosthetic Restorations

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ABSTRACT

Introduction: A thorough understanding of the relationship between periodontal tissue and prosthetic restorations is important to ensure optimal shape, function, and esthetics of restored teeth. This study aimed to assess the practice of dentists in respecting the biologic width in fabrication of prosthetic restorations.

Materials and Methods: This Analytical retrospective cross-sectional study was conducted in the school of dentistry of Guilan at 2022. This study evaluated 323 bitewing radiographs selected by convenience sampling. The distance between the restoration margin and alveolar crest in the proximal tooth surfaces was measured, and values < 2 mm were recorded as cases of biologic width invasion. All measurements were made by a digital caliper on a negatoscope. Data were analyzed by SPSS 19 and a P-value of less than 0.05 was considered statistically significant.

Results: The biologic width was within the normal range in 38% of patients; while, biologic width invasion was found in 62%. Invasion to the biologic width had no significant association with tooth type, restoration type, or jaw (P>0.05). Respecting the biologic width had a higher frequency in the maxilla (41%) than mandible (29.5%) although this difference was not significant (P=0.12).

Conclusion: Considering the biologic width invasion in 62% of the assessed cases and its consequences, the present results highlight the need for further instruction of dentists in this regard.

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1. Introduction

Biologic width is the sum of junctional epithelium and supracrestal connective tissue attachment, and plays a fundamental role in periodontal health. Invasion to the biologic width leads to extensive periodontal tissue destruction (1,2). Healthy periodontal tissue is critical for an efficient and esthetically pleasant dentition. The majority of restorative treatments require a healthy periodontium for a favorable outcome. The relationship of periodontal health and restorative treatment success is undeniable. This relationship is more important at the restoration margins due to gingival tissue response to such treatments and the need for tooth preparation before restoration (3–5).

The height of supra-crestal connective tissue is approximately 1.07 mm, and the height of epithelial attachments below the gingival sulcus base is approximately 0.97 mm, yielding a sum of 2.04 mm width, which is referred to as the biologic width (6,7). The proximal gingival contour follows the underlying bone contour, since the biologic width remains unchanged despite the alterations in the bone contour (8). The magnitude of biologic width can serve as a guide to understand the relationship of gingival tissue and the underlying bone. The supra-bony dimensions of the gingiva, i.e., the distance between the alveolar bone crest and gingival margin, can be calculated for each patient by probing of the alveolar bone level under local anesthesia; this process is referred to as transgingival probing or bone sounding. The magnitude of biologic width is calculated by subtracting the sulcus depth from the probed value (9,10). Accordingly, it is important to use less invasive procedures (11,12).

Biologic width is imperative for epithelial and connective tissue attachments to the tooth surface. It also serves as a barrier against microbial invasion to the periodontium. Thus, to preserve periodontal health, biologic width should be respected in all restorative procedures. Invasion to the biologic width may cause periodontal tissue injury and lead to chronic inflammation of the soft tissue around the restoration, bleeding on probing, localized gingivitis, gingival hyperplasia, gingival recession, periodontal pocket formation, and progressive alveolar bone loss. Discomfort following gingival examination by a periodontal probe may indicate invasion to the biologic width (13).

Studies on measuring biological width using radiographic, probing and surgical methods have shown that these measurements do not have statistically significant differences (14–16). In recent years, molding methods and materials and the use of dental equipment such as loupes have spread among dentists, all of which make dental restoration less invasive to the biological width (17). Interproximal or bitewing radiography as a non-invasive ideal technique for more precise assessment of proximal areas can reveal biologic width invasion. Bitewing radiography is the most suitable imaging modality for detection of biologic width invasion due to its 0-degree vertical angulation (18).

According to our knowledge, Limited studies in this field have been conducted in Iran (19). The practice of dentists in respecting the biologic width during the fabrication of prosthetic restorations is crucial for ensuring periodontal health and the long-term success of dental treatments. Respecting the biologic width is not only crucial for the success of restorative and prosthetic treatments but also plays a key role in preventing periodontal diseases and ensuring the long-term health of teeth and surrounding tissues. This is why dentists pay special attention to this aspect when designing and implementing restorations, implants, and other treatments. A thorough understanding of the relationship of clinical and radiographic findings is imperative for correct diagnosis and treatment of biologic width invasion. Thus, this study aimed to assess biologic width invasion by prosthetic restorations through interpretation of bitewing radiographs.

2. Materials and Methods

This analytical retrospective cross-sectional study was conducted in the School of Dentistry of Guilan

at 2022. In this study (ethical code IR.GUMS.REC.1398.399), 323 bitewing radiographs were selected by simple random sampling. The required number of samples was calculated based on Fatahi et al.'s article and using the sample size formula (19).

$$n = \frac{z^2_{(1-\frac{\alpha}{2})} P(1-P)}{d^2} \qquad n = \frac{1.96^2 * (0.7 * 0.3)}{(0.05)^2} = 323$$

All patients wore a lead apron with thyroid collar to protect against radiation. The patients were systemically healthy. Inclusion criteria: patients with crowns for whom bitewing radiography was prescribed. The exclusion criteria were as follows:

(I) Restored teeth with recurrent caries

(II) Presence of gap or overhang, and poor-quality bitewing radiographs

(III) Teeth with horizontal and vertical bone resorption

(IV) Patients who underwent periodontal surgery after prosthetic crown delivery

(V) Patients in whom, over 3 weeks had passed since their crown cementation (20).

The distance between the restoration margin and alveolar bone crest was measured at proximal tooth surfaces, and values < 2 mm indicated invasion to the biologic width (20).

All radiographs were obtained in the radiology department of Guilan dental school by a X-ray unit (Minray, Sordex, Finland) with similar exposure settings (kvp:60, mA:6, exposure time:250ms, focal spot:0.7mm) for each patient and using size 2 films (Kodak Carestream, E speed).

Because of its higher spatial resolution and availability, film was used instead of digital radiography. In order to reduce the magnification of the images, the radiographs were taken in the parallel and bite-wing method using a holder. A digital caliper was used to accurately measure the distance from the margin of the restoration to the crest of bone on the radiographs located on the negatoscope. Before starting the study, the digital caliper was calibrated with blocks in specific sizes. Environmental controls (e.g., lighting or temperature) were not applied during measurements.

Measurements were performed on the mesial and distal surfaces of the crowns and on both bridge abutment teeth. For each crown, these measurements were made 2 times, first time by a dentist and in the next step by an experienced radiologist, to avoid any possible errors. Finally, the lowest number was entered into the checklist as the distance between the restoration margin and the bone crest. In order to comply with the ethical principles, the information and measurements of the radiographs of each patient were transferred to the checklist with the patient ID number and without mentioning the name and surname. Also, no additional radiographs were taken from the patients during the study.

Data were analyzed (mean, frequency, percentage, standard deviation, minimum, maximum) and the parametric student t-test was applied to compare the two groups regarding qualitative-quantitative variables with normal distribution while the non-parametric Mann-Whitney test was used for non-normally distributed data. The Chi-square test was used to compare the two groups regarding qualitative variables. Data were analyzed by SPSS version19 and a p-value of less than 0.05 was considered statistically significant.

3. Results

Biologic width of 323 teeth with fixed prosthetic restorations was evaluated in this analytical retrospective-cross-sectional study. Of 323 teeth, 26 (8%) were canine teeth, 67 (20.7%) were first premolars, 92 (28.5%) were second premolars, 103 (32%) were first molars, and 35 (10.8%) were second molars.

Of 323 teeth, 230 (71.2%) were in the maxilla, and 93 (28.8%) were in the mandible. In the present study, invasion to the biologic width was found in 200 teeth (62%) while the biologic width was intact in 123 teeth (38%).

Of 323 teeth, 216 (67%) had single crowns and 107 (33%) were part of a prosthetic bridge. The Chi-square test was applied to assess the practice of dentists in respecting the biologic width, which found no significant association (P>0.05) between jaw type and tooth type (except first molars) (Table

1), and also restoration type (crown or bridge) with biologic width invasion (P>0.05) (Table 2).

Table 1. Frequency of respecting the biologic width according to tooth type and jaw type.

Tooth type		Respecting the biologic width				P value*
		Yes		No		
		Number	Percentage (%)	Number	Percentage (%)	
Canine	Maxilla	6	27	16	73	0.56
	Mandible	0	0	4	100	
First premolar	Maxilla	17	32	36	68	0.12
	Mandible	8	66.6	6	33.4	
Second premolar	Maxilla	17	32	36	68	0.49
	Mandible	8	66.6	6	33.4	
First molar	Maxilla	28	43	36	57	0.001
	Mandible	5	13	34	87	
Second molar	Maxilla	13	52	12	48	0.13
	Mandible	2	20	8	80	
Total		123	38	200	62	

*Chi-square test

Table 2. Frequency of respecting the biologic width according to type of the restoration.

Restoration type	Respecting the biologic width				P value*
	Yes		No		
	Number	Percentage (%)	Number	Percentage (%)	
Crown	80	37	136	63	0.62
Bridge	43	40.2	64	59.8	
Total	123	38	200	62	

*Chi-square test

4. Discussion

The close relationship of periodontal health and tooth restorations is undeniable. A healthy periodontium is imperative for optimal long-term clinical service of restorations and tooth survival. To preserve a healthy periodontium, restorations should be compatible with the adjacent periodontal tissue (20).

Clinically, a distance equal or less than 2 mm between the restoration margin and alveolar bone crest, and presence of inflamed gingival tissue with no evidence of any other etiology may indicate invasion to the biologic width (20). A more common finding following deep subgingival placement of restoration margins is that the alveolar bone surface appears to remain unchanged; however, gingival inflammation progresses and remains. To ensure gingival tissue health, it is imperative to clinically correct the space between the alveolar bone and restoration margin and prevent invasion to the biologic width (20).

The present study assessed the biologic width of 323 teeth with prosthetic restorations. In the current study, violence involving the biologic width was approximately 1.5 times more frequent than non-violence involving the biologic width. Invasion to the biologic width had no significant association with tooth type, restoration type, or jaw. However, these results were in contrast to those of Bruna et al. They evaluated invasion to the biologic width in 122 proximal surfaces (in 13 females and 1 male) using clinical and radiographic (bitewing) techniques. They reported that invasion to the biologic width was most common in first molars. Difference between their results and the present findings may be due to differences in sample size and study populations (21).

Dhelfeson et al. evaluated the association of clinical and radiographic findings in cases with biologic width invasion due to over-extended restoration margins in restored molars and premolars. They assessed over-extended restoration margins of restored premolars and molars in 9 patients (8 males and 1 female) with a mean age of 32 years with biologic width invasion in 21 surfaces using bitewing radiography. They reported the highest frequency of invasion to the biologic width

in second premolars followed by first molars, first premolars, and second molars. In teeth with biologic width invasion, the mesial and distal surfaces were almost equally involved and this rate was lower than in the present study (22).

The present results showed that respecting the biologic width had a higher frequency in the maxilla than mandible; although this difference was not significant. The following reasons may explain this finding:

-Knowledge about the critical role of periodontal health in esthetics and respecting the biologic width

-Lower level of destruction of maxillary teeth and less need for subgingival placement of restoration margins (in other words, the supragingival finish lines were more common in maxillary molars).

-Unequal number of examined teeth in the maxilla and mandible

The results showed that canine teeth had the highest frequency of biologic width invasion. This finding may be attributed to the crestal bone anatomy in the anterior region because in bitewing radiography, proximal tooth surfaces are assessed. Thus, the likelihood of proximity of finish line of restorations to the proximal bone crest would be higher.

Respecting the biologic width from high to low included the following items: second premolar, second molar, first premolar, first molar and canine. Nonetheless, it should be noted that the number of different tooth types in the maxilla and mandible was different in the present study; thus, lack of a significant difference may be attributed to this parameter.

Gluckman et al, in their descriptive cross-sectional study assessed dentogingival dimensions in the anterior maxilla using cone-beam computed tomography. They assessed maxillary anterior teeth (n=138) on radial plane cross-sectional cone-beam computed tomography images of 25 healthy patients (17 females and 8 males) and measured their gingival thickness, and horizontal and vertical bone dimensions related to biologic width. They reported that canine teeth and females had the highest frequency of thin labial bone and thin gingiva (23). No significant association was found between biologic width and gender or tooth type.

The present results showed that respecting the biologic width was slightly more in bridges that crowns but this difference was not significant. Biologically, respecting the biologic width is imperative in both single crown and bridge treatments, and the obtained results in this regard are in agreement with the scientific literature.

Invasion to the biologic width can lead to biofilm accumulation and caries development, and brings about adverse consequences for both the gingiva and marginal bone. Procedural errors by dental clinicians can lead to invasion to the biologic width. Thus, care must be taken not to extend the restoration margins by more than 0.5 mm into the gingival sulcus.

Also, clinicians practicing restorative treatments must be well aware of the fundamental role of biologic width in gingival health and proper gingival contour around a restoration, and pay attention to the location of restoration margin particularly in the esthetic zone where the main goal of treatment is to hide the tooth-restoration margin contact line (20).

Takei et al. believed that since biologic width is constant, if the restoration margin invades the biologic width, crestal bone resorption occurs to reestablish the biologic width. Since bone loss starts approximately 3 weeks after restoration placement (in case of biologic width invasion), restorations cemented over 3 weeks ago were excluded from the present study (20).

Karnik et al. measured the biologic width by three methods of radiography, trans-sulcular probing, and measuring the distance between the bone crest and gingival margin postoperatively. They found no significant difference among the three tested methods, and the measured mean biologic width was 4.4 mm by radiography, 4.6 mm by trans-sulcular probing, and 4.6 mm by measuring the distance between the bone crest and gingival margin postoperatively (14).

In general, conventional bitewing dental radiography is used for assessment of proximal tooth surfaces; it can provide optimal information about the crown margin adaptation, its location, and its relationship with bone. Accordingly, conventional radiographic assessment can provide optimal information as an adjunct to clinical examination to reveal the treatment prognosis (15).

Radiographs can reveal invasion to the biologic width. Nonetheless, they do not have high diagnostic

value in mesiofacial and distofacial angles.

Neelam et al. assessed the relationship of clinical examination and radiographic findings about biologic width in periodontally healthy participants versus chronic periodontitis and aggressive periodontitis patients. Ten participants between 20 to 45 years were selected for each of the three groups, and 21 sites were assessed for invasion to the biologic width. The mean biologic width was compared between chronic periodontitis and aggressive periodontitis patients with the control group. A positive association was found between radiographic parameters of invasion to the biologic width and clinical findings. The results showed that the mean clinical biologic width in the control group was significantly higher than that in the other two groups (16).

Galgali and Gontiya used profile parallel radiography for measurement of dentogingival units and suggested that this radiographic modality may be used to measure the length and thickness of dentogingival units with high accuracy and it is simple, non-invasive, and reproducible (15).

Finally, steps are recommended for dentists to reduce the biological width violency:

1. Diagnose biologic width violations using probing and radiographs.
2. Place margins supragingivally or equigingivally whenever possible.
3. Perform crown lengthening or orthodontic extrusion if needed.
4. Manage tissues carefully during impressions and restorative procedures.
5. Respect biologic width in implant placement and prosthetic design.
6. Customize treatment plans based on patient anatomy.
7. Monitor restorations regularly for signs of periodontal issues.

One of the limitations of this study is the unequal number of teeth based on tooth type and jaw type. For future studies, it is suggested to consider an equal number of teeth to achieve more accurate results. The use of digital radiography and specific software for accurate measurement is recommended. It is also possible to investigate the type of restoration (all ceramic, PFM, etc.) and tooth preparation to see how can effect on the biological width.

5. Conclusion

Considering the biologic width invasion in 62% of the assessed cases and its consequences, the results highlight the need for more accurate instruction of dentists in this regard.

Ethical Considerations

The study was approved by the internal ethical review board of the Guilan University of Medical Sciences (IR.GUMS.REC.1398.399)

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Authors' Contributions

Farzaneh Ostovarrad: Conceptualization, Data curation, funding acquisition, Methodology, Project administration, Resources, Validation **Saba Khorram:** Writing–review and editing **Hadi Ranjzad:** Supervision, visualization **Amirhossein Haddadzadeh:** Writing–original draft, Investigation

Conflict of Interests

The authors declare no conflict of interest

Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request

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