ORIGINAL ARTICLE

FREQUENCY FOR THE USE OF CBCT ANALYSIS IN DENTISTRY

Melania Olimpia Cojocaru[1], Emma Cristina Drăghici[1*], Antonia Samia Khaddour[1*], Răzvan Eugen Ghiţă[1], Iulia Roxana Marinescu[1], Adrian Mihail Simionescu[2], Sanda Mihaela Popescu[1], Monica Scrieciu[3]

[1] Department of Oral Rehabilitation, University of Medicine and Pharmacy of Craiova, 200349 Craiova, Romania
[2] Private Practice
[3] Department of Prosthetics Dentistry, University of Medicine and Pharmacy of Craiova, 200349 Craiova, Romania

All authors contributed equally to this work.

[*] Corresponding author:
Emma Cristina Drăghici, Antonia- Samia Khaddour , Department of Oral Rehabilitation, University of Medicine and Pharmacy of Craiova, 200349 Craiova, Romania;
Email:
emma.draghici@umfcv.ro
antoniasamia11@gmail.com

Abstract: Cone beam computed tomography (CBCT) is a method that allows a three-dimensional evaluation of hard craniofacial structures with a lower radiation dose than classic CT. This method began to be used more and more frequently in dentistry. Background: The aim of the study was to evaluate the frequency for use of CBCT in dentistry. Methods: The study was addressed to dentists of various specialties from Oltenia region that completed an online questionnaire with 10 questions. Data were collected regarding the physician's specialty, the type of interventions for which the dentist recommends CBCT, how necessary this investigation is considered, and how invasive it is considered to be. The questionnaire was launched online for a period of 4 weeks, and dentists from the Oltenia region were invited to participate. The statistical analysis was carried out with the help of the Google Docs program, the section dedicated to forms, "Google Forms". Results: Young doctors chose this technology more frequently than doctors with more than 5 years of experience. Although implant planning is the primary reason for CBCT imaging in dentistry, CBCT is increasingly being used for other diagnostic purposes, such as periodontics and endodontics. In nearly 20% of cases, the primary diagnosis and/or treatment plan was changed following CBCT evaluation. Conclusions: There is an increasing trend in the use of CBCT in dentistry, especially by young graduates.

Keywords: CBCT, dentistry, 3D imaging, implantology, endodontics, periodontology, radiological analysis, radiation.

 DOI: 10.58179/RJDR1201

1. Introduction

Over time, the evolution of dentistry has been gradual and steady, leading to new treatment protocols that have challenged conventional procedures [1-9]. The recent explosion of digital technology, software, scanning and diversified materials has led to a major paradigm shift in all aspects of dentistry and slowly, artificial intelligence will enhance the usefulness of CBCT in dentistry [1-10]. Today, digital radiographs are a routine practice in dental clinics, and computer-aided virtual design is also very common: digital impressions, digitally manufactured dental prostheses and guided surgery are a reality of dental practice [9-15].

Panoramic radiography and computed tomography were the main elements of maxillofacial imaging diagnosis [11,16-20]. Dental cone beam computed tomography (CBCT) is the most important advance in oral radiology since panoramic radiology in the 1950s and 1960s, and perhaps since Roentgen's discovery of X-rays in 1895. With the advent of cone beam computed tomography, the practice of dentistry has experienced a paradigm shift [21]. The concept of using a cone-shaped X-ray beam to generate three-dimensional (3D) images has been used successfully in vascular imaging since the 1980s and is also used in dentistry today [22]. The first CBCT unit: NewTom QR-DVT 9000, was initially introduced in Europe in 1999 [21]. CBCT has an X-ray source that rotates around the patient, and at the end of the image acquisition phase, the computer, through software, generates a three-plane reconstruction, and the images are processed using many algorithms, including the reduction of metal artifacts. The final result of the processing is the 3D volume, but also the multiplanar reconstructions (MPR) images that can be evaluated in the three planes (axial, coronal and sagittal) and in any desired angle (360 degrees) [10,11].

Cone beam computed tomography (CBCT) is a new diagnostic tool that has revolutionized diagnosis and treatment planning in the dental field. Multiplanar imaging, is a novelty for the dentist, offers the possibility of a diagnosis in different planes and allows the decryption of the real 3D spatial relationship of various anatomical elements with structures in the maxillofacial region [10,11]. The main applicability of CBCT and the most widely feature used is the measurement function in various sectional plans depending on the location of the area of interest studied. The main advantage of CBCT is the rapid volumetric acquisition, superior spatial resolution to CT, advanced multiplanar reconstruction, two- and three-dimensional analysis of anatomical structures, highlighting fine submillimeter ratios between different anatomical structures [10,11]. CBCT is a more compact, faster version and emits less radiation than conventional computed tomography. Depending on the complexity of the processing and visualization software used by the CBCT manufacturer, there is a diversity of functions for exploring the acquired volume [10,11].

CBCT was adopted in dentistry very quickly due to its compact size, low cost, low

DOI: 10.58179/RJDR1201

exposure to ionizing radiation compared to computed tomography and minimal distortion. Most CBCT equipment is easy to use with visualization software that contains 3D images, provides extensive analysis tools, and allows for treatment planning. The software allows the virtual study and the diagnostic process, the treatment plan and the design of surgical guides for surgical interventions (insertion of implants) [10,11].

Current use is in the field of dental implantology, oral surgery, orthodontics, endodontics, sleep apnea, temporomandibular joint (TMJ) disorders, and periodontics [9,10,23,24]. Dentists who choose to use cone beam computed tomography for their patients assume responsibility for interpreting the entire volume included in the scan, not just the area that may be the reason for the scan [25].

The dentist's role in the identification, diagnosis and management of pathology seen on CBCT scans is to coordinate according to two main objectives: first, the scan is done specifically to evaluate a pathological condition of the patient, identified by history or examination clinically where a facial asymmetry can be observed and secondly, the scan is done to establish the treatment by fixed or mobilizable prosthesis with implant support, or by orthodontic treatments [7-9,10].

Even though the basic objective is to determine the nature of the condition and the type of management required, the steps the doctor will take will be different, with the goal being to preserve and improve the patient's health.

The purpose of the study was to evaluate and determine the categories in which CBCT type radiological scans are used and also to evaluate the opportunity of its use in the complex and complete diagnosis of patients.

2. Materials and method

The study highlighted the areas of dentistry in which dentists frequently use the three-dimensional information of the CBCT scan and the degree of confidence that doctors have in using this technology. The data obtained in this study were corroborated and used to understand if the CBCT evaluation is a standard diagnostic and prognostic method in dentistry.

The data were obtained from dentists with various specializations, from the region of Oltenia, Romania, using as an investigation method an online questionnaire, consisting of 10 questions, which contained both single-choice and multiple-choice questions. The questionnaire was launched for a period of 4 weeks, and a number of 55 dentists, who were assured of anonymity and confidentiality of the research data, responded to it voluntarily.

Information was collected such as: the specialty of the doctor, the type of interventions in which the doctor recommends the CBCT scan, if the CBCT evaluation confirmed the presence of the pathology for which the recommendation was made, if the doctor considers the CBCT scan absolutely necessary for his cases, if the doctor considers the scan CBCT is a radiologically invasive procedure for its patients.

 DOI: 10.58179/RJDR1201

The questionnaire was made up of the following questions:

1. Are you a medical specialist? If the answer is yes, what specialization do you have?
2. How long have you been working in a dental office?
3. Is the office where you work in an urban or rural environment?
4. Do you consider CBCT evaluation absolutely necessary for your patients' cases?
5. What do you think you need to be able to evaluate a CBCT scan?
6. When do you recommend a CBCT scan?
7. What CBCT analysis software do you use?
8. Did the CBCT evaluation confirm the presence of the pathology for which the recommendation was made?
9. Do you consider the CBCT scan to be a radiologically invasive procedure for your patients?
10. Do you use CBCT scanning to make surgical guides for implant therapy or other aesthetic procedures?

Following the results obtained in this study, different graphs were made, which were processed statistically, and which were later exemplified individually, in the chapter dedicated to the results and discussions. The statistical analysis was carried out with the help of the Google Docs program, the section dedicated to the "Google Forms" forms.

The study was approved by the Ethics Committee of the University of Medicine and Pharmacy in Craiova (Approval Number 55/29.01.2024) and was carried out in accordance with the ethical principles of the Declaration of Helsinki (version 2013).

3. Results

The study involved the analysis of data obtained from a group of 55 dentists with various specializations, from Oltenia, Romania. Among them, 16 (29.09%) are not specialist, 10 (18.18%) are dentists in a residency program, 9 (16.36%) work as specialists in general dentistry, 6 (10.91%) specialists in orthodontics, 6 (10.91%) specialists in endodontics, 5 (9.09%) specialists in periodontology and 3 (5.46%) specialists in dento-alveolar surgery (Figure 1, Table 1).

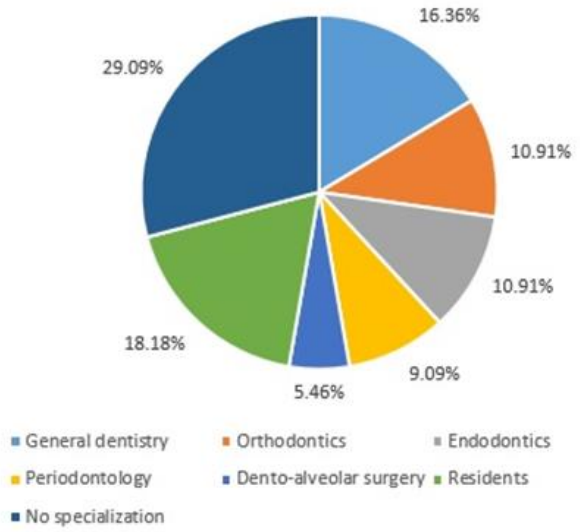

Figure 1. The specializations of the responding dentists.

Regarding experience in the field of dental medicine, 28 (50.90%) responding doctors stated that they have less than 5 years of experience in this field, 19 (34.55%) doctors

DOI: 10.58179/RJDR1201

have more than 5 years of experience and 8 (14.55%) doctors have more than 10 years of experience. Most of the surveyed candidates have an activity period of less than 5 years, which confirms the increased prevalence of the adoption of CBCT technology by the new generations of dentists. At the opposite pole, the lowest percentage belongs to doctors with more than 10 years of experience.

Table 1. The experience of the responding dentists.

Specialization	Number	Percentage (%)
General dentistry	9	16.36%
Orthodontics	6	10.91%
Endodontics	6	10.91%
Periodontology	5	9.09%
Dento-alveolar surgery	3	5.46%
Dentists in a residency program	10	18.18%
No specialization	16	29.09%
General dentistry	9	16.36%

Taking into account the environment in which the responding dentists work, the predominant number is occupied by the urban environment 47 (85.45%), the remaining 8 (14.55%) working in the rural environment (Figure 2). Most dentists, respectively 36 (65.46%), chose to use CBCT technology in some cases, 16 (29.09%) doctors stated that CBCT is always necessary for their patients' cases and only 3 (5.45%) doctors answered that it is not necessary (Table 2). No participant considered that CBCT radiography technology is too expensive or that it requires a lot of time and is not justified.

Most dentists, respectively 36 (65.46%), chose to use CBCT technology in some cases, 16 (29.09%) doctors stated that CBCT is always necessary for their patients' cases and only 3 (5.45%) doctors answered that it is not necessary (Table 2). No participant considered that CBCT radiography technology is too expensive or that it requires a lot of time and is not justified.

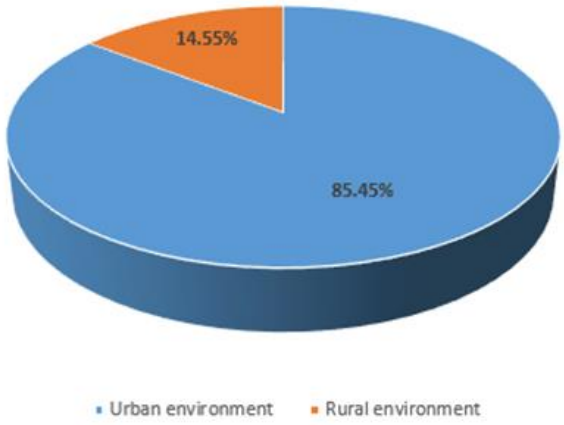

Figure 2. Distribution of subjects according to residence area.

18 doctors (32.7%) answered that they require a CBCT for implantology and surgical diagnosis and only one of the doctors does not recommend CBCT. Most dentists confirmed that CBCT is a very useful tool for diagnostic

 DOI: 10.58179/RJDR1201

confirmation (67.3%), while a third of the responding dentists appreciated that CBCT analysis conducted to a modified treatment plan, very important for the proper management of the patient. Asked if the use of CBCT imposes a necessary training and a special equipment, participating dentists responded that training is necessary (63%), but also equipment (29.6%) (Table 2).

Table 2. Characteristics of the responding dentists.

Characteristics	Number	Percentage (%)
Experience		
≤5 years	28	50.90%
≥5 years	19	34.55%
≥ 10 years	8	14.55%
Use of CBCT		
Always	16	29.09%
Sometimes	36	65.46%
Never	3	5.45%
Impact of CBCT on diagnostic and treatment plan		
CBCT confirmed initial diagnostic	37	67.3%
CBCT modified treatment plan	16	29.1%
No additional benefit	2	3.6%
Training necessary for CBCT use		
Training	34	63%
Training and office equipped with CBCT	16	29.6%
No additional resources necessary	4	7.4%

A total of 45 (81.8%) participants chose the CS 3D image software (Carestream Dental LLC Atlanta, GA, USA), reasoning that the interface is easier to use compared to the variants on the market.

Most participants did not consider CBCT to be an invasive procedure. More than half of the doctors in the study group answered that they use CBCT in the guidelines for implants.

4. Discussions

The study showed a continued increase in CBCT use in dentistry, especially by young dentists with a high acceptance of technology. CBCT is used more in implantology, for diagnostic and treatment planning, but also in orthodontics, dento-alveolar surgery, periodontology and endodontics. CS 3D image software is the most used by dentists in Oltenia, probably because of the recommendation made by radiology equipment producers. Most participants did not consider CBCT to be an invasive procedure. This result showed that most dentists understood that irradiation through CBCT radiography technology is minimally invasive according to the protocol of use.

 DOI: 10.58179/RJDR1201

Also, more than half of the dentists in the study group answered that they use CBCT in the creation of surgical guides for implants. This trend could be explained by the fact that most participants want to decrease possible intraoperative risks at the expense of additional costs. Almost all participants in the study considered CBCT as an important analysis for diagnostic confirmation, since in many cases CBCT led to a change in the treatment plan.

Other studies confirm the increased share of users from the urban environment compared to those from the rural environment, the reason being access to the internet, as well as the initial equipment costs, these representing two objectives that are more accessible to dentists working in the urban environment [1].

There are mentions in many publications in the literature regarding CBCT imaging, which conferred a significant value in the process of diagnosis and establishment of the treatment plan [9-11,26]. Along with the clinical examination, radiological imaging is essential for a complete diagnosis in dentistry. Image analysis is often essential to confirm or deny clinical findings or diagnoses. According to most current guidelines, three-dimensional imaging by cone beam computed tomography is recommended for patients in whom the diagnosis would remain uncertain, or the treatment plan unclear [9-11,26].

There are few research papers published in the literature that describe the analysis of the utility of CBCT in diagnosis, assessment, planning and delivery of treatment. This study was done to improve our understanding of the contribution and limitations of the CBCT imaging modality in diagnosis and treatment planning by various dentistry specialties [9-11,26].

The largest percentage is represented by dentists who have been working for less than 5 years, most of them working in the urban area. We found that a small number of dentists use the CBCT assessment in rural areas. The most indications being for the analysis of the sites necessary for the insertion of dental implants, the second position is occupied by the diagnostics for surgical conditions. None of the respondents checked the answer as an expensive and unjustified investigation.

Before performing a more complex or long-term treatment, complementary examinations are necessary to avoid the risks and complications associated with it, the surveyed doctors recommend CBCT for a limited number of diagnoses, not as an option related to the patient's initial diagnosis [10]. Scan-detected lesions must be evaluated for the following characteristics: location, periphery and shape, internal structure, and the effects of the lesion on adjacent structures with the goal of preserving and improving the patient's health. It is essential that all anomalies are identified, and their nature determined [6,23].

CBCT can also facilitate the planning of surgical treatment in several ways: it is used to examine the precise location and extent of pathologies (odontogenic and non-odontogenic tumors, cysts) of the jaws, as

 DOI: 10.58179/RJDR1201

well as osteomyelitis [27,28], it can allow a clinician to locate and map the structures vital (inferior alveolar, lingual, mental, or greater palatine nerves), when planning surgical therapies [18-20], it can be used to determine the number and morphology of associated roots and canals (both main and accessory), to establish working lengths, and to determine the type and degree of angulation of the root, providing a real assessment of the root present for obturation of the canals, but also to classify the source of the lesion as endodontic or non-endodontic, a fact that can significantly influence the treatment plan [27,29].

Studies performed to evaluate periodontal defects on human and porcine mandibles, using intraoral radiography, panoramic radiography, CT and CBCT concluded that 3D imaging had a high accuracy in detecting alveolar defects [30].

The use of CBCT can replace surgical reintervention because it provides 3D images and measurements of the affected site, which is almost equivalent to direct surgical measurement [10]. In addition, CBCT provides non-overlapping images that are self-corrected for magnification, with a practical 1:1 measurement ratio, for morphometric analysis of structures and anatomical relationships essential to address various orthodontic requirements [10].

Rossini et al. [31] reviewed the literature focused on cone beam computed tomography (CBCT) diagnostic accuracy and effectiveness in detecting impacted maxillary canines and evaluated possible advantages in using the CBCT technique compared to traditional radiographs.

Mota de Almeida et al. reported that in 53% of cases (28 out of 53 cases), the therapy plan changed after the CBCT examination, especially in cases referring to the differentiation of pathology from normal anatomy [32].

Data has been collected, there has been a move to lower radiation protocols and better diagnostic value in high resolution protocol scans. Some researchers have even suggested that CBCT may become the first choice for endodontic treatment planning and outcome assessment, especially when new scanners with lower radiation doses will be used [9]. The published literature suggests that CBCT imaging is superior to 2D imaging in describing periapical lesions, accurately demonstrating the juxtaposition of the lesion to the maxillary sinus, the involvement of the sinus membrane, and the location of the lesion relative to the mandibular canal [10].

To use the software and to have the certainty of a correct diagnosis, most of dentists consider that a dedicated training is needed to use CBCT. By using CBCT, the participating doctors chose its usefulness for implantology interventions. According to the completed questionnaire, CBCT evaluations are most frequently recommended for implantology interventions. Before the surgical placement of dental implants, a thorough planning must be carried out in stages, analyzing: the dimensions, positions and axes of insertion of the implants, which must be established for the intervention [33].

 DOI: 10.58179/RJDR1201

Pre-surgical assessment guidelines emphasize the need for an accurate assessment of bone volume and the location of adjacent anatomic structures in relation to the positioning of the denture-derived dental implant [33]. Imaging for pre-surgical dental implant planning should provide information to support the following goals: establishing the morphological characteristics of the residual alveolar ridge, includes considerations regarding the volume and quality of the bone. The vertical bone height, horizontal width and length of the edentulous ridge determine the amount of bone volume available for placement of the implant fixation device and it is necessary to maintain the available bone volume to determine the diameter and length of the implant [33].

Most respondents use Carestream 3D software. This result can be explained by the low cost of use as only a computer with average specifications is required. Standard imaging software allows the clinician to view the data in several ways: multiplanar reconstruction, standard axial, coronal and sagittal planes that can be traversed in reconstructed panoramic view, cross-sections perpendicular to the dental arch, specific views of of structures such as the temporomandibular joint and three-dimensional (3D) volumetric renderings. Some programs also allow for implant planning and orthodontic analysis, among other functions. The clinician must be trained through training to use the features available in the software package being used [34].

The study was carried out to understand the importance of CBCT evaluation in order to make a precise diagnosis and treatment plan, in different dental specialties. Referral for CBCT imaging should always be guided by the pursuit of improved diagnostic accuracy and the prospect of an improved treatment plan. Ideally, indications for a CBCT scan should be based entirely on case-related factors [10, 33].

In recent years, since the data have been collected, there has been a shift towards lower radiation protocols and better diagnostic value in high-resolution protocol scans. Some researchers have even suggested that CBCT may become the first choice for endodontic treatment planning and outcome assessment, especially when new scanners with lower radiation doses become available [28, 33].

Most participants did not consider CBCT to be an invasive procedure. At the same time, the studies carried out on the new CBCT equipment have demonstrated an emission of radiation that does not negatively affect the human body. Regarding the ALADA (as low as diagnostically acceptable) principle, CBCT has a higher radiation dose compared to other imaging methods. According to the FDI policy statement, all reasonable means should be used to reduce radiation exposures without compromising diagnosis [27, 33]. For CBCT machines, a review by Ludlow et al. estimated effective doses of 13–769 mSv for large or medium FOVs and 7–521 mSv for small FOVs, depending on the machine and acquisition protocols used [35].

 DOI: 10.58179/RJDR1201

5. Conclusions

Although the radiation dose is significantly higher than in the case of two-dimensional radiographs, there is a tendency to increase the use of CBCT with the progress of years among dentists. Although implant planning is the primary reason for CBCT imaging in dentistry, it is also increasingly used for various other diagnostic and treatment planning purposes. In many cases, the primary diagnosis and/or treatment plan was modified following CBCT evaluation, highlighting the important role of CBCT in diagnosis and treatment by various dental specialties. In the future, when the radiation dose of CBCT decreases to similar values of 2-D imaging, it may be the imaging technique of choice in dentistry.

References

1. Shujaat S, Alfadley A, Morgan N, Jamleh A, Riaz M, Aboalela AA, Jacobs R. Emergence of artificial intelligence for automating cone-beam computed tomography-derived maxillary sinus imaging tasks. A systematic review. Clin Implant Dent Relat Res. 2024 Jun 11.
2. Dot G, Chaurasia A, Dubois G, Savoldelli C, Haghighat S, Azimian S, Taramsari AR, Sivaramakrishnan G, Issa J, Dubey A, Schouman T, Gajny L. DentalSegmentator: robust open source deep learning-based CT and CBCT image segmentation. J Dent. 2024 Jun 13:105130.
3. Surendran A, Daigavane P, Shrivastav S, Kamble R, Sanchla AD, Bharti L, Shinde M. The Future of Orthodontics: Deep Learning Technologies. Cureus 16(6): e62045.
4. Maganur PC, Vishwanathaiah S, Mashyakhy M, Abumelha AS, Robaian A, Almohareb T, Almutairi B, Alzahrani KM, Binalrimal S, Marwah N, Khanagar SB, Manoharan V. Development of Artificial Intelligence Models for Tooth Numbering and Detection: A Systematic Review. Int Dent J. 2024 Jun 7:S0020-6539(24)00128-X.
5. Kim N-H, Yang B-E, Kang S-H, Kim Y-H, Na J-Y, Kim J-E, Byun S-H. Preclinical and Preliminary Evaluation of Perceived Image Quality of AI-Processed Low-Dose CBCT Analysis of a Single Tooth. Bioengineering. 2024; 11(6):576.
6. Bezerra A.A., Borges A.F., Leão L.O. , De Araujo CM, Meira Taveira KM. The anterior loop of the inferior alveolar nerve within the mentonian foramen: a scoping review. Surg Radiol Anat (2024).
7. Mohaideen K, Negi A, Verma DK, Kumar N, Sennimalai K, Negi A. Applications of artificial intelligence and machine learning in orthognathic surgery: A scoping review. J Stomatol Oral Maxillofac Surg. 2022 Nov;123(6):e962-e972.
8. Mirzasoleiman P, El-Bialy T, Wiltshire WA, Santos PB, de Sa Leitao Pinheiro FH. Evaluation of Mandibular Projection in Class II Division 2 Subjects Following Orthodontic Treatment Using Clear Aligners. J Contemp Dent Pract 2024;25(4):295–302.
9. Aebisher D, Serafin I, Bartusik-Aebisher D. Temporary Skeletal Anchorage Devices and Cone Beam Tomography in Orthodontics—Current Application and New Directions of Development. Applied Sciences. 2024; 14(12):5028.
10. Jacobs R, Salmon B, Codari M, Hassan B, Bornstein MM. Cone beam computed

tomography in implant dentistry: recommendations for clinical use. BMC Oral Health. 2018; 15;18(1):88.
11. Yoon DC, Mol A, Benn DK, Benavides E. Digital Radiographic Image Processing and Analysis. Dent Clin North Am. 2018; 62(3):341-359.
12. Tyndall DA, Price JB, Tetradis S, Ganz SD, Hildebolt C, Scarfe WC. American Academy of Oral and Maxillofacial Radiology. Position statement of the American Academy of Oral and Maxillofacial Radiology on selection criteria for the use of radiology in dental implantology with emphasis on cone beam computed tomography. Oral Surg Oral Med Oral Pathol Oral Radiol. 2012; 113(6):817-26.
13. Tyndall DA, Brooks SL. Selection criteria for dental implant site imaging: a position paper of the American Academy of Oral and Maxillofacial radiology. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2000; 89(5):630-7.
14. Reddy MS. Radiographic methods in the evaluation of periodontal therapy. J Periodontol. 1992; 63(12 Suppl):1078-84.
15. Cohenca N, Simon JH, Roges R, Morag Y, Malfaz JM. Clinical indications for digital imaging in dento-alveolar trauma. Part 1: traumatic injuries. Dent Traumatol. 2007; 23(2):95-104.
16. Estrela C, Bueno MR, Leles CR, Azevedo B, Azevedo JR. Accuracy of cone beam computed tomography and panoramic and periapical radiography for detection of apical periodontitis. J Endod. 2008; 34(3):273-9.
17. Forghani R, Mukherji SK. Advanced dual-energy CT applications for the evaluation of the soft tissues of the neck. Clin Radiol. 2018; 73(1):70-80.
18. Januario AL, Barriviera M, Duarte WR. Soft tissue cone-beam computed tomography: A novel method for the measurement of gingival tissue and the dimensions of the dentogingival unit. J Esthet Restor Dent. 2008; 20(6): 366–73.
19. Jalili MR, Esmaeelinejad M, Bayat M, Aghdasi MM. Appearance of anatomical structures of mandible on panoramic radiographs in Iranian population. Acta Odontol Scand. 2012; 70(5):384-9.
20. Klinge B, Petersson A, Maly P. Location of the mandibular canal: comparison of macroscopic findings, conventional radiography, and computed tomography. Int J Oral Maxillofac Implants. 1989; 4(4):327-32.
21. Kim IH, Singer SR, Mupparapu M. Review of cone beam computed tomography guidelines in North America. Quintessence Int. 2019; 50(2):136-145.
22. Baratto Filho F, Zaitter S, Haragushiku GA, de Campos EA, Abuabara A, Correr GM. Analysis of the internal anatomy of maxillary first molars by using different methods. J Endod. 2009; 35(3):337-42.
23. Patel S, Dawood A, Ford T, et al. The potential applications of cone beam computed tomography in the management of endodontic problems. International Endodontic Journal. 2007; 40: 818–30.
24. Tsiklakis K, Syriopoulos K, Stamatakis HC. Radiographic examination of the temporomandibular joint using cone beam computed tomography. Dentomaxillofac Radiol. 2004; 33(3):196-201.
25. Barrett JF, Keat N. Artifacts in CT: recognition and avoidance. Radiographics. 2004; 24(6):1679-91.
26. Walter C, Schmidt JC, Dula K, Sculean A. Cone beam computed tomography (CBCT)

for diagnosis and treatment planning in periodontology: A systematic review. Quintessence Int. 2016; 47(1):25-37.
27. Matherne RP, Angelopoulos C, Kulild JC, Tira D. Use of cone-beam computed tomography to identify root canal systems in vitro. J Endod. 2008; 34(1):87-9.
28. Mah P, Reeves TE, McDavid WD. Deriving Hounsfield units using grey levels in cone beam computed tomography. Dento-maxillofac Radiol. 2010; 39(6):323-35.
29. Bhuva B, Barnes JJ, Patel S. The use of limited cone beam computed tomography in the diagnosis and management of a case of perforating internal root resorption. International Endodontic Journal. 2011; 44(8): 777–86.
30. 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(1):48-55.
31. Rossini G, Cavallini C, Cassetta M, Galluccio G, Barbato E. Localization of impacted maxillary canines using cone beam computed tomography. Review of the literature. Ann Stomatol (Roma). 2012; 3(1):14-8.
32. Mota de Almeida FJ, Hassan D, Nasir Abdulrahman G, Brundin M, Romani Vestman N. CBCT influences endodontic therapeutic decision-making in immature traumatized teeth with suspected pulp necrosis: a before-after study. Dentomaxillofac Radiol. 2021; 50(8):20200594.
33. Kaaber L, Matzen LH, Schropp L, Spin-Neto R. Low-dose CBCT protocols in implant dentistry: a systematic review. Oral Surg Oral Med Oral Pathol Oral Radiol. 2024 Apr 6:S2212-4403(24)00132-9. doi: 10.1016/j.oooo.2024.03.013. Epub ahead of print. PMID: 38679501.
34. Winkler J, Sculean A, Gkantidis N. Intraoral Scanners for In Vivo 3D Imaging of the Gingiva and the Alveolar Process. J Clin Med. 2022; 11(21):6389.
35. Ludlow JB, Timothy R, Walker C, Hunter R, Benavides E, Samuelson DB, Scheske MJ. Effective dose of dental CBCT-a metaanalysis of published data and additional data for nine CBCT units. Dentomaxillofac Radiol. 2015; 44(1):20140197.

Author contributions

Authors read and approved the final manuscript. All authors have equally contributed to this work.

Acknowledgements

Not applicable.

Funding information

No source of external funding was received for the completion of this study.

Conflict of interest statement

The authors declare no conflicts of interest concerning this study.

Data availability statement

Will be provided on request.

Ethics statement

Approved by the Scientific Ethics and Deontology Commission of UMF Craiova (no. 55/29.01.2024).

ORCID

Melania Olimpia Cojocaru: https://orcid.org/0000-0002-8975-7485
Antonia Samia Khaddour: https://orcid.org/0009-0000-1672-9734
Sanda Mihaela Popescu: https://orcid.org/0000-0003-3011-6322

How to cite:
Cojocaru MO, Drăghici EC, Khaddour AS, Ghiţă RE, Marinescu IR, Simionescu AM, Popescu SM, Scrieciu M. Frequency for the use of CBCT analysis in dentistry. Rom J Dent Res. 2024; Vol 1(Nr. 2):6-18.