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Review Article

Applications of cone beam computed tomography in the field of prosthodontics: A review of literature

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ABSTRACT:
Cone beam computed tomography (CBCT) is a clinical imaging method of X-ray computed tomography wherein the X-rays are divergent, forming a cone. CBCT systems have been designed for imaging hard tissues of the maxillofacial region. The growing technology for of this generation affords the dental clinician with an imaging modality able to imparting a three-dimensional view of the maxillofacial skeleton with least distortion. Therefore, the aim of this review is to specify the applications of CBCT in the field of prosthodontics along with the benefits and limitations of CBCT.
Keywords-CBCT, prosthodontics, dentistry

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INTRODUCTION

Although combinations of simple X-ray transmission projections and panoramic radiography may be good enough in some of scientific situations, radiographic evaluation may also on occasion be facilitated through multiplanar photos consisting of computed tomographs (CTs).CBCT affords a completely unique imaging option, which may be a boon in diverse factors of prosthodontic practice – from imaging of the temporomandibular joint for correct motion simulation, to template assisted maxillofacial reconstruction. Cone beam computed tomography (CBCT, additionally called C-arm computed tomography [CT], cone beam extent CT, or flat panel CT) is a clinical imaging approach of X-ray CT wherein the X-rays are divergent, forming a cone. The preface of cone beam computed tomography (CBCT) for the maxillofacial region provides a new opportunity to request for multiplanar imaging. CBCT permits the advent of "real-time" images now no longer most effective withinside the axial plane however additionally two-dimensional (2D) images withinside the coronal, sagittal or even indirect or curved image planes - a procedure called multiplanar reformatting (MPR)[1].

Cone beam computed tomography scanners are based on volumetric tomography, using a 2D extended digital array providing an area detector. The cone beam method includes a single 360° experiment wherein the X-ray source and a reciprocating vicinity detector synchronously circulate across the patient's head, stabilized with a head holder. Single projection images, referred to as "basis" images, are taken at specific degree intervals. These look like lateral cephalometric radiography images, but they're slightly offset from each other. The projection data refers to this set of base projection images. These imaging data are processed using software programmes that use advanced methods like back-filtered projection to create a 3D volumetric data set that may be used to generate primary reconstruction images in three orthogonal planes (axial, sagittal and coronal).

Although the CBCT principle has been in use for about two decades, affordable systems have only recently been commercially available because to the advent of low-cost X-ray tubes, high-quality detection systems such as flat panel detectors (FPDs), and powerful personal computers. A literature search for direct indications in prosthodontics was inconclusive, except from those identified referring to its usefulness in implant dentistry, hence an attempt was made to examine possible areas where cone beam computed tomography (CBCT) imaging finds application in prosthodontics.This review broadly explains role of CBCT in prosthodontics.

ROLE OF CBCT IN PROSTHODONTICS

1. TEMPOROMANDIBULAR IMAGING

In situations of trauma, discomfort and dysfunction, and fibro-osseous ankylosis, as well as the detection of condylar cortical/sub-cortical erosion and cysts, CBCT has emerged as the imaging tool of choice. CBCT allows for easy measuring of the roof of the glenoid fossa and visualisation of the three-dimensional relationship between the condylar head and the glenoid fossa due to its accuracy. Soft tissue calcifications surrounding the TMJ are plainly visible, reducing the need for an MRI in these situations.

The implementation of the image-guided puncture technique, which is a therapy modality for TMJ disc adhesion, is made safer thanks to the use of three-dimensional features. Real-time imaging, which is employed for TMJ movement investigations, is the most recent advancement[2-4].

2. DENTAL IMPLANTS

Depending on the centre of rotation required for the particular structure, conventional panoramic radiography produces a magnification ratio of around 1:1.2. When planning implants, this must be considered. According to preliminary CBCT tests, the image underestimates the actual distance. The growing popularity of dental implants as a feasible option for replacing lost teeth has demanded the development of a dependable technique capable of acquiring extremely precise measurements in order to avoid potential harm to essential tissues during implant placement[5,6].

CBCT allows for easy viewing of anatomic features such as the inferior alveolar nerve, maxillary sinus, mental foramen, and surrounding roots. Furthermore, these specialised CBCT pictures allow for precise distance, area, and volume measurements. The surgical guide can be created using a CBCT picture in the absence of the patient (reducing the number of patient appointments), allowing for perfect implant placement, prefabrication of the abutments and prosthesis, and “same day” prosthesis delivery.

Cone beam computed tomography can be very useful in finding regions where there is insufficient bone to support dental implants. This information would help determine the volume of graft needed and the sort of graft material to use before surgery. Cone beam computed tomography is useful for determining the thickness and perforations of the sinus membrane, as well as the patency of the osteomeatal complex and for better planning surgical access into the sinus[7-9].

3. MAXILLOFACIAL PROSTHODONTICS

Cone beam computed tomography has now replaced the standard CT in imaging and planning craniofacial defect reconstruction. Software volume rendering can build three-dimensional augmented virtual models of the patient's face, skeletal structures, and teeth from CBCT DICOM data for treatment planning. This digital compatibility (DICOM) is a worldwide acknowledged standard for data transmission that was intended to prevent malpractice with low distortion and a true main image. Any workstation can be selected by the viewer in order to aid in a better understanding of the task. The shape of the graft can be virtually planned and positioned in the defect prior to surgery, generating a virtual reconstruction of the defect.

Several procedures, including nasopharyngoscopy, cephalometry, nasal airway resistance, and polysomnography, have been used to determine the position of the airway for many years. The use of lateral and frontal radiography to evaluate the pharyngeal airway has also proven to be beneficial. CBCT can also be used to create a threedimensional picture of the airway and surrounding structures in order to undertake accurate volumetric analysis. The examination of the anatomy of complex airways using CBCT scans has been found to be accurate, as evidenced by prior investigations. CBCT-based volumetric measurement of airways is proven to be accurate and error-free. As a result, three-dimensional imaging is a particularly effective approach for examining encroachments and monitoring diffuse or focal airway narrowing. Obturators for cleft closures can be precisely machined in larger CAD/CAM equipment, removing the hard clinical process of obturator manufacture entirely[10-13].

4. ASSESSMENT OF QUALITY OF BONE

The word "bone quality" is frequently used in implant success and failure reports. Skeletal sizes, bone structures, the three-dimensional orientation of the trabeculae, and bone matrix characteristics are all factors that influence bone quality. As a result, it is a critical patient-based element in deciding success.

Bone quality is of four types:

Type 1: Homogeneous cortical bone;

Type 2: Thick cortical bone with marrow cavity;

Type 3: Thin cortical bone with dense trabecular bone of good strength; and

Type 4: Very thin cortical bone with low density trabecular bone of poor strength[14]

5. ASSESSMENT OF RIDGE MORPHOLOGY

Cortical bone loss and accompanying concavities are visible. Mc Ginvney et al and Schwartz et al concluded that 3D scans displayed actual osseous topography more correctly, and that it was a useful diagnostic tool. The buccolingual ridge pattern is difficult to assess on two dimensional imaging system, but CBCT system presents the alveolar ridge morphology. irregular ridges, thin crestal ridge form, or knife-shaped ridges are examples of ridge patterns[14].

6. COMPREHENSIVE TREATMENT PLANNING IN OVERDENTURE PATIENTS

It's not a new concept to keep some teeth/roots for overdenture therapy. It was described for the first time about 150 years ago. Clinicians discovered in the 1950s that when teeth were taken, the remaining alveolar bone was constantly resorbing, leaving complete dentures with very little support and making them difficult to wear.

The rate of resorption was highest in the first six months following tooth extraction, although it varied and was influenced by a range of biological and mechanical factors. According to Tallagren, who discovered that after 25 years of denture wear, the average bone loss in the mandible was 9–10 mm of vertical height compared to 2.5–3 mm on the maxilla, the rate of resorption in the mandible was 4 times that of the maxilla[15,16].

ADVANTAGE OF CONE BEAM COMPUTED TOMOGRAPHY OVER CT

- Cost of equipment is approximately 3–5 times less than traditional Medical CT
- The equipment is substantially lighter and smaller
- No special electrical requirements are needed
- No floor strengthening required as most CBCTs are wall mounted
- Radiation dose is considerably less than with a medical CT
- Protocol selection (e.g., slice thickness) selection is at times difficult with CT in comparison to CBCT
- The spatial resolution of CBCTs is better (i.e., smaller pixels)
- The lower cost of the machine may be passed on to the patient in the form of lower fees
- Both jaws can be imaged at the same time
- Simple to use and maintain; minimal technician training is necessary
- Some cone beam dealers and manufacturers speci alise in the dental sector.

This allows for a better understanding of the dentist's r equirement

LIMITATIONS OF CBCT

- Increased image noise
- The divergence of the x-ray beam and
- Numerous inherent flat-panel detector-based artefacts

CONCLUSION

In conclusion, since the cost of CBCT technology continues to fall, it is just a matter of time before it is used in all clinical offices. Increased diagnostic capacity combined with decreased radiation exposure will also help this technique gain traction. With scan periods of 10 to 70 seconds and a reported radiation dose similar to 4 to 15 panoramic radiographs, CBCT imaging provides clinicians with sub-millimeter spatial resolution images of high diagnostic quality.

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