THE ROLE OF CBCT IN THE EVALUATION OF PERIODONTAL DISEASES

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Abstract

Scope: Diagnosis of periodontal disease is firstly based on clinical signs and symptoms, however, when bone destruction is involved, radiographic examination is the most conclusive diagnosis method to be recommended. Even if the 2D radiography is most frequently used for such a diagnosis, CBCT (Cone Beam Computed Technology) comes to complete, help and provide new data on diagnosing periodontal lesions. The present study reviews original articles and synthesis papers issued between 2004-2014 in ScienceDirect, EBSCO, PubMed. Conclusions: In periodontology, CBCT appears as superior to 2D radiographies, being especially useful in the diagnosis of branch craters, lesions, vestibular and oral bone destructions, offering to the patient highly superior benefits compared to the risks caused by exposure.

Keywords: CBCT, CBCT in periodontology, periodontal disease

1. INTRODUCTION

Nowadays, the area of radiology and medical imaging is constantly evolving, which has a high impact on general practitioners and dentists, who may thus evaluate the presence, absence and progression of lesions, permitting to establish a correct diagnosis and useful treatment, along with other laboratory investigations [1]. The aim of this article is to underline the role of CBCT, which comes to complete, aid and provide new data in diagnosing periodontal lesions.

Cone Beam Technology appeared for the first time on the European market in 1996 by QR SRL (NewTom 9000), and on the American one - in 2001. The original members of the research group awarded a prize for the invention of CBCT, on October 2003 [2]. In less than 5 years, 5 CBCT systems approved by FDA appeared. The image produced by CBCT, achieved at a relatively low radiation dose, is not used only for diagnosis, but also for helping specialists to reach a higher level of performance. [3]

CBCT represented a huge improvement in dental imaging. Introduction of Cone Beam Computed Tomography (CBCT) in the maxillofacial field has opened up new horizons in the use of three-dimensional (3D) imaging as a diagnosis and treatment tools in orthodontics, periodontics, implantology, oral surgery and otolaryngology and maxillofacial surgery [4-6].

CBCT is an imaging method applied in different medical fields, recently introduced in dental medicine, too. The device on whose basis the image is provided by CBCT is an X-ray cone beam and a detector (image intensifier) which needs a single rotation around the patient to take hundreds of pictures in the area of interest, which are then reconstructed using an imaging software, for obtaining a 3D virtual model of the patient. In terms of irradiation doses, studies showed that the irradiation dose for CBCT is much lower compared to that of a conventional CT, but higher compared to a panoramic radiography [7,8]. CBCT gives the possibility of choosing the field of view, depending on the area of interest, therefore the area exposed to radiation is a single one, the others being safe; last, but not least, this function is considered as very important for the patient, due to its low radiation dose [7,6]. Usually, it performs a 360-degree rotation around the patient, but some devices implemented a 180-degree or a slightly higher rotation arc, sufficient to reconstruct the image, which results in a significant reduction of the radiation quantity [6]. CBCT can give details on the bone defects at lingual and vestibular level, on fenestration, furcations, craters; also, bone measurements may be performed with minimal
errors, providing a detailed morphological description of the alveolar bone [9].

Generally, review articles identify the literature, the case studies and models which support the chosen theme; in our case, as the number of studies dedicated to the role of CBCT in periodontology is quite reduced, the review intends to highlight the need of its use in this area, as a diagnosis method superior to the other techniques.

2. METHODS

**DOCUMENTATION SOURCES**

Few studies have been dedicated to the role of CBCT in the field of periodontology. The present synthesis - conducted in June 2015 - reviews the diagnostic applications of CBCT, namely its utilization in detecting periodontal problems. Twenty-one relevant studies issued between 2004-2014 were identified and included. The data bases used were: ScienceDirect, EBSCO, PubMed. The search was carried out using the key words: “CBCT in periodontology”, “periodontal disease”, “CBCT”. The reference lists of the identified studies and reviews were also examined. Studies reporting the use of CBCT in periodontology are also included. In the evaluation of studies, the following problems were addressed: the advantages and disadvantages of CBCT, the instructions for the use of CBCT and the role of CBCT in the evaluation of periodontal diseases.

3. RESULTS AND DISCUSSION

<table>
<thead>
<tr>
<th>INDICATIONS OF CBCT</th>
<th>ADVANTAGES OF CBCT</th>
<th>DISADVANTAGES OF CBCT</th>
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<tbody>
<tr>
<td>1. 3D view of teeth position and structure</td>
<td>1. Most of CBCTs offer fields of view of different sizes (small, medium and large). The smaller the field of view, the lower is the effective radiation dose.</td>
<td>1. The high cost compared to that of standard 2D radiographies.</td>
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<td>2. Determination of anatomic bone sizes</td>
<td>2. Compared to CT, the time of exposure to radiations is more reduced.</td>
<td>2. It cannot offer a resolution with increased contrast and also it is not indicated in the exploration of soft tissues, but only in the exploration of bone tissue in the maxilla-facial sphere.</td>
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<td>3. Study of the airways</td>
<td>3. Its cone beam allows the limitation of radiations in the interested area.</td>
<td>3. A significant disadvantage of CBCT is represented by the artefacts that may be present on the image - not due to the scan, but to the presence of implants, restorations from the amalgam, metallic prosthetic restorations or endodontic treatments. These artefacts are characterized by hyperdense lines and dark images, which affect the quality of the desired image.</td>
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<td>4. Positioning of temporary anchoring devices</td>
<td>4. The accuracy of the image is given by a resolution ranging between 0.4 mm to 0.076 mm.</td>
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<td>5. Cephalometric analyses</td>
<td>5. The effective dose of radiations on a patient in the case of CBCT is between 29 and 477 microSv while, in the case of CT, it is of about 2000 microSv.</td>
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<td>6. ATM evaluation</td>
<td>6. CBCT succeeds in reconstructing the 3D image of the patient in three planes (sagittal, coronal and axial).</td>
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<td>7. Evaluation before the implant</td>
<td>7. Panoramic and multi-plane images may be obtained by increasing the number of voxels, on also permitting the use of the 3D volume mode, reaching the desired image through corresponding settings.</td>
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<td>8. Endodontic evaluation</td>
<td>8. Rendering of the 3D volume is possible through direct and indirect techniques.</td>
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<td>9. Periodontal evaluation</td>
<td>9. The presence of artifacts on the images given by CBCT is much reduced.</td>
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<td>10. Evaluation of bone resorption</td>
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<td>11. 3D reconstructions</td>
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Table 2. Aspects on the role of CBCT in periodontology, described in literature [1,4,8,9,17,19]

[4] The image provided by CBCT is qualitatively superior. Defects of bones, craters and furcation areas are much better described on CBCT than on intraoral radiography, even if they do not offer significant advantages at bone level.

[8] Currently, CBCT is used for multiple diagnosis and treatment plans, but, up to now, its use in periodontology was not very well-reviewed and documented. 2D radiographs have been used until the occurrence of CBCT, but, in the case of craters, lamina dura and periodontal bones, the images are limited by the geometry of projection and overlapping of the other anatomical elements. These shortcomings of 2D imaging are eliminated by CBCT, which evidences distinct benefits in periodontics; however, its utilization and indications should be strictly followed, if considering the potential hazards of examination.

[9] CBCT is very important in periodontal therapy, because it can analyze the depth, weight and morphology of the bone.

[17] The results of this study indicate that the 3D imaging method, CBCT, is more accurate than the periapical films used in the diagnosis of interradicular periodontal lesions.

[19] CBCT is superior to intraoral digital radiography, reproducing superior images in the case of craters and furcation.

[1] CBCT may be useful in cases of infra-bone defects and furcation lesions, where clinical and conventional radiographic examinations do not provide the information needed for their management.

4. DISCUSSION

Periodontal diseases represent a group of affections encountered at the level of the oral cavity, nowadays present among children, teenagers and adults. “The term “periodontal disease” includes any inherited or acquired disorder of the tissue supporting the tooth (gum, cement, periodontal ligament, alveolar bone)” [11].

The periodontal disease is characterized by destruction of the periodontal tissue and of the alveolar bone following a secondary inflammatory response of an infection produced by periodontal bacteria [11]. In the oral cavity there are about 700 species of bacteria, of which 400 are encountered in the subgingival bacterial plaque, considered as the main etiological factor producing the periodontal disease. In the subgingival bacterial plaque from the deep periodontal pockets, anaerobic gram-negative bacteria and spirochetes - in particular Porphyromonas gingivalis, Aggregatibacter actinomycetemcomitans, Bacteroides forsythus, Prevotella intermedia and Fusobacterium nucleatum - are usually present. In the beginning, the periodontal disease may be asymptomatic, being traced through clinical or radiological examination [12].

Radiological examination has an important role in diagnosing the periodontal disease. Different types of radiographies may be used in this respect, among which: bitewing, periapical, panoramic and CBCT radiographies. The radiological examination used in the evaluation of the periodontal disease provides information related to the level and manner of bone destruction, which may be measured from the small-cement junction to the alveolar ridge. Furthermore, this examination also provides information related to lamina dura, the periodontal ligament, the junction level, impacted teeth, calculi, incorrectly adapted obturations and root shape [13].

The panoramic radiography is used to evaluate the periodontal disease, as it offers information related both to the alveolar bone and teeth and to the neighbouring structures, even if, due to the geometric projection used for their achievement, artefacts and different elements may appear superposed. Periapical radiography is most often used for the evaluation of the periodontal disease, but it can also present certain shortcomings, which prevent reaching of
a precise diagnosis [13,8]. To overcome the difficulties created by the intraoral radiography, CBCT has been introduced and used at large scale in the maxillofacial sphere [14].

Nowadays, the use of CBCT in periodontology is quite limited, about 3% of the published articles mentioning it, as well as its use in the OMF sphere [13,15]. A precise evaluation of the bone level and of the present changes induced by the manifestation of the periodontal disease usually requires a 3D radiological investigation or a combination between the radiological image given by standard 2D and 3D radiographies [16].

Different scientists, [17-19] who conducted studies on skull and hemimandible, concluded that CBCT is more accurate than conventional radiography in detecting bone defects, that it provides increased precision in the case of bone defects in the oro-vestibular orientation, that it shows an improved sensitivity compared to intraoral radiography, and that it is superior in evaluating craters and furcations, compared to the conventional techniques [4,17,18]. The first signs encountered in the periodontal disease may be related to the interruption of lamina dura continuity on the mesial and distal face of a tooth, signs which cannot be assessed on 2D conventional radiographs (which also show some significant drawbacks, among which the overlap of some anatomical elements, caused by positioning of the radiation tube), because they require a special fineness, achieved only by CBCT [4,20]. However, it is interesting that another scientist [21] found out no significant differences in bone measurements made on conventional radiographs and CBCT, even if measurements on the facial and lingual face could not be made on 2D radiographs [21]. A great scientist [19] conducted a laboratory study, on also emphasizing that the differences between 2D radiographs and CBCT are not significant, however, later in 2008, a more extended in vivo study, also conducted by him, revealed the accuracy of measurements obtained with CBCT, compared to those of intraoral radiographs. The same study revealed the superiority of CBCT to intraoral radiographs in assessing craters and furcation injuries. Alveolar bone defects are also well-revealed by CBCT, which was proved in a study using intraoral, panoramic, CT and CBCT.

5. CONCLUSIONS

To sum up, CBCT represents a new step in the evolution of dental imaging. Even if, currently, the studies devoted to the use of CBCT in periodontology are quite few, the already existing ones have demonstrated its usefulness and advantages compared to other imaging investigation techniques. CBCT remains useful in particular situations of advanced periodontitis, becoming mandatory in patients who require implantar rehabilitation.

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