Udruženje inžinjera medicinske radiologije u FBiH

Radiološke tehnologije – Časopis iz oblasti radiološke tehnologije | Volumen 15 | Novembar/Studeni 2024. godine

IMPORTANCE OF CBCT DIAGNOSTICS IN DENTAL IMPLANTOLOGY

Merisa Repeša Komarica,
X-ray cabinet, Faculty of Dental Medicine with the Dental Clinical Center of the University of Sarajevo

Selma Ćosović,
Admission clinic, Faculty of Dentistry with the Dental Clinical Center of the University of Sarajevo

Selma Alić Drina,
Department of Prosthodontics with Dental Implantology, Faculty of Dental Medicine with the Dental Clinical Center of the University of Sarajevo

Submited: October 25, 2024
Accepted: November 3, 2024
DOI: https://doi.org/10.48026/issn.26373297.2024.1.15.5

ABSTRACT

In today's world, the aesthetic demands of patients in dentistry are very high, followed by functional requirements. CBCT diagnostics facilitate the achievement of these goals. Modern dentistry involves replacing missing teeth with dental implants. In dental implantology, precise imaging techniques are essential to accurately capture the area where implants will be placed, in order to avoid damaging adjacent vital structures during surgery. Today, radiological analysis of CBCT scans is considered the best method of choice, or the gold standard, in the pre-implantation procedure.

On CBCT scans, we can visualize the height, width, and density of the available bone for implant placement, the precise location of the maxillary sinus, mandibular canal, mental foramen, incisive canal, and diagnose certain present pathological changes.

1. CASE REPORT

The placement of dental implants has become an integral part of the treatment plan for partially and completely edentulous patients (1). Successful implantation depends on numerous factors, including the patient's overall health, the amount and quality of bone at the implantation site, the biocompatibility of the implant, the implant surface, and the surgical procedure itself (2). Radiography plays a vital role in diagnosis and treatment planning (3). Before the use of 3D imaging, preoperative data were obtained based on clinical examination, model analysis, and 2D images. Radiographic data obtained using 2D imaging techniques have limitations such as structure angulation, enlargement, superimposition, distortion, and misrepresentation, which poses significant challenges when implants need to be placed near structures like nerves, arteries, or maxillary sinuses. A miscalculation can lead to certain complications, such as soft tissue insufficiency, paresthesia, or implant failure (4).

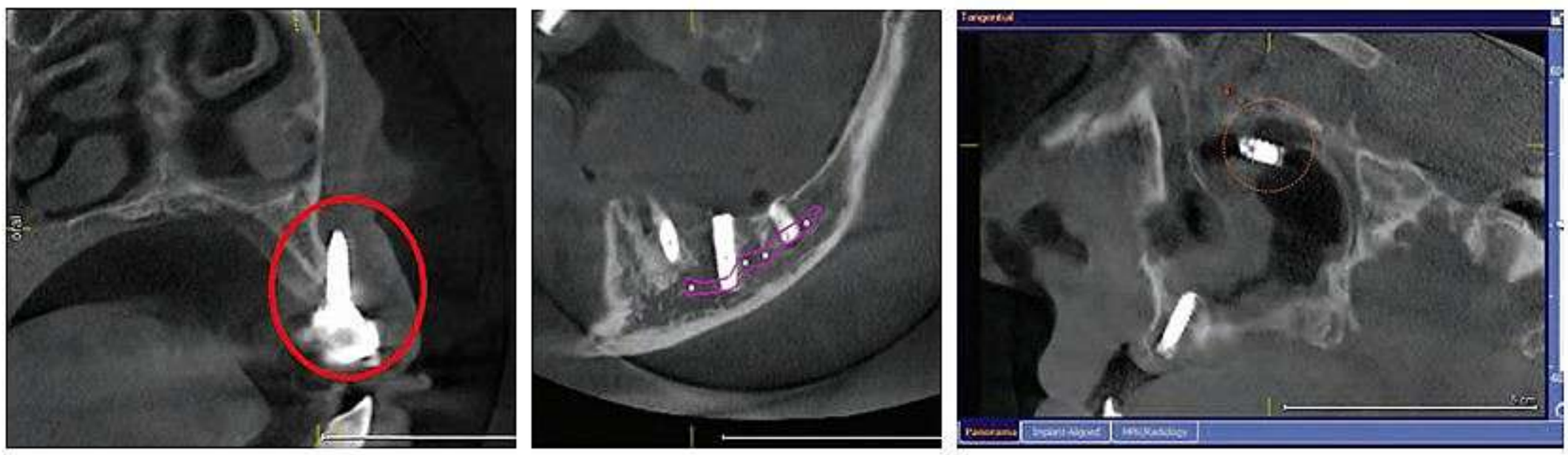

Figure 1. Complications following implant placement using 2D imaging for planning

The application of CBCT technology leads to significant advancements in all areas of dental medicine (5.6).

CBCT imaging provides cross-sections through three planes, allowing for a three-dimensional assessment of hard and soft tissues. The planes are as follows: the axial or horizontal plane provides data from the top to the bottom of the visual field, the frontal or coronal plane offers information from the front to the back of the visual field, and the sagittal plane contains data from the buccal to the lingual side within the visual field. Due to the vast amount of anatomical data contained within the scanned volume, a structured and systematic approach to interpreting CBCT images is essential; otherwise, critical information important for treatment planning and outcomes may be overlooked (7).

Preoperative diagnostic planning involves obtaining information such as the quantitative availability of bone volume, which includes determining the width, height, and density of the bone, the orientation and length of the edentulous ridge, and the distance of relevant anatomical structures (nerves, arteries, sinuses). The purpose of postoperative imaging is to verify and confirm the position and fixation of the implants, as well as to monitor the bone levels around the implants (8). CBCT provides the opportunity for qualitative assessment of bone type and trabecular structure, which is often the most common indication for its use (9).

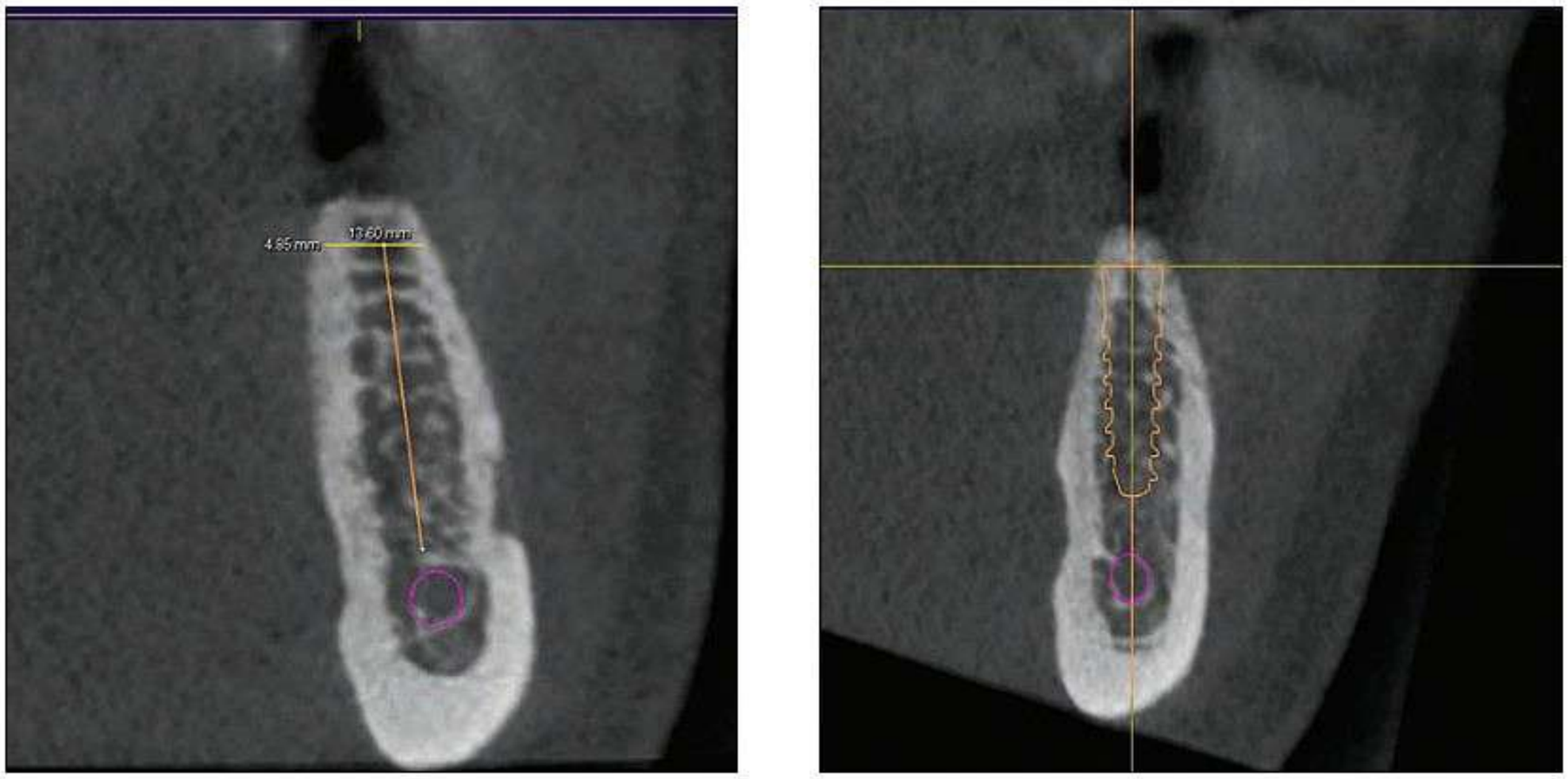

Figure 2 Planning implant placement.

The jaws are divided into four implantological zones, each possessing characteristic anatomy, blood supply, bone resorption patterns, specific quality and quantity of bone, and the need for bone grafting, among other factors.

1. FUNCTIONAL ZONE 1- alveolar ridge of the premaxilla, encompassing the teeth from the left premolar to the right premolar. Characterized by: the greatest bone resorption after extraction, occurring in the vestibulo-oral direction. Any loss of bone significantly impacts aesthetics. The anatomical structure important in this zone is the nasopalatine canal (which contains nerves, arteries, and fibrous connective tissue).

If the implant comes into contact with the nerve tissue of the canal, osseointegration will not occur, leading to sensory dysfunction.

If a patient has been without central incisors for an extended period, mandatory CBCT detection of the nasopalatine canal is required.

Figure 3 Detection of the nasopalatine canal.

2. FUNCTIONAL ZONE 2 -sinus zone located at the base of the maxillary sinus.

CBCT imaging must determine: the height of bone between the sinus floor and the alveolar ridge, and whether sinus pneumatization indicates the need for elevation of its floor. The presence of sinus septa can complicate the sinus lift procedure.

Print: ISSN 2232-8726
Online: ISSN 2637-3297

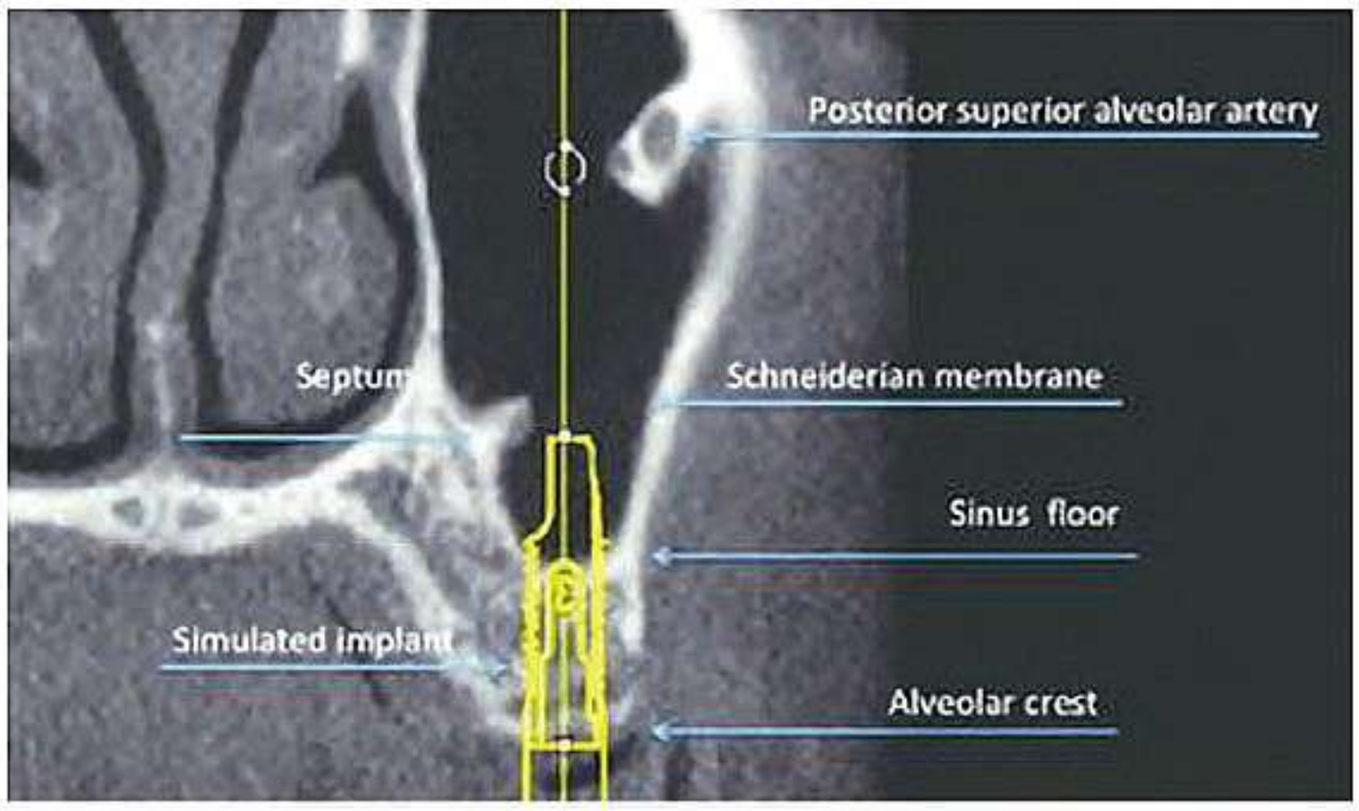

Figure 4 Planning implant placement in functional zone 2

3. FUNCTIONAL ZONE 3 – the anterior mandibular zone, symphysis zone, extending from the left to the right premolar. The placement of implants in this zone is determined by the position of the mental foramen and the presence of accessory foramina.

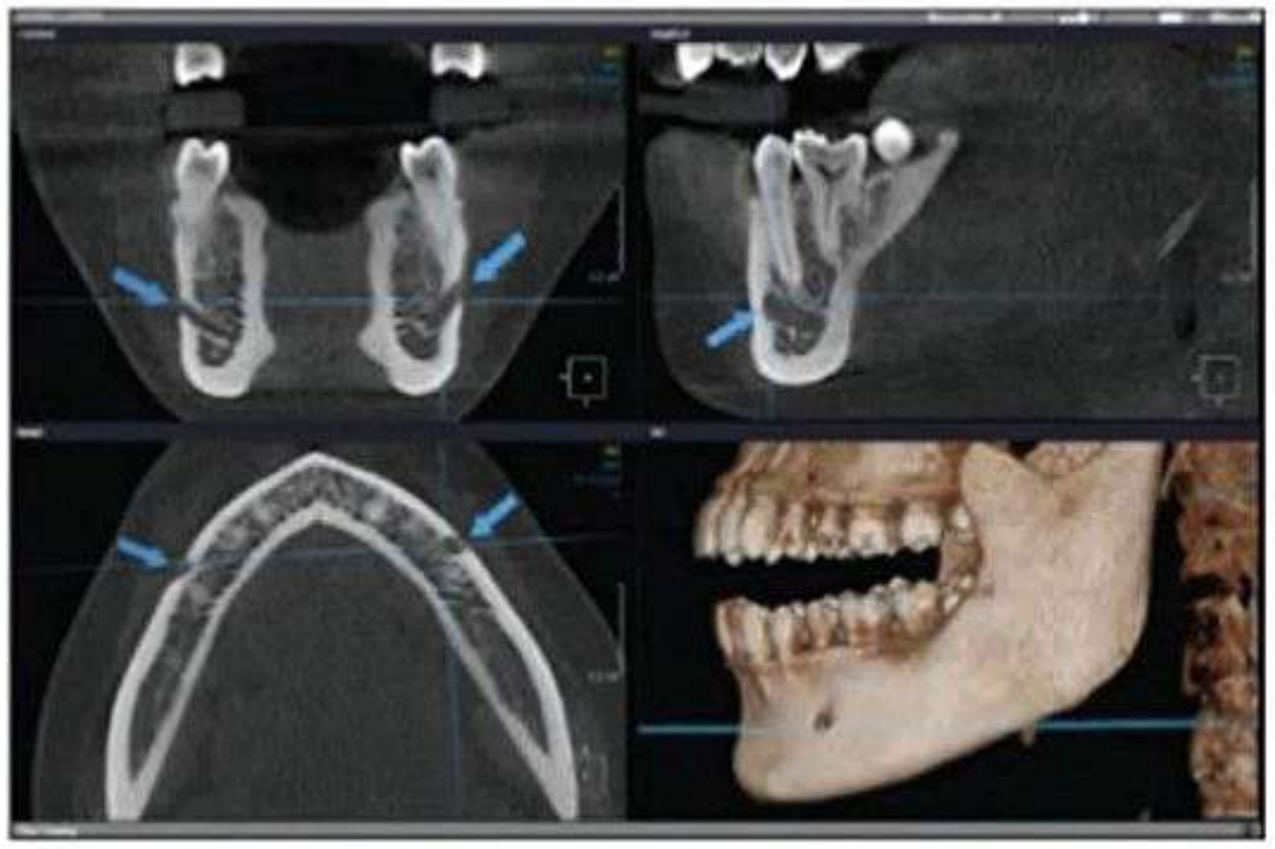

Figure 5 Mental foramen display

4. FUNCTIONAL ZONE 4 – located behind the mental foramen extending to the retromolar area. The position and anatomy of the mandibular canal dictate the placement of the implant. A minimum distance of 2mm from the mandibular canal (the so-called safety zone) is required (10).

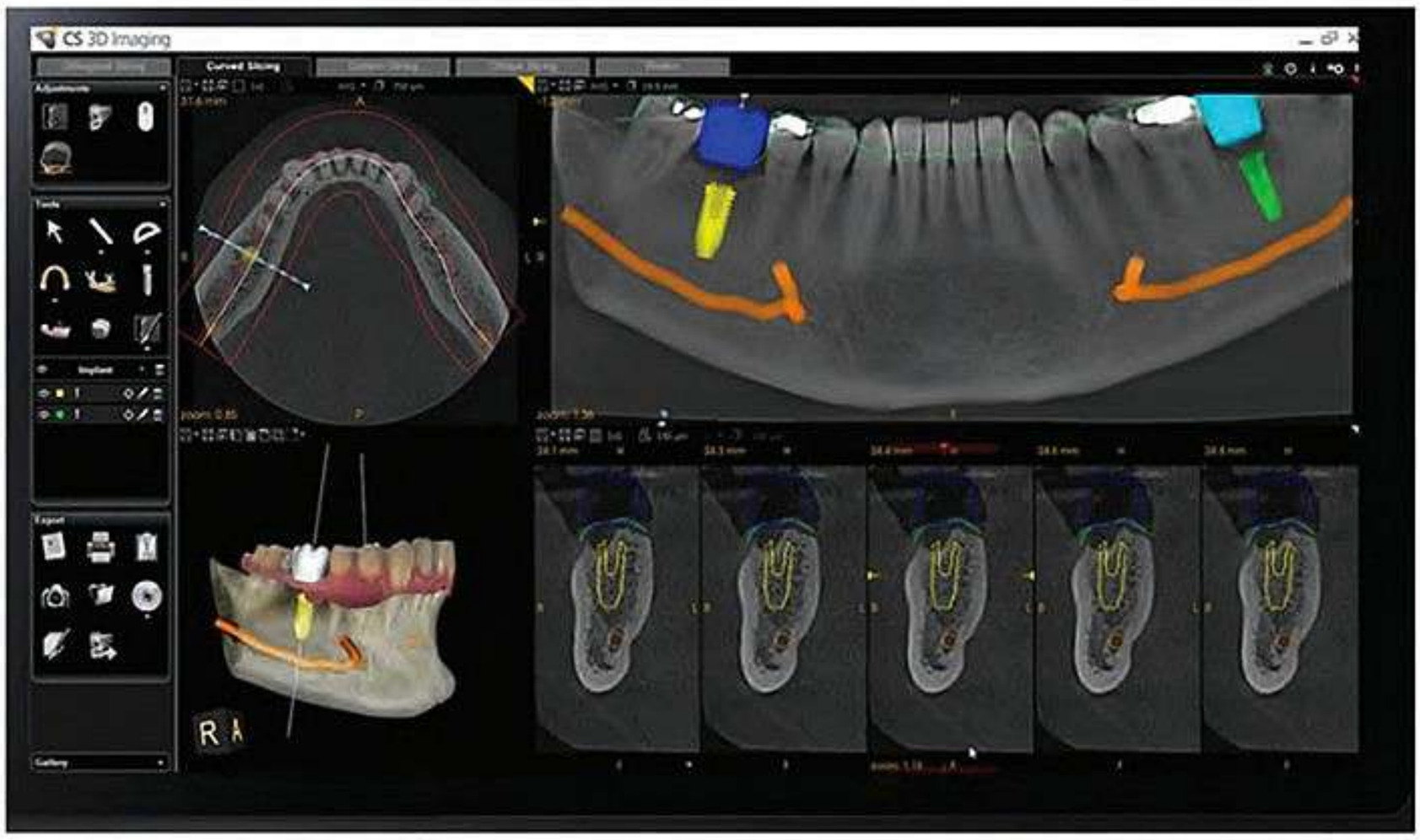

Figure 6. Planning the implant placement in functional zone 4

In addition to diagnostics, CBCT also offers therapeutic possibilities through computer-assisted planning of surgical and prosthetic treatments. DICOM data are combined with stereolithographic (STL) files obtained from an intraoral optical scanner to produce a 3D model of the jaw for virtual planning and the creation of surgical guides for implantation (11).

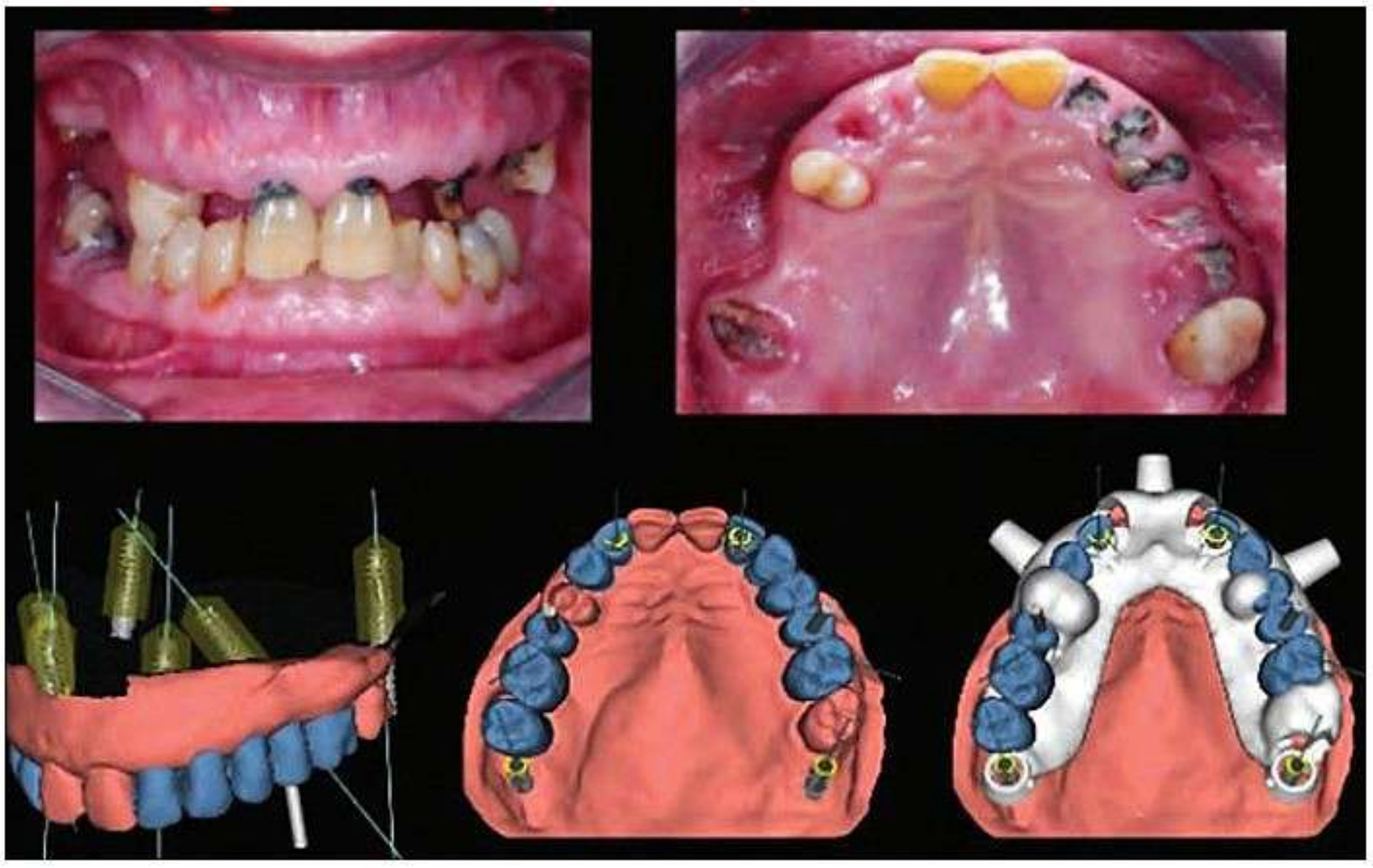

Figure 7 Computer-aided planning of surgical treatment

Print: ISSN 2232-8726
Online: ISSN 2637-3297

Precise planning and placement of implants is a key advantage of CBCT images. The position of the implant is confirmed through virtual placement of the dental implant, as the CBCT device has the capability to create a complete digital model of the bone, soft tissue, and teeth after the patient's teeth are optically scanned. The most important benefit of 3D imaging is the prevention of injury to important anatomical structures during implantation. To prevent such complications, it is necessary to select specific implant dimensions, which can be achieved through measurements provided by the software programs of CBCT scans (5). Radiation doses from CBCT devices are significantly lower than those used in CT devices and are tailored to each patient and their specific indications (12). For comparison, the radiation dose for CBCT ranges from 13 μSv to 479 μSv for devices with a field of view of 4x4 cm. The radiation dose for maxillomandibular medical CT ranges from 474 μSv to 1160 μSv (13).

The quality of interpreting images obtained from CBCT devices depends on several factors, including the diagnostic ability of the physician, the use of specific software, and the selection of the appropriate field of view (FOV) for each individual case (14).

In addition to its many advantages, CBCT has certain drawbacks. The greatest issue is the poor contrast of soft tissues and the occurrence of artifacts due to patient movement if the imaging takes longer (5).

The disadvantages of two-dimensional radiography were the main impetus for the development and widespread use of CBCT devices, which are utilized in numerous branches of dentistry, particularly in dental implantology, due to their precision and accuracy. The installation of implants, with the development of CBCT diagnostics, becomes a straightforward and accurate process for both the patient and the doctor. CBCT, as a radiological method, holds indispensable significance in the planning of implant procedures and in achieving a more successful therapeutic protocol.

REFERENCES

1. Refaie A, Zohdy M, Aboelfadl A, Wahsh M. Effect of different immediate implant loading protocols on peri-im-plant soft tissue health. Braz Dent Sci. 2020; 23(4):1–7. https://bds.ict.unesp.br/index.php/cob/article/view/1998

2. George J, Paulose A, Devassy JP, George J. Immediate loading in implant Dentistry: A review. The Journal of Prosthetic and Implant Dentistry 2021; 4(3):118-22. https://www.ipskerala.com/JPID-vol-4/journal-jpid/JPID-Vol-04-Issue-03-Article03.pdf

3. White S, Pharaoh M. Oral Radiology Principles and Interpretation, 6th edition. Philadelphia, Mosby Elsevier; 2010. https://doi.org/10.1093/ejo/cjp004

4. Paquette DW, Brodala N, Williams RC. Risk factors for endosseous dental implant failure.

5. Dent Clin North Am 2006;50:361–74. https://pubmed.ncbi.nlm.nih.gov/16818020/

6. Hartshorne, J. Essential guidelines for using cone beam computed tomography (CBCT) in implant dentistry. Part 2: Clinical considerations. Int. Dent. Afr. Ed. 2018, *8*, 19.

7. https://www.moderndentistrymedia.com/aug_sep2018/hartshorne_part2_references.pdf

8. Alamri HM, , Sadrameli M, , Alshalhoob MA, , Sadrameli M, , Alshehri MA. Applications of CBCT in dental practice: a review of the literature. Gen Dent 2012; 60: 390–400. https://pubmed.ncbi.nlm.nih.gov/23032226/

9. Horner K, O'Malley L, Taylor K, Glenny AM. Guidelines for clinical use of CBCT: a review. Dentomaxillofac Radiol. 2015;44(1):20140225. https://pubmed.ncbi.nlm.nih.gov/25270063/

10. Tyndall DA, Price JB, Tetradis S, Ganz SD, Hildebolt C, Scarfe WC. 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;113:817-826. https://pubmed.ncbi.nlm.nih.gov/22668710/

11. Valiyaparambil JV, Yamany I, Ortiz D, et al. Bone quality evaluation: Comparison of cone beam computed tomography and subjective surgical assessment. Int J Oral Maxillofac Implants 2012;27(5):1271-7. https://pubmed.ncbi.nlm.nih.gov/23057044/

12. Tolstunov L. Implant zones of the jaws: implant location and related success rate. J Oral Implantol. 2007;33(4):211-20 https://pubmed.ncbi.nlm.nih.gov/17912962/

13. Bornstein MM, Al-Nawas B, Kuchler U, Tahmaseb A. Consensus statements and recommended clinical procedures regarding contemporary surgical and radiographic techniques in implant dentistry. Int J Oral Maxillofac Implants 2014;29 Suppl:78-82. https://pubmed.ncbi.nlm.nih.gov/24660191/

14. 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 May 15;18(1):88 https://pubmed.ncbi.nlm.nih.gov/29764458/

15. Joshi H, Pandya J. 3D IMAGING AND CBCT: A RISING TREND IN DENTISTRY

16. AND ORTHODONTICS [Internet]. International Research Journal of Modernization in Engineering Technology and Science. Volume:03/Issue:03/March-2021

17. https://www.irjmets.com/uploadedfiles/paper/volume3/issue_3_march_2021/6581/1628083278.pdf

18. Benavides E, et al. Use of Cone Beam Computed Tomography in Implant Dentistry, Implant Dentistry: April 2012 - Volume 21 - Issue 2 - p 78-86 https://pubmed.ncbi.nlm.nih.gov/22382748/

Print: ISSN 2232-8726
Online: ISSN 2637-3297