Original

Morphological measurement of biologic width in Chinese people

Guang-yuan Xie, Ji-Hua Chen, Hui Wang and Ying-jie Wang

Department of Prosthodontics, School of Stomatology, Fourth Military Medical University, Xi'an, China

(Received 23 April and accepted 5 June 2007)

Abstract: This study evaluated the biologic width in a Chinese population. Ten autopsy specimens of human jaws from 5 male Han Chinese cadavers were collected. Block sections of the jaws were dissected at autopsy. Six-µm-thick, mesio-distal and bucco-lingual sections were cut and stained with hematoxylin and eosin. The widths of the junctional epithelium and connective tissue were measured with a micrometer microscope at the middle of the mesial, distal, buccal, and lingual sites. Differences in biologic width among the 4 measured sites as well as between anterior and posterior teeth were compared. The mean biologic width was 2.17 mm. The width of the junctional epithelium was 1.07 mm, and that of the connective tissue 1.10 mm. The biologic width varied among the 4 sites and the width of the posterior teeth was greater than that of the anterior teeth. (J. Oral Sci. 49, 197-200, 2007)

Keywords: biologic width; histological measurement; Chinese population.

Introduction

Healthy periodontal tissues are essential for proper esthetics and function of the dentition. Most prosthetic therapies generally require a healthy periodontium for successful treatment outcome. The relationship between the periodontal tissues and restoration is important, especially the location of the restorative margin and response of the gingival tissues to restorative preparations.

The gingiva is attached to the tooth by junctional

Correspondence to Dr. Ji-hua Chen, 145, Changlexi road, Xi'an, 710032, China Tel: +86-29-84776329 Fax: +86-29-84776329 E-mail: jhchen@fmmu.edu.cn epithelium and connective tissue, coronal to the crest of the alveolar bone (1). The junctional epithelium and connective tissue act as a barrier separating deep periodontal tissues from the outside environment. The combined dimension of epithelial attachment and connective tissue attachment has been described as the biologic width. Biologic width is an important concern when considering the restoration of a tooth fractured or destroyed by caries near the alveolar crest level, and crown lengthening may be needed (2). Furthermore, esthetic demands often require subgingival preparation of restorative margins, which can lead to violation of this dimension.

Various reports have suggested minimal distances between restorative margins and the bone crest to avoid deleterious effects (3-5). The base of determining the minimal distance is the data given by Gargiulo et al. (6), which were extensively used to develop a blue-point for clinical application of biologic width. The measurements in Gargiulo's study were averages, and there is a significant range of values for epithelial attachment and connective tissue attachment. Vacek's mean measurements for epithelial attachment and connective tissue attachment were quite different from Gargiulo's (7).

The data of previous studies were based on measurement of Caucasian subjects. No similar reports were available from the Asian population, and no studies have determined the difference in biologic width between different populations either. Therefore, the purpose of the present study was to measure and evaluate the biologic width in a Chinese population.

Materials and Methods

Ten autopsy specimens of human jaws (provided by the Department of Anatomy, Fourth Military Medical University) from 5 male Han Chinese cadavers were used in the present study. The age ranged from 25 to 48 years. All specimens had complete dentition (except the third molar) and no periodontal probing depth exceeded 3 mm. The specimens were fixed in 10% formalin. All jaws were taken at autopsy as block sections to obtain all the component parts of the dentogingival junction. The block sections were demineralized in 0.6 N HCL, dehydrated and embedded, and 6 μ m-thick paraffin sections were prepared. The sections were stained with hematoxylin and eosin.

The measurements were performed in microscopic specimens of the 10 jaws. A total of 280 sites in 140 tooth sections were measured, of which 70 were middle mesial



Fig. 1 Measurement of the junctional epithelium and connective tissue.

WJE: Width of junctional epithelium WCT: Width of connective tissue



The width of the junctional epithelium and the width of the connective tissue were measured to the nearest 0.1 mm at every site with a micrometer microscope (C3, Optical instrument plant 3, Shanghai, China). According to Gargiulo et al. (6), the width of connective tissue was the distance between the deepest point of junctional epithelium and alveolar crest, and the width of junctional epithelium was the distance between the floor of the gingival sulcus and the deepest point of junctional epithelium (Fig. 1).

SPSS10.0 for Windows was employed for analysis of the data.

Results

Figure 1 shows the microscopic observation of the sections. The measurement of the width of junctional epithelium and connective tissue was carried out along the tooth axis between the coronal and apical border points of the junctional epithelium as well as the connective tissue. The border points could be easily identified from their histological characteristics. However, the coronal extent of junctional epithelium was more difficult to identify than the others because the junctional epithelium exfoliated from the tooth surface after demineralization. The coronal extent of junctional epithelium was the



- Fig. 2 Observation of biologic width (\times 20) and local magnified image (\times 200) of the incisor.
 - A: crest of the alveolar bone
 - B: apical border points of junctional epithelium
 - C: demarcation between junctional epithelium and gingival sulcular epithelium

The bar displays a distance of 0.2 mm.



- Fig. 3 Observation of biologic width (×20) and local magnified image (×200) of the premolar.
 - A: crest of the alveolar bone
 - B: apical border points of junctional epithelium
 - C: demarcation between junctional epithelium and gingival sulcular epithelium
 - The bar displays a distance of 0.2 mm.

demarcation between the junctional epithelium and gingival sulcular epithelium, which was judged by differences in the cytology and staining. The junctional epithelium appeared like a non-keratinized cord and the cells were light stained, flat, with 15-20 cell layers parallel to the tooth, and loosely adhered. The gingival sulcular epithelium was keratinized, with dense epithelial tacks, and various cells (8) (Figs. 2, 3).

Table 1 shows the mean widths of junctional epithelium and connective tissue in all of the 280 sections. The mean width of junctional epithelium was 1.07 mm. The mean width of connective tissue was 1.10 mm. The mean value of the biologic width was 2.17 mm.

Table 2 shows the mean values of the measurement at the 4 sites. The junctional epithelium at the lingual site was the narrowest at 0.88 mm. The connective tissue was wider at buccal and lingual sites, 1.13 mm and 1.20 mm, respectively, and narrower at mesial and distal sites. Oneway ANOVA showed significant differences among the 4 sites of junctional attachment, connective attachment and biologic width, respectively (P < 0.001). LSD test revealed that there were no significant differences between the mesial and distal sites in the widths of junctional attachment and connective attachment (P > 0.05). As for the biologic width, significant differences were only available when comparing lingual sites with mesial or distal sites (P < 0.001).

All the sections were divided into 2 groups: the anterior group composed of all incisors and canines and the posterior group composed of all molars and premolars. Table 3 shows the comparison of measurement between these 2 groups. The width of junctional epithelium in the posterior group was 1.13 mm, wider than the anterior group, 0.98 mm. The width of connective tissue in the posterior group was similar to that in the anterior group. Independent-

Table 1 Measurement for all of sections (mean ± SD, mm)

	Mean value of measurement
WJE	1.07 ± 0.18
WCT	1.10 ± 0.13
BW	2.17 ± 0.18

WJE: Width of junctional epithelium, WCT: Width of connective tissue, BW: Biologic width

samples T test showed that there were significant differences in junctional epithelium width and biologic width between anterior and posterior groups (P < 0.001).

Discussion

The biologic width is defined as the dimension of the soft tissue that is attached to the portion of the tooth over the crest of the alveolar bone. The term 'biologic width' was coined by Dr. D. Walter Cohen, based on the work of Gargiulo et al. (6), who observed the dimensions and relationship of the dentogingival junction in humans. Gargiulo et al. (6) indicated that there is a definite proportional relationship among the alveolar crest, the connective tissue attachment, the junctional epithelium attachment, and the sulcus depth. The mean dimensions reported by Gargiulo et al. (6) were as follows: a sulcus depth of 0.69 mm, an epithelial attachment of 0.97 mm, and a connective tissue attachment of 1.07 mm. Based on this data, the biologic width is commonly stated to be 2.04 mm, which represents the sum of the epithelial and connective tissue attachments. However, it must be realized that significant variations of dimensions are observed, particularly in the epithelial attachment. The connective tissue attachment, on the other hand, is relatively constant. Vacek et al. (7) reported correlate biologic width dimensions in 1994, and observed mean measurements of 1.34 mm for sulcus depth, 1.14 mm for epithelial attachment, and 0.77 mm for connective tissue attachment. This report also found that the connective tissue attachment was the most consistent measurement.

It is generally agreed that invasion of restorative margins into the biologic width frequently induces gingival inflammation, leading to bone loss, clinical attachment loss, and replacement of epithelial attachment in a radical direction. This is probably the response of the organism

Table 3 Measurement of anterior and posterior group (mean ± SD, mm)

	anterioor	posterior	T value	P value	
WJE	0.99 ± 0.14	1.12 ± 0.19	-6.419	.000	
WCT	1.11 ± 0.12	1.10 ± 0.14	0.527	0.598	
BW	2.10 ± 0.16	2.22 ± 0.18	-5.777	.000	
					_

WJE: Width of junctional epithelium, WCT: Width of connective tissue, BW: Biologic width

Table 2 Measurement at 4 sites (mean ± SD, mm)

	vestibular	lingual	mesial	distal	F value	P value
WJE	1.03 ± 0.13	$\textbf{0.88} \pm \textbf{0.09}$	1.20 ± 0.16	1.16 ± 0.16	92.023	.000
WCT	1.13 ± 0.13	1.21 ± 0.12	1.02 ± 0.10	1.05 ± 0.09	40.148	.000
BW	$\textbf{2.16} \pm \textbf{0.21}$	2.08 ± 0.16	2.22 ± 0.17	2.21 ± 0.16	8.320	.000

WJE: Width of junctional epithelium, WCT: Width of connective tissue, BW: Biologic width

to reconstruct the biologic width by osseous resorption, which leads to chronic inflammation (9).

In the present study, the average measurements were: junctional epithelium 1.07 mm, connective tissue 1.10 mm, and biologic width 2.17 mm. The value of biologic width was slightly greater than that reported by Gargiulo et al. (6) and Vacek et al. (7). This difference could be due to the small number of samples in the present study, or the variation between populations.

The analysis of the widths of junctional epithelium and connective tissue in the 4 sites revealed that there was a variation among the sites. Consequently, difference of width of biologic width was also displayed. This indicates that the biologic width at different tooth surfaces was variable. This result was consistent with the findings reported by Gargiulo et al. (6) and Vacek et al. (7).

Additionally, there was a difference in biologic width between anterior and posterior teeth. This indicates that more tissue would have to be removed during crown lengthening treatment. The variation was mainly explained by the difference in the width of junctional epithelium. It was thus reconfirmed that the width of the connective tissue attachment was relatively constant compared to that of the epithelial attachment.

Müller et al. proposed that the biological width might in fact depend on and be an expression of the periodontal phenotype (10). In subjects with a thin and delicate gingival phenotype, the biological width might be less than mean values reported by Gargiulo et al. (6), and vice versa. Furthermore, the tooth character has been shown to vary in different racial groups (11), but few reports of variation of periodontal tissue between different races were available. As a periodontal feature, the biologic width of Chinese people might vary from Caucasians. Factors that may influence the biologic width such as periodontal phenotype, genetic and racial factors need to be further investigated.

References

1. Litigate MA (1972) Normal development, structure,

physiology and repair of gingival epithelium. Oral Sci Rev 1, 3-67

- Yeh S, Andreana S (2004) Crown lengthening: basic principles, indications, techniques and clinical case reports. N Y State Dent J 70, 30-36
- Ingber JS, Rose LF, Coslet JG (1977) The "biologic width" – a concept in periodontics and restorative dentistry. Alpha Omegan 70, 62-65
- Maynard JG Jr, Wilson RDK (1979) Physiologic dimensions of the periodontium significant to the restorative dentist. J Periodontol 50, 170-174
- 5. Nevins M, Skurow HM (1984) The intracrevicular restorative margin, the biologic width, and the maintenance of the gingival margin. Int J Periodontics Restorative Dent 4, 30-49
- 6. Gargiulo AW, Wentz FM, Orban B (1961) Dimensions and relations of the dentogingival junction in humans. J Periodontol 32, 261-267
- Vacek JS, Gher ME, Assad DA, Richardson AC, Giambarresi LI (1994) The dimensions of the human dentogingival junction. Int J Periodontics Restorative Dent 14, 154-165
- Jiang Q, Li DY (2004) Comparative study on the histomorphology of the JE of human and several laboratory animals. Shanghai Kou Qiang Yi Xue 13, 539-543 (in Chinese)
- Oakley E, Rhyu IC, Karatzas S, Gandini-Santiago L, Nevins M, Caton J (1999) Formation of the biologic width following crown lengthening in nonhuman primates. Int J Periodontics Restorative Dent 19, 529-541
- Müller HP, Heinecke A, Schaller N, Eger T (2000) Masticatory mucosa in subjects with different periodontal phenotypes. J Clin Periodontol 27, 621-626
- Lavelle CLB (1972) Maxillary and mandibular tooth size in different racial groups and in different occlusal categories. Am J Orthod 61, 29-37