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Research Article

Valuate The Accuracy Of Cone-Beam Computed Tomographic Imaging Of Furcation Involvement In Periodontal Diseases: A Systematic Review And Meta-Analysis

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Abstract

Background and aim: The aim of current systematic review and meta-analysis study was evaluate the accuracy of cone-beam computed tomographic imaging of alveolar bone level and furcation involvement in periodontal diseases.

Methods: From the electronic databases, PubMed, Scopus, LILACS, Web of Science, EBSCO, LIVIVO, and Embase have been used to perform a systematic literature over the last five years between 2016 and September 2021. Mean differences with 95% confidence interval (CI), fixed effect model and Inverse-variance method were calculated. The Meta analysis have been evaluated with the statistical software Stata/MP v.16 (The fastest version of Stata).

Results: 451 studies were selected to review the abstracts, the full text of 50 studies was reviewed. Finally, eleven studies were selected. Mean difference of Alveolar bone level between CBCT measurement and control group was -0.22 mm (MD, -0.22mm 95% CI -0.49mm, 0.05mm. P= 0.11). The CBCT versus intrasurgical furcation measurements were 2.18 ± 0.86 mm and 2.30 ± 0.89 mm for furcation height.
Conclusions: Most of the findings of the studies indicate that CBCT measurements are similar to intra-surgical alveolar bone measurements and no significant difference was observed in their findings.
Keywords: cone-beam computed tomographic imaging, furcation involvement, alveolar bone level, periodontal diseases

Introduction

Periodontitis is a common infection that damages the soft tissue and bone supporting the tooth. Without treatment associated with a decrease in alveolar bone height(1). The loss of alveolar bone volume can occur before dental extraction due to periodontal disease, periapical pathology and trauma to the teeth(2). Examination and evaluation of residual alveolar bone before periodontal treatment can begin can provide useful information about hard tissue morphology and through which a more accurate treatment plan can be developed(3). A furcation involvement, also called a furcation invasion, is defined as an area of bone loss at this branching point of a tooth root. The bone loss results from periodontal disease(4, 5).

The area in periodontal assessment in which radiographs play a pivotal role is in treatment planning(6); Radiographs continue to play an important role in the diagnosis and management of periodontal disease(7), because they show the morphology of hard tissue, which is a key indicator of periodontal disease(8). Conventionally periapical and panoramic radiographs were used to assess the periodontal hard tissue status with practically no or limited insight into buccal and lingual alveolar bone morphology(9). In panoramic radiographic data, the highest prevalence of tissue lesion was periodontal lesion and periapical abnormality 33.7%(10). Cone-beam computed tomography (CBCT) is a radiographic imaging method that allows accurate, three-dimensional (3D) imaging of hard tissue(11). CBCT is particularly indicated because it is able to provide excellent images of the involved bony structures and is effective to detect them(12). Over the past few years, few clinical studies have been performed using CBCT to determine the extent of periodontal hard tissue destruction, with positive results(13). A comprehensive review and the provision of sufficient evidence are of great importance, taking into account factors such as the accuracy of the diagnosis. It is very important to study and evaluate bone changes in periodontal diseases. Therefore the aim of current Systematic Review and Meta-analysis study was evaluate the accuracy of cone-beam computed tomographic imaging of alveolar bone level and furcation involvement in periodontal diseases.

Method

Search strategy

From the electronic databases, PubMed, Scopus, LILACS, Web of Science, EBSCO, LIVIVO, and Embase have been used to perform a systematic literature over the last five years between 2016 and September 2021. The reason for choosing studies in the last five years is to be able to provide sufficient evidence in this area and use newer studies. Therefore, a software program (Endnote X8) has been utilized for managing the electronic titles.

Searches were performed with mesh terms:

("Periodontal Diseases"[Mesh]) AND "Alveolar Bone Grafting"[Mesh]) OR "Alveolar Bone Loss"[Mesh]) AND "Furcation Defects"[Mesh]) AND "Cone-Beam Computed Tomography"[Mesh]) AND "Data Accuracy"[Mesh]) OR ("Diagnostic Imaging"[Mesh] OR "diagnostic imaging" [Subheading]).

This systematic review has been conducted on the basis of the key consideration of the PRISMA Statement–Perfumed Reporting Items for the Systematic Review and Meta-analysis(14).

Data Extraction and analysis method

The data were extracted from the research included years, Number of patients, sample size, observers, and periodontal parameter and measurement tools in clinical practice.

For Data extraction, two reviewers blind and independently extracted data from abstract and full text of studies that included. Prior to the screening, kappa statistics was carried out in order to verify the agreement level between the reviewers. The kappa values were higher than 0.80.

Mean differences with 95% confidence interval (CI), fixed effect model and Inverse-variance method were calculated.
Random effects were used to deal with potential heterogeneity and I^2 showed heterogeneity. I^2 values above 50% signified moderate-to-high heterogeneity. The Meta analysis have been evaluated with the statistical software Stata/MP v.16 (The fastest version of Stata).

Results
In the review of the existing literature using the studied keywords, 451 studies were found. In the initial review, duplicate studies were eliminated and abstracts of 432 studies were reviewed. At this stage, 381 studies did not meet the inclusion criteria, so they were excluded, and in the second stage, the full text of 50 studies was reviewed by two authors. At this stage, 39 studies were excluded from the study due to incomplete data, inconsistency of results in a study, poor studies, lack of access to full text, inconsistent data with the purpose of the study. Finally, eleven studies were selected (Figure1).

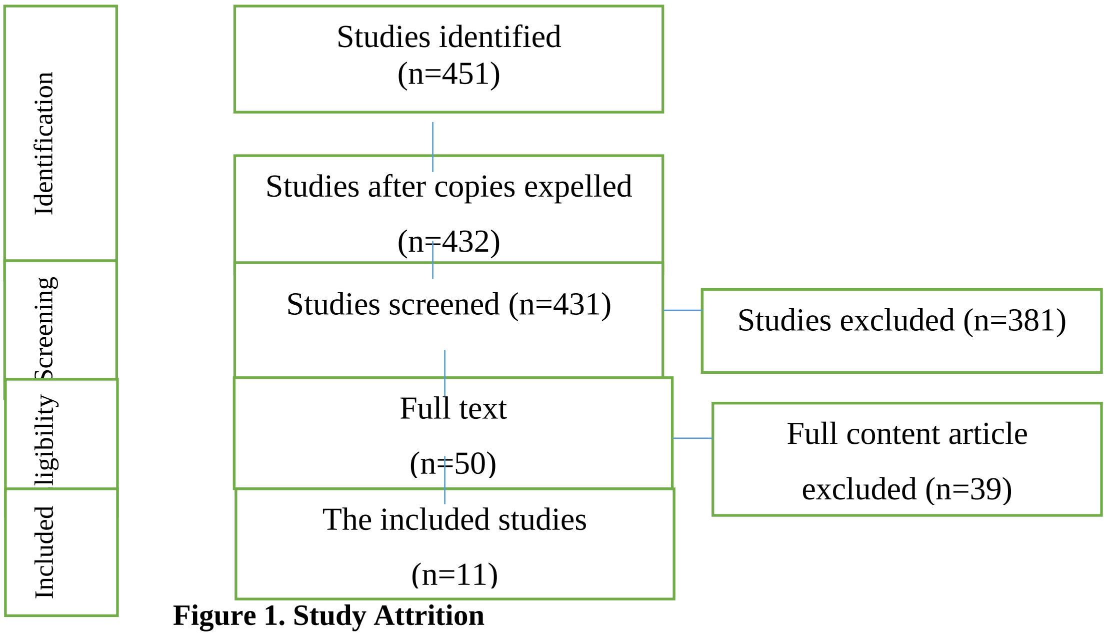

Figure 1. Study Attrition

Table 2. Studies were selected for systematic review and meta-analysis.

Study. Years	Number of patients	observers	Periodontal parameter	linear measurements
Nayyar et al., 2019 (15)	12	1	Bone defects	CBCT
Sreih et al.,2019 (16)	10	1	Marginal bone levels	surgical, Peri-apical radiographs ,CBCT
Yang et al.,2019 (17)	30	3	Alveolar bone loss	CBCT, surgical, clinical attachment level
Patil et al., 2018 (18)	32	1	periodontal defects	CBCT
Parvez et al., 2018 (19)	17	1	Furcation involvement	CBCT, surgical
Zhang et al., 2018 (20)	83	2	Furcation involvement	CBCT, surgical

Padmanabhan et al.,2017 (21)	14	2	Furcation involvement	CBCT, surgical
Guo et al., 2016 (22)	6	4	Alveolar bone loss	CBCT, surgical
Pour et al., 2016 (23)	30	1	Alveolar bone loss	CBCT, surgical
Zhu et al., 2016 (24)	11	1	Furcation involvement	CBCT
Panjinigara et al., 2016 (25)	40	2	Furcation involvement	CBCT, surgical

; CBCT: cone-beam computed tomographic; CAL: clinical attachment level.

Characteristics

Eleven studies have been included in present article. The number of patients a total was 285 and the range of observers was between one to four examiners. Other specifications are reported in Table 1.

Alveolar bone level measurements

Mean difference of Alveolar bone level between CBCT measurement and control group was -0.22 mm (MD, -0.22mm 95% CI -0.49mm, 0.05mm. P= 0.11) among four studies with high heterogeneity (I^2 = 83.49%; p=0.00) (Figure2). The result showed difference was statistically not significant (p=0.11).

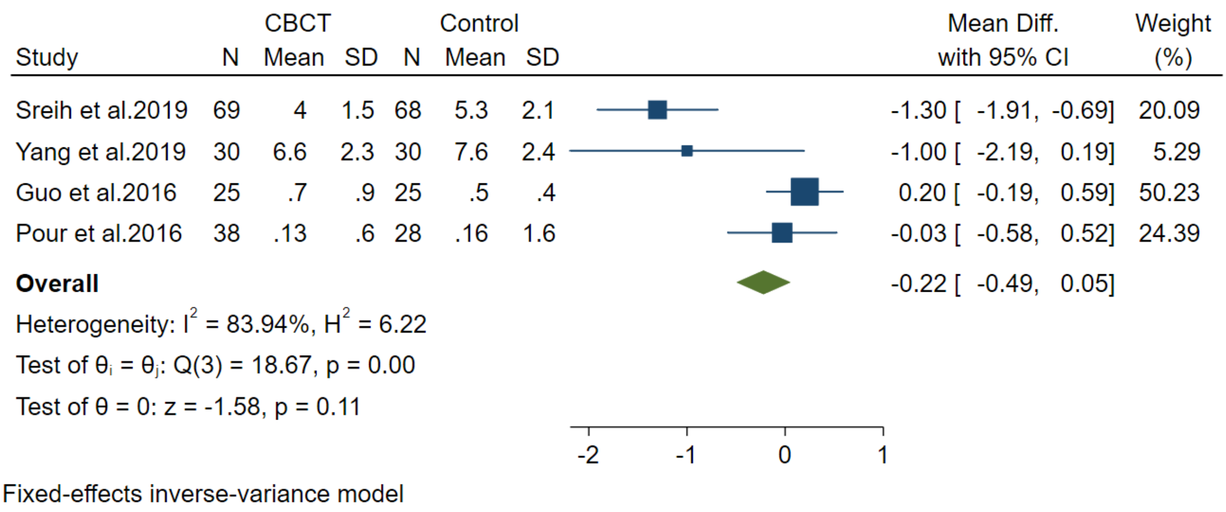

Figure2. The Forest plot showed Mean difference of Alveolar bone level

Statistical significance was found between the modalities concerning linear measurements in Sreih et al.2019 (16) and CBCT showed less bone loss while intrasurgical measurements showed more bone loss. Yang et al.2019 (17) showed statistically significant differences between CBCT and CAL + 2.04 mm (P = 0.000), as well as intra-surgical evaluation (P = 0.001). All sites showed differences in CBCT versus intra-surgical measurement and versus CAL + 2.04 comparisons, except the buccal sites (P = 0.187 and 0.147, respectively). In Guo et al.2016 (22) no statistically significant difference was found between the surgical and CBCT measurements (p=0.84). CBCT enables accurate measurement of bone loss comparable to surgical exploration and can be used for diagnosis of bone defects in periodontal diseases in clinical settings, Pour et al.2016 (23).

Furcation involvement

Nayyar et al. 2019 (15) showed CBCT measurements and clinical measurements for various sites in the anterior and posterior teeth was found to be highly significant in all the cases (P = 0.001). Patil et al. 2018 (18) reported no significant difference was found regarding the CBCT measurements of the facio-lingual width and M-D width of the defect when compared with the measurements obtained during the surgical procedures. Also Parvez et al. 2018 (19) observed there was no statistically significant difference between CBCT measurements and surgical measurements (p≤0.05). Zhang et al. 2018 (20) reported similar result and highest agreement between measurements obtained using CBCT imaging technique and true level of involvement seen during OFS (89%) when compared to clinical and OFS measurements (11%) and clinical and CBCT measurements (3%).

The CBCT versus intrasurgical furcation measurements were 2.18 ± 0.86 mm and 2.30 ± 0.89 mm for furcation height, 1.87 ± 0.52 mm and 1.84 ± 0.49 mm for furcation width, and 3.81 ± 1.37 mm and 4.05 ± 1.49 mm for furcation depth, respectively. Results showed that there was no statistical significance between the measured parameters, indicating that the two methods were statistically similar, Padmanabhan et al.2017 (21). The parameters and related methods of measurements proposed in the study showed high reproducibility. CBCT images provided more details in assessing maxillary molar, Zhu et al.2016 (24). However Panjinigara et al.2016 (25) reported Pre-surgery clinical measurements (vertical 6.15 ± 1.71 mm and horizontal 3.05 ± 0.84 mm) and CBCT measurements (vertical 7.69 ± 1.67 mm and horizontal 4.62 ± 0.77 mm) underestimated intra-surgery measurements (vertical 8.025 ± 1.67 mm and horizontal 4.82 ± 0.67 mm) in both vertical and horizontal aspects, and the difference was statistically not significant (vertical P = 1.00).

Discussion

Studies show that CBCT can be effective in diagnosing periodontal bone levels, and recent studies confirm these findings (26, 27). Similar results were found in the study of Pour et al., (23) and Guo et al., (22) but in both studies there was no statistically significant difference between surgical and CBCT measurements. Patil et al., (18) showed no difference between CBCT and intra-surgical diagnostic methods. While in Yang et al., (17) study different results observed and there was a statistically significant difference between the measurements of this method. In addition, some researchers have suggested that the accuracy of measuring bone levels may depend on the type of CBCT equipment and resolution. It has been found that measuring images with a resolution of 0.25 mm is significantly more accurate than measuring images with a resolution of 0.4 mm (28). One of the reasons for this difference in results can be poor access in certain areas, especially in terms of language and palate, which causes inconsistencies in measuring bone levels during surgery and CBCT (29). As Nayyar et al., (15) showed CBCT incompatibility in determining bone level, especially in the palatal / lingual locations of the anterior teeth, however, no statistical difference was observed between CBCT measurements and intraoperative measurements in posterior teeth. Radiation dose is also a factor that should be discussed. When using CBCT to measure alveolar bone level, the radiation dose is higher than periapical radiography or panoramic radiography(9, 30).

Qiao et al., (31) showed that CBCT images show high accuracy in assessing furcation involvement, and the findings of Walter et al., (32) support these results. Some studies have shown conflicting results. However, some studies have found different results regarding the accuracy of CBCT in accordance with clinical measurements in different types of furcation(5). Cimbaljevic et al., (33) reported that clinical experience and CBCT expertise did not significantly affect the detection of furcation involvement in CBCT scans. Zhu et al., (24) also found that CBCT scans were more effective in assessing maxillary furcation involvement.In general and in similar studies, the CBCT imaging technique provides reliable images of furcation involvement and height of the alveolar bone (9).

Conclusion

Most of the findings of the studies indicate that CBCT measurements are similar to intra-surgical alveolar bone measurements and no significant difference was observed in their findings. However, some findings indicate that the accuracy of the measurements in the anterior regions with relatively thin cortical regions should be further investigated. Some have reported that accurate surgical measurements are difficult to access and that it is better to use CBCT measurements. The radiation dose and clinical factors of the patient should be evaluated before measuring CBCT. CBCT should not be the first choice to measure bone periodontal defects. Its use should be preferably for cases where clinical and conventional images are insufficient or unclear for diagnosis and treatment decision. Further studies with more sample size and high quality studies in this field are needed and it is suggested that more studies be done in this field.

References

1. Yao Y, Kauffmann F, Maekawa S, Sarment LV, Sugai JV, Schmiedeler CA, et al. Sclerostin antibody stimulates periodontal regeneration in large alveolar bone defects. Scientific Reports. 2020;10(1):1-10.
2. Mezzomo LA, Shinkai RS, Mardas N, Donos N. Alveolar ridge preservation after dental extraction and before implant placement: a literature review. Revista Odonto Ciência. 2011;26:77-83.
3. Korostoff J, Aratsu A, Kasten B, Mupparapu M. Radiologic assessment of the periodontal patient. Dent Clin North Am. 2016;60(1):91-104.
4. Gusmão ES, Picarte ACLC, Barbosa MBCB, Rösing CK, Cimoes R. Correlation between clinical and radiographic findings on the occurrence of furcation involvement in patients with periodontitis. Indian Journal of Dental Research. 2014;25(5):572.
5. Milena M. Clinical and CBCT-based diagnosis of furcation involvement in patients with severe periodontitis. Quintessence Int. 2015;46:863-70.
6. Corbet E, Ho D, Lai S. Radiographs in periodontal disease diagnosis and management. Australian dental journal. 2009;54:S27-S43.
7. Gutteridge D. The use of radiographic techniques in the diagnosis and management of periodontal diseases. Dentomaxillofacial Radiology. 1995;24(2):107-13.
8. Bueno CRE, Sumida DH, Duarte MAH, Ordinola-Zapata R, Azuma MM, Guimarães G, et al. Accuracy of radiographic pixel linear analysis in detecting bone loss in periodontal disease: Study in diabetic rats. The Saudi Dental Journal. 2021.
9. Shetty SR, Reddy S, Abdelmagyd HA, Marei H, Shetty R, Elsayed WS. Assessment of alveolar bone level and furcation involvement in periodontal diseases using dental cone-beam computed tomography (CBCT): a systematic review. Brazilian Dental Science. 2020;23(3):8 p- p.
10. Yunus B, Wulansari DP. Hard and soft tissue lesion in oral cavity assessed by periapical and panoramic radiography. Medicina Clínica Práctica. 2020;3:100096.
11. Kumar M, Shanavas M, Sidappa A, Kiran M. Cone beam computed tomography-know its secrets. Journal of international oral health: JIOH. 2015;7(2):64.
12. Shintaku WH, Venturin JS, Azevedo B, Noujeim M. Applications of cone-beam computed tomography in fractures of the maxillofacial complex. Dental traumatology. 2009;25(4):358-66.

13. Han Z. Clinical Analysis of Alveolar Bone Changes After Chronic Periodontitis Based on Cone Beam CT (CBCT). Journal of Medical Imaging and Health Informatics. 2021;11(3):827-35.
14. Moher D, Liberati A, Tetzlaff J, Altman DG, Altman D, Antes G, et al. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement (Chinese edition). Journal of Chinese Integrative Medicine. 2009;7(9):889-96.
15. Nayyar AS. Cone beam computed tomography and detection of periodontal bone defects in patients with advanced periodontal disease indicated for periodontal surgeries. International Journal of Head and Neck Pathology. 2018;1(1):12.
16. Sreih R, Ghosn N, Chakar C, Mokbel N, Naaman N. Clinical and radiographic periodontal parameters: Comparison with software generated CBCT measurements. International Arab Journal of Dentistry. 2019;10(1).
17. Yang J, Li X, Duan D, Bai L, Zhao L, Xu Y. Cone-beam computed tomography performance in measuring periodontal bone loss. Journal of oral science. 2019;61(1):61-6.
18. Patil SR, Al-Zoubi IA, Gudipaneni R, Alenazi KKK, Yadav N. A comparative study of cone-beam computed tomography and intrasurgical measurements of intrabony periodontal defects. International Journal of Oral Health Sciences. 2018;8(2):81.
19. Robinson ED, Nzotta CC, Onwuchekwa I. Evaluation of scatter radiation to the thyroid gland attributable to brain computed tomography scan in Port Harcourt, Nigeria. Int J Res Med Sci. 2019;7(2):530-5.
20. Zhang W, Foss K, Wang B-Y. A retrospective study on molar furcation assessment via clinical detection, intraoral radiography and cone beam computed tomography. BMC oral health. 2018;18(1):1-7.
21. Padmanabhan S, Dommy A, Guru SR, Joseph A. Comparative evaluation of cone-beam computed tomography versus direct surgical measurements in the diagnosis of mandibular molar furcation involvement. Contemporary clinical dentistry. 2017;8(3):439.
22. Guo Y-J, Ge Z-p, Ma R-h, Hou J-x, Li G. A six-site method for the evaluation of periodontal bone loss in cone-beam CT images. Dentomaxillofacial Radiology. 2016;45(1):20150265.
23. Pour DG, Romoozi E, Shayesteh YS. Accuracy of cone beam computed tomography for detection of bone loss. Journal of Dentistry (Tehran, Iran). 2015;12(7):513.
24. Jie Z, Ouyang XY. Assessing maxillary molar furcation involvement by cone beam computed tomography. Chin J Dent Res. 2016;19(3):145-51.
25. Pajnigara N, Kolte A, Kolte R, Pajnigara N, Lathiya V. Diagnostic accuracy of cone beam computed tomography in identification and postoperative evaluation of furcation defects. Journal of Indian Society of Periodontology. 2016;20(4):386.
26. Anter E, Zayet MK, El-Dessouky SH. Accuracy and precision of cone beam computed tomography in periodontal defects measurement (systematic review). Journal of Indian Society of Periodontology. 2016;20(3):235.
27. Haas LF, Zimmermann GS, De Luca Canto G, Flores-Mir C, Corrêa M. Precision of cone beam CT to assess periodontal bone defects: a systematic review and meta-analysis. Dentomaxillofacial Radiology. 2017;47(2):20170084.
28. Sun Z, Smith T, Kortam S, Kim D-G, Tee BC, Fields H. Effect of bone thickness on alveolar bone-height measurements from cone-beam computed tomography images. American Journal of Orthodontics and Dentofacial Orthopedics. 2011;139(2):e117-e27.
29. Feijó CV, Lucena J, Kurita LM, Pereira S. Evaluation of cone beam computed tomography in the detection of horizontal periodontal bone defects: an in vivo study. Int J Periodontics Restorative Dent. 2012;32(5):e162-8.

30. Roberts J, Drage N, Davies J, Thomas DW. Effective dose from cone beam CT examinations in dentistry. The British journal of radiology. 2009;82(973):35-40.

31. Qiao J, Wang S, Duan J, Zhang Y, Qiu Y, Sun C, et al. The accuracy of cone-beam computed tomography in assessing maxillary molar furcation involvement. Journal of clinical periodontology. 2014;41(3):269-74.

32. Walter C, Weiger R, Dietrich T, Lang NP, Zitzmann NU. Does three-dimensional imaging offer a financial benefit for treating maxillary molars with furcation involvement?–A pilot clinical case series. Clinical oral implants research. 2012;23(3):351-8.

33. Cimbaljevic M, Misic J, Jankovic S, Nikolic-Jakoba N. The use of cone-beam computed tomography in furcation defects diagnosis. Balkan Journal of Dental Medicine. 2016;20(3):143-8.