International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

The Role of CBCT-Imaging Technique in Periodontology

Tsvetalina Gerova, Mariya Miteva

Department of Periodontology and Dental Implantology, Faculty of Dental Medicine, Medical University of Varna, Bulgaria

Abstract: ***The gold standard for periodontal examination is and continues to be the clinical periodontal evaluation (including probing pocket depth, bleeding on probing, mobility, gingival margin level, furcation involvement, etc.) and radiographic evaluation (OPG and intraoral radiographs). This conventional assessment contributes significantly to the diagnosis of periodontal diseases. Nowadays, compared to conventional X-ray methods, the use of CBCT technology has been increasingly sought after in the diagnosis of periodontal diseases. Although the data on CBCT and its application in periodontology is quite limited, some specific clinical situations are emerging in which CBCT is an indispensable complement to conventional assessment.***

Keywords: CBCT, radiographic evaluation, X-ray methods, periodontal examination, bitewing, periapical X-ray

1. Introduction

The gold standard for periodontal examination is and continues to be the clinical periodontal evaluation (including probing pocket depth, bleeding on probing, mobility, gingival margin level, furcation involvement, etc.) and radiographic evaluation (OPG and intraoral radiographs). This conventional assessment contributes significantly to the diagnosis of periodontal diseases [1]. Nowadays, compared to conventional X-ray methods, the use of CBCT (cone beam computed tomography) technology has been increasingly sought after in the diagnosis of periodontal diseases [2]. Although the data on CBCT and its application in periodontology are quite limited, some specific clinical situations are emerging in which CBCT is an indispensable complement to conventional assessment [1].

2. Aim

The purpose of this study is to describe and consider the role of CBCT technology in the field of Periodontology.

3. Materials and Methods

Articles related to the subject were searched in PubMed and Google Scholar databases. Articles only in English language, published from 1958 to 2019, were included. Variety of keywords in different combinations were used to conduct the search: CBCT, radiographic evaluation, X-ray methods, periodontal examination, bitewing, periapical X-ray.

4. Results and Discussion

Intraoral radiographs, which include bitewing and periapical segmental X-ray, are used in periodontics to evaluate alveolar bone around natural teeth and dental implants. These radiographic examinations are easy to use, low-cost, and provide little information about anatomical features [3, 4, 5]. However, significant loss or demineralization of the bone (30-50%) must be observed in order to be established by conventional intraoral radiography [6-9].

The disadvantage of intraoral radiographs is that their main diagnostic task is limited to determining the level of the interproximal sections of the alveolar bone. It should be noted that in these studies there is an overlap of anatomical structures, which may lead to misdiagnosis. It is not possible to estimate the width of the alveolar ridge with these radiographic methods [10]. The detection and measurement of 2-wall and 3-wall intrabony defects is a huge challenge [11, 12]. In 1958, Goldman said, "an X-ray examination of an intraosseous defect reveals vertical bone loss but does not give us any information about the morphology of the defect" [13].

Despite these shortcomings, dentists still routinely evaluate two-dimensional intraoral radiographs for signs of progressive demineralization or pathology. This is usually done by comparing a current radiographic examination with one done a while ago. The study of two intraoral segmental images assigned at different times is limited, not only because of all the shortcomings listed above, but also because of the need for a high level of standardization in the technique of image acquisition, which is difficult to achieve [11, 12].

Grimard et al. compare measurements of 35 vertical bone defects made clinically direct approach using intraoral periapical radiography, and CBCT. The team has found that CBCT is significantly more accurate than periapical radiography and that the need for a second surgery, as a technique for evaluating outcomes after regenerative therapy, can be eliminated through CBCT measurements [14].

In 2012 du Bois et al. [15] also compare the different types of images used to diagnose periodontal defects. They review in detail data from the application of conventional and digital periapical radiographs, conventional CT (computed tomography) and CBCT. The conclusion, similar to Mohan R et al. (2011) [16] is that CBCT has unbeatable advantages over other imaging methods, but they also note that "CBCT should not be routinely used to evaluate all patients with periodontitis."

In 2015, Banodkar et al. have conducted a study to assess the accuracy of CBCT for measuring periodontal defects by comparing linear measurements from CBCT data with actual clinical measurements made during surgery [17]. The criteria for patient selection were as follows: 1 / the patient must be over 18 years of age; 2 / the patient is diagnosed with advanced periodontitis (localized or generalized); 3 / the patient has planned for surgery with a mucoperiosteal flap; 4 / patients with systemic diseases, smokers, pregnancy, lactation and those who refused to sign informed consent were excluded from the study. After initial non-surgical periodontal therapy, high-resolution CBCT was performed on the day of surgery. Clinical direct measurements of the defects were made after anesthesia, mucoperiosteal flap elevation, debridement, removal of granulation tissue, and hemostasis. The surgical wounds were then irrigated with saline and the flap was repositioned, adapted and sutured. The patients were given written post-operative instructions along with antibiotics and analgesics. The sutures were removed on the 7th postoperative day.

In addition to these data, a number of authors highlight the advantages of CBCT over segmental and panoramic radiographs, such as the lack of distortion and overlap of images. Dimensions obtained through CBCT are compatible with the actual dimensions [11, 12, 18-21]. Although the presence of the defects can be identified by clinical assessment and standard 2D intraoral X-ray examination, evidence is available that CBCT, with its undeniable accuracy and detail, is increasingly finding its place in the diagnostic process of periodontal diseases [1].

It is clear that nowadays, compared to conventional X-ray methods, the use of CBCT technology has been increasingly sought after in the diagnosis of periodontal diseases. In addition, this technology has an undeniable priority in planning implant therapy, because it gives the advantage that the study area is evaluated and analyzed in three dimensions [2, 22, 23].

X-ray images obtained by CBCT have a higher resolution than those obtained by conventional X-ray methods. CBCT gives a three-dimensional vision of the study area and it is more detailed with respect to the alveolar bone than two-dimensional X-rays [10].

Although the data on the CBCT and its application in periodontology are quite limited, some specific clinical situations are emerging in which CBCT is an indispensable complement to conventional assessment. In addition to the benefits discussed, CBCT can significantly assist in the treatment of periodontal diseases. Through CBCT imaging, vital anatomical structures and features in the planning of surgery can be identified and localized. The technology can be used in periodontology to identify vertical bone defects, furcation defects, dehiscences and/or fenestrations. However, one of the most useful applications of CBCT assessment is post-treatment evaluation [1].

Sometimes after surgery, re-examination is required to verify the results of surgery. In private practice, these surgical results are usually evaluated using clinical and radiographic evaluation. However, the CBCT evaluation of post-surgical treatment has quickly become a standard in both private practice and periodontal researches [1]. In addition to the accuracy of CBCT for detecting and measuring the vertical bone and furcation defects described above, CBCT can be used to assess bone level using the traditional six-site method [24, 25]. In particular, CBCT evaluation after regenerative therapy for furcation defects was recommended by the American Academy of Periodontal Regeneration in 2015 [26].

The conclusion regarding the use of CBCT in the diagnosis and treatment of periodontal diseases is that there is limited evidence to support its use as a standard in the diagnosis and treatment of periodontal diseases [27-29]. Conventional evaluation is still considered the gold standard, but in certain situations (advanced vertical bone resorption, various types of defects, suspected end-period lesions, root resorption, etc.) CBCT images may be helpful. The dentist must determine when CBCT images are beneficial and apply the “As low as reasonably achievable” principle (ALARA) [1].

In 2005, with the approval of the University of Michigan, Kelly A. Misch et al. acquired two human carcasses in order to conduct clinical examinations of vertical alveolar bone defects made by them, using two-dimensional radiographs and CBCT. They created intraosseous vestibular, lingual and interproximal defects (using a bone bur) of various sizes, in the area of the lower premolars and molars. In addition, they put a gutter pin in the defects to establish a reference point for X-ray and CBCT measurements. During each periapical radiography, the film is placed parallel to the tooth examined, with the central beam of the X-ray pointing perpendicularly to the tooth. The CBCT was done at an average resolution of 0.4 mm using a 20-second scan (120 KVp and 47.74 mAs). For each defect three measurements were taken 1. The distance from the cemento-enamel junction (CEJ) to the base of the bone defect (A); 2. The distance from the CEJ to the highest bone level of the bone defect (B); 3. The width of the defect (C). For reference, all bone defects are measured with a caliper. Measurements of all artificially created bone defects were made, with the exception of 10 (33%) vestibular or lingual defects using two-dimensional radiography due to lack of visualization. All intraosseous defects were detected using CBCT and probing. After examining the results, it is concluded that the CBCT is as accurate as direct probe measurements and as reliable as radiographic examinations for interproximal areas. Since vestibular and lingual bone defects can not be detected on 2D radiographs, CBCT is superior in this regard. When comparing the results of the periapical radiographs and the CBCT, only 67% of the intraosseous defects were identified on the 2D radiographs because the vestibular and lingual defects were not visualized. However, CBCT have identified 100% of the investigated defects [30].

In 2012 [31], a study aimed at comparing periapical radiographs and CBCT images for the detection and localization of alveolar bone defects by comparing linear measurements of the height, depth and width of the defects

was made. The images used in the study were selected from a database containing images of patients sent for periodontal assessment. The images included in the study meet a set of criteria such as - good image quality (according to density and contrast), centralization of the area being evaluated and visualization of the CEJ. The sample consists of 51 areas of horizontal and vertical bone loss. Three measurements were made for each site: the alveolar crest (AC) measured from CEJ to AC; the depth of the defect, measured from the CEJ to the bottom of the defect; and the width of the defect, measured from the highest point of the bone defect to the adjacent root. When the examiner observed two levels of the bottom of the bone defect / AC (lingual / palatal and vestibular), the deepest points were measured. To classify the presence of alveolar resorption, the distance of 3 mm from the CEJ to the bottom of the bone defect was used as a norm parameter. Bone resorption was detected in 51 areas (39 teeth). It was found that horizontal bone resorption was observed in 36 areas and vertical resorption in the other 15 regions. The study results show that there are no statistically significant differences between the two methods regarding the identification of the alveolar bone loss pattern. There were statistically significant differences ($p < 0.05$) between the two methods when measuring the distance between the CEJ and the AC by an average of 3.8 mm for measurements of periapical radiographs and 4.1 mm for CBCT measurements. When measuring the distance between the CEJ and the deepest point of the defect and establishing the width of the defect, no statistically significant difference is found.

The findings of the study show that the two methods differ in detecting the height, depth and width of defects. CBCT is the only method that allows analysis of the vestibular and lingual / palatal surfaces of the alveolar ridge and better visualization of bone morphology.

5. Conclusion

It is important to note that proper assessment of bone status is essential for the diagnosis, treatment planning and prognosis of periodontal diseases [31, 32, 33]. Diagnostic images provide information about the height of the alveolar bone relative to the CEJ and the presence or absence of vertical bone defects [31, 34, 35].

References

[1] Eshraghi VT, Malloy KA, Tahmasbi M. Role of Cone-Beam Computed Tomography in the Management of Periodontal Disease. Dent J (Basel). 2019 Jun 1;7(2).
[2] Evaluation Of Facial Alveolar Bone Dimension Of Maxillary Anterios And Premolar Teeth - Int J Oral Maxillofac Implants. 2012 Nov-Dec;27(6):1514-9
[3] Manson, JD, Nicholson, K. The Distribution of Bone Defects in Chronic Periodontitis. 1974. J. Periodontol. (45)2.88-92.
[4] Mol A, Dunn SM. Effect of bone chip orientation on quantitative estimates of changes in bone mass using digital subtraction radiography. J Periodontal Res. 2003;38:296-302.
[5] Ludlow JB, Davies-Ludlow LE, Brooks SL, Howerton WB. Dosimetry of 3 CBCT devices for oral and maxillofacial radiology: CB Mercuray, NewTom 3G and i-CAT. Dentomaxillofac Radiol. 2006;35:219-26.
[6] Åkesson L, Håkansson J, Rohlin M. Comparison of panoramic and intraoral radiography and pocket probing for the measurement of the marginal bone level. J Clin Periodontol. 1992;19:326-332.
[7] Eickholz P, Hausmann E. Accuracy of radiographic assessment of interproximal bone loss in intrabony defects using linear measurements. Eur J Oral Sci. 2000;108:70-73.
[8] Pepelassi E, Diamanti-Kipioti A. Selection of the most accurate method of conventional radiography for the assessment of periodontal osseous destruction. J Clin Periodontol. 1997;24:557-567.
[9] Tonetti M, Pini-Prato G, Williams R, Cortellini P. Periodontal regeneration of human infrabony defects: III. Diagnostic strategies to detect bone gain. J Periodontol. 1993;64:269-277.
[10] Yousef A. Aljehani. Diagnostic Applications of Cone-Beam CT for Periodontal Diseases. International Journal of Dentistry, Volume 2014, Article ID 865079, 5 pages
[11] Mol A. Imaging methods in periodontology. Periodontol 2000.2004;34:34-48.
[12] Green, Peter Thomas. “Three-dimensional cone-beam computed tomography volume registration for the analysis of alveolar bone changes.” (2017).
[13] Goldman HM, Cohen WD. The infrabony pocket: classification and treatment. J Periodontol 1958: 29: 272.
[14] Grimard BA, Hoidal MJ, Mills MP, Mellonig JT, Nummikoski PV, Mealey BL. Comparison of clinical, periapical radiograph, and cone-beam volume tomography measurement techniques for assessing bone level changes following regenerative periodontal therapy. J Periodontol 2009;80:48-55.
[15] du Bois AH, Kardachi B, Bartold PM. Is there a role for the use of volumetric cone beam computed tomography in periodontics? Aust Dent J. 2012 Mar;57 Suppl 1:103-8.
[16] Mohan R, Singh A, Gundappa M. Three-dimensional imaging in periodontal diagnosis - Utilization of cone beam computed tomography. J Indian Soc Periodontol. 2011 Jan;15(1):11-7. doi: 10.4103/0972-124X.82256. PubMed PMID:21772715; PubMed Central PMCID: PMC3134038.
[17] Banodkar AB, Gaikwad RP, Gunjikar TU, Lobo TA. Evaluation of accuracy of cone beam computed tomography for measurement of periodontal defects: A clinical study. J Indian Soc Periodontol. 2015 May-Jun;19(3):285-9.
[18] Misch KA, Yi ES, Sarment DP. Accuracy of cone beam computed tomography for periodontal defect measurements. J Periodontol 2006; 77: 1261–1266.
[19] Fuhrmann RAW, Wehrbein H, Langen HJ, Diedrich PR. Assessment of the dentate alveolar process with high resolution computed tomography. Dentomaxillofac Radiol 1995; 24: 50–54.
[20] Vandenberghe B, Jacobs R, Yang J. Diagnostic validity (or acuity) of 2D CCD versus 3D CBCT images for assessing periodontal breakdown. Oral

Surg Oral Med Oral Pathol Oral Radiol Endod 2007; 104: 395–401.
[21] Mengel R, Candir M, Shiratori K, Flores-De-Jacoby L. Digital volume tomography in the diagnosis of periodontal defects: an in vitro study of native pigs and human mandibles. J Periodontol 2005; 76: 665–673.
[22] Sabeva, Elitsa. Comparison between the influence of implant diameter and implant length on the primary stability. Scripta Scientifica Medicinae Dentalis, [S.I.], v.4, n.2, p. 36-41, dec. 2018. ISSN 2367-7244. doi:http://dx.doi.org/10.14748/ssmd.v4i2.5635.
[23] Peev S., Gusiyska A., Sabeva E.,Guided Bone Regeneration and Simultaneous Implant Placement, International Journal of Science and Research, 2016, 5(2),1529-1530
[24] Fleiner, J.; Hannig, C.; Schulze, D.; Stricker, A.; Jacobs, R. Digital method for quantification of circumferential periodontal bone level using cone beam CT. Clin. Oral Investig. 2013, 17, 389–396.
[25] 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. Dentomaxillofac. Radiol. 2015, 45, 20150265.
[26] Reddy, M.S.; Aichelmann-Reidy, M.E.; Avila-Ortiz, G.; Klokkevold, P.R.; Murphy, K.G.; Rosen, P.S.; Schallhorn, R.G.; Sculean, A.; Wang, H.L. Periodontal regeneration—furcation defects: A consensus report from the AAP Regeneration Workshop. J. Periodontol. 2015, 86, S131–S133.
[27] Mandelaris, G.A.; Scheyer, E.T.; Evans, M.; Kim, D.; McAllister, B.; Nevins, M.L.; Rios, H.F.; Sarment, D. American Academy of Periodontology Best Evidence Consensus Statement on Selected Oral Applications for Cone-Beam Computed Tomography. J. Periodontol. 2017, 88, 939–945.
[28] Kim, D.M.; Bassir, S.H. When Is Cone-Beam Computed Tomography Imaging Appropriate for Diagnostic Inquiry in the Management of Inflammatory Periodontitis? An American Academy of Periodontology Best Evidence Review. J. Periodontol. 2017, 88, 978–998.
[29] McAllister, B.S.; Eshraghi, V.T. Commentary: Cone-Beam Computed Tomography: An Essential Technology for Management of Complex Periodontal and Implant Cases. J. Periodontol. 2017, 88, 937–938.
[30] Misch KA, Yi ES, Sarment DP. Accuracy of cone beam computed tomography for periodontal defect measurements. J Periodontol. 2006 Jul;77(7):1261-6.
[31] de Faria Vasconcelos K, Evangelista KM, Rodrigues CD, Estrela C, de Sousa TO, Silva MA. Detection of periodontal bone loss using cone beam CT and intraoral radiography. Dentomaxillofac Radiol. 2012 Jan;41(1):64-9.
[32] Langen HJ, Fuhrmann R, Diedrich P, Gunther RW. Diagnosis of infra-alveolar bony lesions in the dentate alveolar process with high-resolution computed tomography: experimental results. Invest Radiol 1995; 30: 421–426
[33] Armitage GC. The complete periodontal examination. Periodontol 2000 2004;34:22-33.
[34] Jeffcoat MK. Current concepts in periodontal disease testing. J Am Dent Assoc 1994; 125: 1071–1078.
[35] Reddy MS. Radiographic methods in the evaluation of periodontal therapy. J Periodontol 1992; 63: 1078–1084