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Research Article

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Average Distance between the Gingival Margin and the Cemento-enamel Junction

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ABSTRACT

to the cemento-enamel junction (CEJ). This pilot study was conducted to record and compare the position of the gingival margin relative to the CEJ before and after flap elevation.
Methods: In total, 27 patients who were referred for surgical crown lengthening were included. Gingival margin location relative to the CEJ was recorded on sound teeth mesial and distal to the tooth that required crown lengthening. A single calibrated examiner conducted all the examinations using a UNC-15 probe and a custom-made stent. Data were analyzed by paired t-test, independent t-test and personal correlation.
Results: The mean age (± standard deviation) of the study sample was 25 (±8) years. The mean values for GM-CEJ distance before (closed) and after (open) flap reflection were 1.32 (±0.64) mm and 1.34 (±0.62) mm, respectively. The difference between the open and closed measurements was not statistically significant ($p>0.05$). The GM-CEJ distance was negatively associated with age ($r=-0.44$, $p<0.001$). Females had a significantly greater mean GM-CEJ distance than did males ($p<0.001$).
Conclusion: Within the limitations of this study, no differences were found in the GM-CEJ distance measurements obtained by the open and closed methods.

Key words:*Cemento-enamel junction, Clinical attachment level, Closed measurements, Gingival margin, Open measurements, Stent*

INTRODUCTION

The positions of the gingival margin and the cemento-enamel junction (CEJ) are important parameters during the initial periodontal examination and throughout periodontal therapy as well as maintenance visits. The location of the CEJ, which is a static landmark, serves as an important anatomical site for the measurement of probing depth (PD) and clinical attachment level (CAL) [1]. Similarly, the gingival margin position (GMP) plays a vital role in periodontal therapy, particularly in esthetic/plastic surgery procedures [2]. Further, the continuation of restorative and prosthetic work depends on the final location and the stabilization of the marginal gingiva in those individuals who underwent periodontal surgeries [3].

Standard periodontal probing to detect the CEJ position is considered difficult due to the variable nature of the anatomy of the CEJ, differing with different tooth types and surfaces, as well as to its subgingival location, leading to inaccurate recordings [1]. Moreover, many studies have reported possible sources of errors associated with the

use of conventional probing techniques [4, 5]. Hence, different modified probes have been invented to minimize errors with regard to traditional probes. These modified probes are combined with controlled force application, automated measurement and computerized data collection and provide a means for recording attachment changes over time [6-9]. However, some of these modern probes suffer from limitations, including a lack of tactile sensitivity, mainly because of their independent movement, which forces the operator to predetermine an insertion point and angle [9]. Because of the need for more precise information for the diagnosis and earlier detection of periodontal disease, accurate measuring tools with a higher level of control of variables were required [10]. Hence, several studies used the stent method along with periodontal probing and investigated its reliability in the recording of different periodontal parameters [4, 11-14]. The stent eliminated the particular issue associated with the change in probe direction [9].

To the best of our knowledge, there have been no studies using a stent for comparison of the position of the gingival margin relative to the CEJ before and after flap elevation. The prime objective of this study, therefore, was to measure the average distance between the gingival margin and the CEJ with and without flap elevation by means of a periodontal probe and a stent, to ascertain the number of times the closed CEJ measurements were under-, over- or equally estimated compared with the open CEJ measurements.

MATERIALS AND METHODS

This study was conducted at the Department of Periodontics at IbnSina National College for Medical Studies and was approved by the Institutional Ethics Committee. Included in the study were subjects of both genders, aged 17 years and older, who had been referred for surgical crown lengthening with the prerequisite presence of sound and intact teeth mesial and distal to the tooth that required lengthening. The exclusion group consisted of patients aged under 16 years and with a history of known systemic disease, rotated teeth and teeth with crowns, deep restorations, gingival recession, gingival enlargement or mobility. In total, there were 27 patients, 14 males and 13 females. Sixty-eight teeth were included, and 392 sites were measured.

Gingival margin location relative to the CEJ was recorded on sound teeth mesial and distal to the tooth that required crown lengthening. A single examiner conducted all measurements using a UNC-15 probe (Hu-Friedy) and a custom-made stent. The stent was made with condensation silicone putty impression material. It was of a uniform thickness, fully covering the tooth surfaces. Vertical grooves were made on the stent by means of a straight fissure carbide bur no. 837 and an air-rotary, contra-angle high-speed handpiece, to guide the UNC-15 probe at the selected sites. For each tooth, mesiobuccal, midbuccal and distobuccal sites and three corresponding lingual/palatal sites were measured. The free gingival margin was marked on the stent as a fixed reference point (FRP), and the CEJ recordings relative to the FRP were taken by placement of the UNC-15 probe in the grooves made on the stent, before (Closed CEJ) and after (Open CEJ) flap reflection (Fig-1, Fig-2).

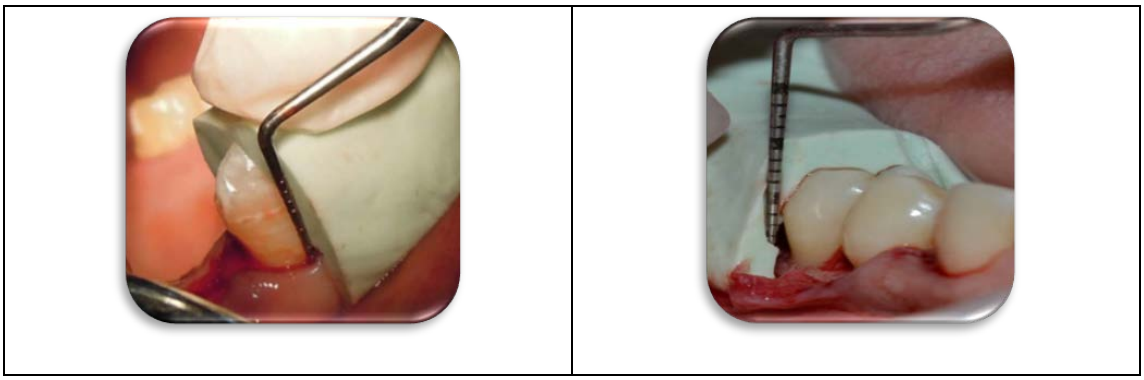

Fig-1: A UNC-15 probe and customized stent were used for measurements taken before and after flap elevation.

Fig-2: The probe was guided through the vertical grooves made on the stent.

One experienced examiner performed all measurements. A periodontal instructor calibrated the periodontal evaluation for validity of the periodontal measurements. Calibration exercises occurred prior to the start of the study. No data from the training exercises were collected or analyzed. Statistical analysis was conducted with SPSS statistical software for Windows (version 21, SPSS Inc., Chicago, IL). Data were analyzed by paired t-test, independent t-test and personal correlation.

RESULTS

The mean age and the standard deviation values of those in the study sample were 25 (±8) years. The GM-CEJ distance was negatively associated with age; the correlation coefficient was equal to -0.44. The mean GM-CEJ distances before (closed) and after (open) flap reflection were 1.31 (±0.62) mm and 1.28 (±0.60) mm, respectively. The results showed no statistically significant difference ($p>0.05$) between the open and closed measurements (Table 1). However, when the sample was stratified by gender, there was a statistically significant difference ($p<0.001$) between open and closed measurements in both groups (Tables 2 and 3). Furthermore, females had significantly greater mean values for CEJ-GM distance in both open and closed approaches.

Table 1: Comparison of CEJ-GM distance means and the standard deviation values between open and closed approaches.

Sites	Open method	Closed method	p-value
Distobuccal	1.56 (0.39)	1.57 (0.45)	0.837
Distopalatal	1.61 (0.45)	1.67 (0.49)	0.278
Mesiobuccal	1.58 (0.38)	1.58 (0.46)	0.837
Mesiopalatal	1.61 (0.39)	1.64 (0.43)	0.301
Midbuccal	0.71 (0.53)	0.71 (0.51)	0.798
Midpalatal	0.71 (0.43)	0.74 (0.42)	0.199
Total sites	1.28 (0.60)	1.31 (0.62)	0.128

Table 2: Comparison of CEJ-GM distance means and the standard deviation values between open and closed approaches in females.

Sites	Open method	Closed method	p-value
Distobuccal	1.67 (0.36)	1.72 (0.40)	0.254
Distopalatal	1.73 (0.42)	1.83 (0.46)	0.165
Mesiobuccal	1.71 (0.32)	1.74 (0.41)	0.600
Mesiopalatal	1.68 (0.36)	1.78 (0.39)	0.070
Midbuccal	0.87 (0.54)	0.88 (0.49)	0.767
Midpalatal	0.75 (0.46)	0.78 (0.46)	0.534
Total sites	1.39 (0.59)	1.44 (0.62)	0.001

Table 3: Comparison of CEJ-GM distance means and the standard deviation values between open and closed approaches in males.

Sites	Open method	Closed method	p-value
Distobuccal	1.43 (0.40)	1.37 (0.44)	0.375
Distopalatal	1.46 (0.44)	1.46 (0.45)	1.001
Mesiobuccal	1.43 (0.40)	1.37 (0.44)	0.326
Mesiopalatal	1.52 (0.42)	1.48 (0.083)	0.490
Midbuccal	0.50 (0.083)	0.50 (0.43)	1.001
Midpalatal	0.65 (0.40)	0.70 (0.36)	0.184
Total sites	1.15 (0.60)	1.14 (0.58)	0.001

DISCUSSION

The aims of this study were to record the position of the gingival margin (GM) relative to the CEJ by means of a UNC-15 probe along with a customized stent and to compare the reproducibility of the measurements of GM-CEJ distance before and after flap elevation. The results showed no significant difference between closed and open measurements of GM-CEJ distance; however, female participants in this study demonstrated significantly higher mean values in the GM-CEJ distance than did males.

Numerous studies have evaluated the position of the gingival margin, before and after periodontal therapy, by the use of a periodontal probe alone [15] or with the aid of a stent [3, 16, 17]. Hughes and Caffesse located the position of the gingival margin relative to the CEJ as a fixed reference point following scaling [16]; however, other studies used a specific point on the stent to locate the gingival margin [3] — for example, in studies by Vandana and Gupta, the lower end of the stent was used as a fixed reference point [17, 18]. In the present study, the free gingival margin was marked on the stent and used as the fixed reference point for measurement of the distance to the CEJ. Also, measurements were taken before any periodontal therapy was attempted. Only one study conducted measurements

before and after flap elevation, but these were taken to locate the CEJ [18]. Hence, no study in the periodontal literature addressed the GM-CEJ distance before and after flap elevation. As a result, no study was found with which the results of the present study could be compared.

The custom-made stent has been utilized by many studies in comparison with other methods to reproduce probing depths, calculate CAL or locate the CEJ or the GM position [4, 11-14]. The stent method has been proven to be highly accurate, and measurements done without a stent are less reproducible and subject to enormous variations [4, 11, 12, 18]. Periodontal probing by means of a conventional probe, which is dependent on visual inspection and tactile sensation, is deemed poor for reproducing the CEJ position due to visual and tactile errors as a result of the lack of clear landmarks or difficulty in identifying those that do exist [4, 12]. The presence of calculus, existing overhanging restoration or the crown's contour contributes to reading errors [5]. Operator-induced errors that affect consistency when measurements are taken may include incorrect angulation of the probe, the amount of pressure applied to the probe, misreading the measurement on the probe and recording the data imprecisely [5]. To minimize the occurrence of errors in the present study, a well-calibrated UNC-15 periodontal probe along with a custom-made stent was used for all measurements taken at baseline before and after reflection of the periodontal flap. The customized stent was used to guide the probe through the vertical grooves created on the stent, thus standardizing the angulation of the probe and point of probe penetration. Also, strict criteria were set for tooth selection: teeth should be sound, and all tooth surfaces should be intact and devoid of any restorative or prosthetic work.

Concerning the pressure applied during probing (although in the present study one examiner conducted all measurements, and variations in probing force appeared to be evident not only between different examiners but also within a single examiner [6]), previous studies have demonstrated that probing force was not a primary cause for variation in probing depth measurements [19, 20].

Another factor to be considered is the type of tooth and the type of tooth surface being examined. AlvesRde et al. selected only anterior teeth [7], and Osborn et al. evaluated only the proximal surfaces of posterior teeth [8], whereas Gupta et al. used only mandibular first molars [9]. Differences in probing measurements have been reported between anterior and posterior areas due to better access and visibility of the anterior areas [10]. In the present study, both anterior and posterior teeth were included, and each tooth was evaluated at six sites. Hence, different results may be obtained with specific groups of teeth or selected surfaces.

Degree of inflammation in the periodontal tissues is another factor that may influence the accuracy of measurement recording [21]. Probing a healthy periodontium with a shallow sulcus has contributed to high reproducibility [22, 23]. Conversely, reproducibility of probing depth has been reported to be lower in deep pockets in patients with untreated periodontitis, despite the use of a stent [4]. Moreover, it has been reported that consistency in recorded data can be influenced by the presence of bleeding and inflammation [13]. In our study, subjects were periodontally healthy with a probing depth that did not exceed 4 mm. However, different findings could arise as a result of differences in the severity of the periodontal condition.

LIMITATION

It is recommended that further studies evaluate the GM-CEJ distance using other probing methods with different fixed reference points, accounting for different variables that may affect the accuracy of the measurements.

CONCLUSION

Based on the results of this study, the measurements for GM-CEJ distance taken before flap reflection were comparable with those taken after flap reflection.

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