Original Article

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Comparison between Measurements of Clinical Attachment Level and Transgingival Probing with Alveolar Bone Crest Level in Chronic Periodontitis Patients

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Abstract

Background: Periodontitis is an inflammatory disease of the supporting tissues of the teeth that leads to crucial changes in the bony architecture. Early detection is of great practical significance so that treatment may be administered before irreversible destruction could occur. Differences exist between different diagnostic methodology concerning the relationship between the measurements and the level of the lesion. The aim of this study was to assess relationship between clinical attachment level (CAL) and alveolar bone crest level (ABCL), reliability of transgingival bone probing level (TBL) for ABCL measurement, and clinical biologic width (CBW) measurement in chronic periodontitis patients.

Methods: An analytical cross-sectional study was conducted on 238 periodontal sites in 25 chronic periodontitis patients, aged 20–60 years who were planned for periodontal flap on residual pocket depth of 5-8 mm after four weeks of non-surgical therapy. Stent was used for coronal fixed reference point. The relative attachment level (RAL), relative transgingival bone probing level (RTBL), relative alveolar bone crest level (RABCL), and CBW were measured at six sites per tooth excluding third molars. Descriptive and inferential statistical analysis was done. Probability of significance (p-value) was set at 5%.

Results: Overall RAL, RTBL and RABCL (mean ± SD) were 8.08 ± 1.23, 10.82 ± 1.1, and 11.15 ± 1.36 mm respectively. Overall CBW (mean ± SD) was 3.06 ± 0.634 mm.

Conclusions: There was a significant positive correlation of CAL and TBL with ABCL. Also, the CBW was greater than that of standard histologic BW.

Keywords: Alveolar bone crest; Clinical attachment level; Periodontitis, Chronic.

Declarations

Ethics approval and consent to participate: Ethical approval obtained from the Institutional Review Committee, B.P. Koirala Institute of Health Sciences (Ref, No:280/077/078-IRC). Written informed consent was taken from all the participants.

Consent for publication: Not applicable

Availability of data and materials: The datasets used and/ or analyzed during the current study are available from the corresponding author on reasonable request. All relevant data are within the manuscript.

Competing interest: None

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Over the years, different parameters have been used for assessing the quantity of periodontal destruction in the individual or in group of individuals [1]. The primary methods used for evaluation include histology, periodontal probing, radiographic analysis and direct measurement of bone [2]. Differences exist between the diagnostic methodologies concerning the relationship between the measurements and the level of the lesion [1]. Periodontal diagnosis and monitoring rely upon clinical parameters to a large extent which is of great significance so that treatment may be administered before irreversible destruction has occurred or further destruction can be arrested [3]. The Clinical attachment level (CAL) and transgingival bone probing level (TBL) are non-invasive and semi-invasive methods respectively for detecting periodontal disease activity at a specified site by means of clinical measurements.

The studies by Greenberg et al., Kim et al., Zanatta et al. and Savitha et al. have found bone probing depth measurement is a kind of reliable method to estimate the bone level [4-7]. Similarly, Michalowicz et al., Hafez et al., Christiaens et al. and Farook et al. had found CAL can be used as an indicator for ABCL measurement [1, 8–10]. The studies on biologic width by Parashar et al., Hamasani et al. and Abullais et al. showed CBW varies even in same individual [11–13].

The aim of this study was to evaluate the relationship between clinical diagnostic methods like CAL and TBL with surgical method for actual alveolar bone crest level (ABCL) measurement; and clinical biologic width (CBW) in chronic periodontitis patients in Nepal which will work as a baseline data for the further research and also aid in the diagnosis, prognosis, and treatment plan of periodontal disease.

METHODS

An analytical cross-sectional study was conducted in patients with chronic periodontitis visiting Department of Periodontology and Oral Implantology, CODS, BPKIHS, Dharan, Nepal after obtaining approval from Institutional Review Committee. The study was conducted from March 2021 to December 2021. The duration of the study was nine months. Sample size was calculated based on the study by Ursell et al [14]. Mean ± SD of measurements of probing depth and surgical bone level (SBL) had been reported as (7.78 ± 3.50) mm and (9.55 ± 4.26) mm, respectively. The difference of mean of molar in between probing depth and SBL was 1.77 mm and pooled SD was 3.88 mm i.e. mean difference (d) = 1.77 mm, standard deviation (σ) = 3.88 mm. Considering 99% power and 95% confidence interval, the sample size was estimated by using the formulae, $n = [2(Z_\alpha+Z_\beta)^2\ \sigma\ 2]/d^2$, where, Z_α at 5% power = 1.96, Z_β at 99% power = 2.58. A sample size of 198.08 was calculated. Adding 20% for non response, the final sample size was 238 periodontal sites.

Patients with residual pocket depth of 5-8 mm after non-surgical periodontal therapy were included in the study after taking their consent. Convenience sampling method was used to enroll patients among which periodontal flap was performed. Patient taking any drug or having any systemic condition that could interfere with periodontal status; teeth with class 2 and 3 mobility as per Miller's classification; and with inadequate endodontic treatment/ restorations were excluded from the study.

The clinical periodontal examination was carried out manually using plane mouth mirror and University of North Carolina-15 probe (UNC-15 probe). It was 15 mm long probe with markings at each mm and color coding at 5th, 10th and 15th mm. Customized acrylic stent was used for fixed reference point (FRP). For stent fabrication, stone models of the area to be studied were made from alginate impression, and onlay type of stent was fabricated using auto curing acrylic resin. The stent was trimmed flat at the lower margin (which was at the cervical third of the tooth) with vertical locating grooves made with bur for proper guidance and orientation of the periodontal probe. All the measurements were taken by the same author.

Relative attachment level (RAL) which is the distance from the FRP to the base of the periodontal pocket was recorded **(Fig.1)**. Following the measurement of RAL, local anesthesia was administered and then, from FRP, the deepest depth at which the probe met resistance by contact to the bone was recorded as the relative transgingival bone probing level (R-TBL) **(Fig.2)**. For the actual ABCL, the flap was elevated and debrided. The distance from the FRP to the bone was measured and was termed as relative alveolar bone crest level (R-ABCL) **(Fig.3)**. For measurement of CBW, RAL was subtracted from the R-ABCL. The RAL, R-TBL and R-ABCL were measured at all six periodontal sites of the tooth.

Figure 1: Relative attachment level of 9 mm

Figure 2: Relative Transgingival bone probing level of 11 mm

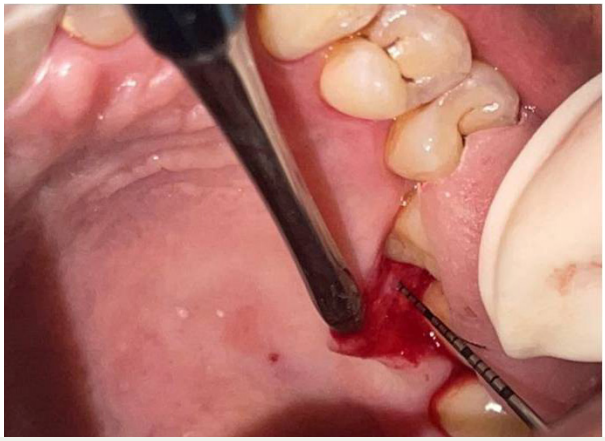

Figure 3: Relative alveolar bone crest level of 11 mm

Collected data were entered into Statistical Package for Social Science (SPSS, version 11.5) for statistical analysis. Frequency, percentage, mean, and standard deviation (SD) were calculated for descriptive statistics. Paired t-test and Wilcoxon sign rank test were used for paired data. Spearman correlation coefficient (σ) was calculated to see the association of CAL and TBL with ABCL. Simple linear regression analysis was used to predict ABCL on the basis of CAL and TBL. Probability of significance (p-value) was set at 5% level.

RESULTS

Periodontal flap were carried out on 238 periodontal sites in 25 chronic periodontitis patients aged 20-60 years. The overall RAL, RTBL, and RABCL (mean ± SD)were 8.08 ± 1.23 mm, 10.82 ± 1.1 mm, and 11.15 ± 1.36 mm, respectively. There was statistically significant difference in the mean measurements of RABCL and RAL; and RABCL and RTBL **(Table 1)**.

There was statistically significant positive correlation between RABCL and RAL (r = 0.858; σ = 0.883; p<0.001); RABCL and RTBL (r = 0.930; σ = 0.948; p< 0.001); and RAL and RTBL (r = 0.798; σ= 0.798; p<0.001). Simple linear regression model to predict RABCL from RAL (R^2 = 0.78); and RABCL from RTBL (R^2 = 0.9) has been shown in **Table 2**. The equation for predicting RABCL from RAL and RTBL is given below;

RABCL = 0.9822 x RAL + 3.2112
RABCL = 1.1678 x RTBL - 1.4886
The overall mean of CBW observed in this study was 3.06 ± 0.63 mm.

DISCUSSION

Periodontitis exhibits a site-specific clinical picture where attachment and bone loss are not equally distributed throughout the dentition as well as around individual tooth [15]. The CAL reflects the periodontal destruction more precisely which is measured using periodontal probes as the distance from the CEJ to the base of the pocket [16]. The CEJ acts as a static landmark to measure CAL. However, there are several problems in CEJ identification that have led to provision of stent for coronal FRP so that it would be easily accessible and visible. Stent is a customized accessory tool used in recording clinical parameters to minimize intra and inter-examiner variability, over and underestimation of

Table 1: Comparison of different periodontal measurements

		Paired difference		t statistics	p-value*
		Mean ± SD	95% CI		
RABCL	RAL	3.07 ± 0.64	2.99 – 3.15	73.99	<0.001
	RTBL	0.33 ± 0.47	0.268 – 0.388	10.75	<0.001

*Wilcoxon Signed Rank Test; Level of significance is set at 95%

Table 2: Simple linear regression models for predicting RABCL

	R^2	Intercept	B coefficient	95% CI (lower-upper)	p-value
RAL	0.780	3.211	0.9822	0.915 – 1.049	<0.001
RTBL	0.900	-1.489	1.1678	1.118 – 1.218	<0.001

Level of significance is set at 95%

measurements [17].

The present study showed that there was statistically significant positive correlation between RABCL and RAL (σ = 0.883). Papapanou and Wennstrom found a strong positive correlation between the CAL and ABCL (r = 0.8, p <0.001)[18]. They also revealed that there was no difference between the two variables irrespective of the tooth type and tooth surface but the correlation was poor at sites with severe periodontal tissue breakdown. Similarly, moderate positive correlation between CAL and ABCL was reported by Farook et al. (r = 0.5), Zhang et al. (r = 0.55) and Machtei et al. (r = 0.73) [1, 19, 20]. However, these studies used CEJ as a FRP which is not predictable at times and also, they have compared the CAL with radiographic ABCL. In contrast, the present study used customized stent for FRP and also the CAL has been compared with ABCL at surgery. In a comparative study, Petersen and Baehni found that the correlation between CAL and TBL or CAL and ABCL when measured at surgery was positive (r = 0.81 and 0.75, respectively). Consistent with the study by Petersen and Baehni,the present study also revealed a positive correlation between RABCL and RAL (σ = 0.883). Similarly, statistically significant positive correlation was also observed in RABCL and RTBL (σ = 0.948) [21].

Ursell et al. investigated the relationship between ABCL obtained by transgingival probing and at surgery. The result showed a mean difference of 0.12 mm which was not statistically significant and a higher degree of correlation (r=0.98) when all 178 sites were considered. In accordance to the study by Ursell et al., the present study showed similar correlation (r=0.9) between RABCL and RTBL. However, the mean difference between RABCL and RTBL was 0.3 mm which was higher than study by Ursell et al [14]. These results are also in agreement with the previous studies done by Greenberg et al. who compared TBL with ABCL measured at the time of surgery and found close agreement between the two methods of measurements. In contrast to study by Greenberg et al. in which they had included only the buccal surfaces of easily accessible tooth, the present study recruited both buccal and lingual surfaces [4]. Renvert et al. found a mean difference of 0.3 mm when TBL was compared with ABCL at surgery, and a correlation of 0.81. In contrast to study by Renvert et al. who included 62 sites only, the present study included more number of sites (238) and also higher correlation was seen (0.9) between the two methods [22].

The secondary objective of the present study was to find the average CBW in chronic periodontitis patients and to compare it with the standard histological finding by Gargiulo et al. (2.04 mm) [23]. Several data exist with regards to the ideal dimensions of BW, leading to difficulties for its clinical recommendations **(Table 3)**.

Table 3: Average biologic width advocated by various authors RABCL

Authors	Minimum requirement (mm)
Novak et al. 2008 [25]	3.95
Weinberg and Eskow 2000 [27]	3.5 to 4
Vacek et al. 1994 [26]	1.91
Wagenberg et al. 1989 [28]	5 to 5.25
Nevins & Skurow 1984 [29]	3.0
Rosenberg and colleagues 1980 [30]	3.5 to 4
Palomo and Kopczyk 1978 [31]	1
Ingber et al. 1977 [32]	3 mm

However, mean values of the BW obtained from two meta-analyses ranged from 2.15 to 2.30 mm with large intra- and inter-individual variances (subject sample range: 0.2 – 6.73 mm). This variation in BW is affected by tooth type and site, the presence of a restoration and periodontal diseases/ surgery [24]. So it is obvious that no universal dimension of the BW appears to exist and so each individual site/sites has to be assessed separately.

In the present study, the average CBW was 3.06 ± 0.634 mm, which is greater than that of Gargiulo. This may be because: (a) in the original study by Gargiulo et al. (frequently referenced for BW), measurements were taken on autopsy jaws, [23](b) dimensions of the BW seem to differ with respect to periodontal health and in patients with untreated chronic periodontitis, [25] (c) periodontal disease progression has an inverse correlation with dimensions of the BW [13]. The progression of periodontal disease causes reduction in BW which is regained to its original dimension after periodontal therapy. It takes around three months for the shallow pockets to regain the original dimension when treated by scaling and root planing, whereas moderate pockets regain it after six months when treated with periodontal flap, (d) due to gain in CAL or formation of long JE or, both, (e) BW in Nepalese population may be different.

Novak et al. who included only accessible proximal sites, found the mean CBW to be 3.95 mm in severe, generalized, chronic periodontitis. In contrast to study by Novak et al., the present study found a slight smaller dimension of CBW (3.06 ± 0.634mm) [25]. The present study observed a higher CBW than that of Hamasani who reported the mean CBW of 1.13 ± 0.28 mm [12]. This smaller CBW was explained based on soft tissue penetration of the probe tip during probing depth measurements and also only four sites per tooth were taken into consideration [26]. However, in the present study six periodontal sites were included.

The limitations of the study include periodontal parameter when measured with stent placement is not the true reflection of the disease condition, and use of manual

periodontal probe for measurements. The use of manual periodontal probe has no control for probing force and the tip of the probe might have passed beyond the base of the pocket as it is dependent on patient discomfort, degree of inflammation, probe tip thickness, and root anatomy, particularly in furcation areas. This was also responsible for errors during visualizing the readings and an assistant was needed to transfer the readings due unavailability of automatic data collection.

This study recommend the CAL measurement when performed with the CEJ as a fixed reference point instead of margin of stent (at the cervical third of the tooth) would reflect the actual condition of disease as position of CEJ is not altered and is constant throughout the life span.

CONCLUSION

CAL had positive relationship with the ABCL i.e., the more the CAL, the more apical would be the ABCL. The amount of bone level when measured through transgingival probing almost completely coincides with the actual ABCL when measured at surgery, thus, TBL can be used as a reliable method for revealing the complete picture of bone level and bony topography. The CBW dimension was 3.06 ± 0.634 mm, which is greater than that of standard histologic BW.

References

1. Farook FF, Alodwene H, Alharbi R, Alyami M, Alshahrani A, Almohammadi D, et al. Reliability assessment between clinical attachment loss and alveolar bone level in dental radiographs. Clin Exp Dent Res. 2020;6(6):596–601. DOI: 10.1002/cre2.324
2. Glavind L, Loe H. Errors in the clinical assessment of periodontal destruction. J Periodontal Res. 1967;2(3):180–4. DOI: 10.1111/j.1600-0765.1967.tb01887.x
3. Goodson JM, Tanner AC, Haffajee AD, Sornberger GC, Socransky SS. Patterns of progression and regression of advanced destructive periodontal disease. J Clin Periodontol. 1982;9(6):472–81. DOI: 10.1111/j.1600-051x.1982.tb02108.x
4. Greenberg J. Transgingival probing as a potential estimator of alveolar bone level. J Periodontol. 1976;47(9):514–7. DOI: 10.1902/jop.1976.47.9.514
5. Kim HY, Yi SW, Choi SH, Kim CK. Bone probing measurement as a reliable evaluation of the bone level in periodontal defects. J Periodontol. 2000;71(5):729–35. DOI: 10.1902/jop.2000.71.5.729
6. Zanatta FB, Giacomelli BR, Dotto PP, Fontanella VR, Rosing CK. Comparison of different methods involved in the planning of clinical crown lengthening surgery. Braz Oral Res. 2010;24(4):443–8. DOI: 10.1590/s1806-83242010000400012
7. Savitha B, Vhanmane P, Bagde H, Waghmare A. Bone levels - from hypothesis to facts. IOSR J Dent Med Sci. 2013;6(5):19–23. DOI: 10.9790/0853-0651923
8. Michalowicz BS, Hodges JS, Pihlstrom BL. Is change in probing depth a reliable predictor of change in clinical attachment loss? J Am Dent Assoc. 2013;144(2):171–8. DOI: 10.14219/jada.archive.2013.0096
9. Diab H, Shafik S, Yousef RA, AlHudaithi F, Baslaib D, Alzaben A, et al. Evaluating the variations in between clinical attachment and bone loss : a statistical perspective. Egyptian Dental Journal. 2017;63(3):8.
10. Christiaens V, De Bruyn H, Thevissen E, Koole S, Dierens M, Cosyn J. Assessment of periodontal bone level revisited: a controlled study on the diagnostic accuracy of clinical evaluation methods and intra-oral radiography. Clin Oral Investig. 2018;22(1):425–31. DOI: 10.1007/s00784-017-2129-8
11. Parashar A, Zingade A, Sanikop S, Gupta S, Parasher S. Biological width: The silent zone. Int Dent J Stud Res. 2015;2(4):11–6.
12. Hamasni FM, El Hajj F. Comparison of the clinical biological width with the published standard histologic mean values. J Int Soc Prev Community Dent. 2017;7(5):264-71. DOI: 10.4103/jispcd.JISPCD_261_17
13. Abullais S, Anoop G, Dani N, Al-qahatani S, Yaqoob A, Khan A, et al. Assessment of supracrestal tissue attachment variation in patients with chronic periodontitis before and after treatment: A clinical-radiographic study. Vojnosanit Pregl. 2020;77(11):1175–83. DOI: 10.2298/VSP181118007A
14. Ursell MJ. Relationships between alveolar bone levels measured at surgery, estimated by transgingival probing and clinical attachment level measurements. J Clin Periodontol. 1989;16(2):81–6. DOI: 10.1111/j.1600-051x.1989.tb01618.x
15. Newman GM, Takei HH, Klokkevold RP. Newman and Carranza's Clinical Periodontology. 13th ed. Elsevier; 2018:62.
16. Vandana KL, Gupta I. The location of cemento enamel junction for CAL measurement: A clinical crisis. J Indian Soc Periodontol. 2009;13(1):12. DOI: 10.4103/0972-124X.51888
17. Singh S, Vandana KL. Stent as an accessory tool in periodontal measurements: An insight. J Indian Soc Periodontol. 2019;23(1):81-4. DOI: 10.4103/jisp.jisp_331_18.
18. Papapanou PN, Wennstrom JL. Radiographic and clinical assessments of destructive periodontal disease. J Clin Periodontol. 1989;16(9):609–12. DOI: 10.1111/j.1600-051x.1989.tb02146.x
19. Zhang W, Rajani S, Wang BY. Comparison of periodontal evaluation by cone-beam computed tomography, and clinical and intraoral radiographic examinations. Oral Radiol. 2018;34:208-18. DOI: 10.1007/s11282-017-0298-4
20. Machtei EE, Hausmann E, Grossi SG, Dunford R, Genco RJ. The relationship between radiographic and clinical changes in the periodontium. J Periodontal Res. 1997;32(8):661–6. DOI: 10.1111/j.1600-0765.1997.tb00576.x
21. Kandelman D, Arpin S, Baez RJ, Baehni PC, Petersen PE. Oral health care systems in developing and developed countries: Oral health care systems. Periodontol. 2000. 2012;60(1):98–109. DOI: 10.1111/j.1600-0757.2011.00427.x
22. Renvert S, Egelberg J. Healing after treatment of periodontal intraosseous defects. II. Effect of citric acid conditioning of the root surface. J Clin Periodontol. 1981;8(6):459–73. DOI: 10.1111/j.1600-051x.1981.tb00895.x
23. Gargiulo AW, Wentz FM, Orban B. Dimensions and relations of the dentogingival junction in humans. J Periodontol. 1961;32(3):261–7. DOI: 10.1902/jop.1961.32.3.261
24. Schmidt JC, Sahrmann P, Weiger R, Schmidlin PR, Walter C. Biologic width dimensions- a systematic review. J Clin Periodontol. 2013;40(5):493–504. DOI: 10.1111/jcpe.12078
25. Novak MJ, Albather HM, Close JM. Redefining the biologic width in severe, generalized, chronic periodontitis: implications for therapy. J Periodontol. 2008;79(10):1864–9. DOI: 10.1902/jop.2008.080066
26. Vacek JS, Gher ME, Assad DA, Richardson AC, Giambarresi LI. The dimensions of the human dentogingival junction. Int J Periodontics Restorative Dent. 1994;14(2):154-65. PMID: 7928131
27. Weinberg MA, Eskow RN. An overview of delayed passive eruption. Compend Contin Educ Dent. 2000;21(6):511–22. PMID: 11199669
28. Wagenberg BD. Surgical tooth lengthening: biologic variables arid esthetic concerns. J Esthet Restor Dent. 1998;10(1):30–6. DOI: 10.1111/j.1708-8240.1998.tb00333.x.
29. Nevins M, Skurow HM. The intracrevicular restorative margin, the biologic width, and the maintenance of the gingival margin. Int J Periodontics Restorative Dent. 1984;4(3):30–49. PMID: 6381360
30. Potashnick SR, Rosenberg ES. Forced eruption: principles in periodontics and restorative dentistry. J Prosthet Dent. 1982;48(2):141–8. DOI: 10.1016/0022-3913(82)90100-7
31. Palomo F, Kopczyk RA. Rationale and methods for crown lengthening. J Am Dent Assoc. 1978 Feb;96(2):257–60. PMID: 272411
32. Ingber JS, Rose LF, Coslet JG. The "biologic width"--a concept in periodontics and restorative dentistry. Alpha Omegan. 1977 Dec;70(3):62–5. PMID: 276259