



Review Article

Various application's of cone beam computed tomography in dentistry: A review

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ABSTRACT

To get the volumetric data of the maxillary and the mandibular dental arches, the teeth itself, the morphology of the bone, to get the imaging and extent of the bony defects that too with low radiation, cone beam computed tomography plays a major role. CBCT is very much helpful in detecting the three dimensional view of the alveolar bone, helpful in getting the quite accurate extent of the bony defects, helpful in some of the difficult cases of root canal treatment where the dentist is not been able to find the actual curvature of the canal or where the accessory canal has been missed from the primary canal. This technique cone beam computed tomography provides the image to the dentist with minimal of distortion.

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1. Introduction

The prime most use of cone beam computed tomography in the field of dentistry is to provide accurate three dimensional imaging of bony hard structure form the oral and maxillofacial region. Cone beam computed tomography provides itself a unique imaging option of hard tissues for different treatment option in dentistry. It is useful in different aspects of prosthodontics clinical practice from three dimensional imaging of the temporomandibular joint for proper three dimensional mandibular movements in the fabrication of complete denture to diagnose the proper bone morphology at the surgical site before going to place the implant.

Cone beam computed tomography has also been known as C-arm CT (computed tomography), cone beam volume computed tomography, flat panel computed tomography. Cone beam computed tomography is basically an imaging technique or we can say more of medical imaging technique.

The development of computed tomography was introduced in the year of 1973, that helps in imaging the bony hard structures with an image of three dimension. This cone beam computed tomography technology still using in various fields, out of all one is dentistry. This technology of cone beam computed tomography has its great use with the implant surgery, and is very useful.

Aria along with his colleagues invented a small or compact computed tomography apparatus specifically to be used in the field of dentistry. Aria with his colleagues in the year of 1997 developed limited cone beam computed tomography device.¹ The more of the relevance of use of cone beam computed tomography in the field to prosthodontics is up to implant surgery.^{1,2} The process of multiplanar reformatting has been used in cone beam computed tomography.³ It helps in creation of real time images in two dimension i.e. in coronal and sagittal even oblique images can be obtained from cone beam computed tomography. Cone beam computed tomography identifies the actual position of the head of the condyle in the glenoid fossa. Which helps in checking the extent of translation of

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the condyle with in the glenoid fossa. It helps in visualizing the three dimensional extent or relation of the head of the condyle with the glenoid fossa.⁴

It is very much necessary to recognize the inter relationship between the dose of the radiation and the quality of the image. According to a research group, they stated that the level of the radiation should be as low as diagnostically acceptable but must be indication oriented as specific regarding to the patient. Protocol for radiation that has been recommended to assist the practitioner's in optimization is of low dose protocol, that has been picked up by the equipment manufacturers of cone beam computed tomography.⁵⁻⁷ Depending upon the generation type of computed tomography equipment and the protocol for the exposure to be applied, the level for multi slice radiation for computed tomography might be lower than the levels of exposure to cone beam computed tomography scan.⁸

1.1. Uses of Cone Beam Computed Tomography⁸:

1. In the imaging of Temporomandibular joint
2. To determine the morphology of the bone prior to implant placement
3. In managing maxillofacial defects or as in maxillofacial imaging
4. Analysis of craniofacial bony defects or to check the exact extent of the bony defect.
5. As a treatment modality, to check the bony architecture for denture supported by implants or as tooth supported over denture.
6. To evaluate the root curvature
7. To evaluate the nerve proximity in the mandibular arch, before the placement of the implant.

1.2. Implant Prosthodontics

Now a days dental implants can be used as an alternative approach for the replacement of missing teeth. To avoid the damage to the important and vital structures present underneath the alveolar bone, proper measurement that should be available from highly accurate and reliable method used to determine the length of the implant, and that one method can be cone beam computed tomography. Specific images that obtained from cone beam computed tomography is accurate, precise and sharp in contrast to measurement of distance between the structures.²

Images that are produced by cone beam computed tomography for the maxillofacial and dental region were quite accurate, as the sense of isotropism were exhibited by the voxels, that reveals uniformity in all the three dimensions.³ Cone beam computed tomography has become the excellent modality for imaging, for planning the implant placement in the mandible or the maxilla as the measurements taken by the cone beam computed tomography are more accurate.³ So with the

help of measurements obtained from cone beam computed tomography, one should be confident enough in the treatment planning with tough surgical procedures like bone augmentation procedure, sinus lift procedure.

As in prosthetically driven implant technique, radio opaque material, tooth coated with barium can be used to mark the final tooth position. This data when used by cone beam computed tomography equipment, can be utilized for the fabrication of surgical guide for proper implant placement at proper angulation, as in case of all on four prosthesis, where surgical guide is used for proper placement of implant at proper angulation.⁷

1.3. Imaging of temporomandibular joint

The prime most advantage of cone beam computed tomography in temporomandibular joint is to detect the actual and correct position of the condyle with in the glenoid fossa. That help us in checking the extent of translation of the condyle with in the glenoid fossa. Helps in checking the dislocation of the condyle, the extent of dislocation of the condyle with in the glenoid fossa.⁹ Cone beam computed tomography helps in determining the three dimensional relationship of the head of the condyle with the glenoid fossa.

Cone beam computed tomography also helps in determining the calcifications of the soft tissue in relation to the temporomandibular joint. Due to the wide variety of applications, cone beam computed tomography has become one of the efficient treatment imaging device of choice in detection of pain around the TMJ, dysfunction or limited movement of the TMJ, condylar dislocation¹⁰ and in detecting erosive cysts.¹¹

1.4. Assessing the bony architecture of the alveolar residual ridge

The system known as cone beam computed tomography helps in giving the three dimensional view of the residual alveolar ridge. The images obtained from the cone beam computed tomography reveals the actual bucco lingual morphology or architecture of the bone, it reveals the actual height of the residual alveolar ridge, and the amount of bone available for the placement of implant, it reveals the three dimensional morphology or architecture of the residual alveolar bone to determine, whether the alveolar ridge residual requires any bone augmentation procedure or not. Bone loss along with concavities if present can be evaluated earlier to any procedure with the help of cone beam computed tomography.²

1.5. Assessing the quality of the bone

The success of the implant is depend on the quality of the alveolar bone residual. Quality of the alveolar bone reveals the architecture of the residual alveolar bone, three

dimensional view of the bony trabeculae and properties of the bone matrix.

1.5.1. Maxillofacial imaging

Cone beam computed tomography helps in determining the accurate extent of the cranio facial defect through proper imaging of the defect. Cone beam computed tomography helps in creating the virtual models in three dimensions in the treatment planning of the patient cranio facial defect, bony deformity of the cranio facial region, and the dentition of the patient with the help of software known as “DICOM”. DICOM is a developed protocol, which is accepted globally in transferring the data along with minimal distortion and actual and correct image.

Cone beam computed tomography was found to be very much successful modality in determining the obstruction of the airway. Cone beam computed tomography enables volumetric analysis along with three dimensional representation of the airways with its surrounding. A study revealed that cone beam computed tomography accurately scans the anatomy of complex structures.^{12–14}

1.6. Helpful in treatment planning for overdentures

It is a fact that, when teeth get extracted, there occur a continuous resorption of the residual alveolar ridge. Because of this reason it was difficult to wear a complete denture as very less support from the alveolar ridge was left. Previous study revealed that, there was continuous as well as progressive bone loss in the patients, those were wearing complete denture from long time.^{15,16} A 25 year follow up study revealed that, the rate of resorption of mandible is four time the rate of resorption of the maxilla. They stated that the rate of resorption of alveolar bone residual in vertical height is 9-10mm for mandible and quite less for the maxillary ridge i.e. 2.5-3mm.¹⁵

So cone beam computed tomography can play an important role in the determining the prognosis for the treatment plan decided for the patient.

Cone beam computed tomography plays its role in endodontic treatment, by getting the actual morphology of root curvature of the tooth, in detecting the actual and accurate morphology of the accessory canal, so that it can't be missed during the endodontic treatment. Cone beam computed tomography is also help full in determining the exact and accurate extent of cleft of the paedo patient, and help in prognosis and treatment planning.

1.7. Advantages

1. Better resolution of the image is obtained by cone beam computed tomography
2. Easy to operate, so manpower is reduced
3. Inexpensive as compared to medical computed tomography

4. Light weight device with smaller size
5. Patient comfort and acceptance is higher with cone beam computed tomography
6. Reduces the fear of claustrophobia to the patient
7. Low radiation dose as compared to medical computed tomography
8. Occurrence of artifacts is very much lesser in case of cone beam computed tomography as compared with other imaging technologies for e.g. OPG, medical computed tomography.
9. Maxillary and the mandibular jaws can be imaged at the same time in cone beam computed tomography machine.
10. Cone beam computed tomography is superior to conventional medical computed tomography that too especially in the maxillo facial region.¹¹

1.8. Disadvantages

1. Clarity of the cone beam computed tomography can be affected by noise and due to poor contrast of the soft tissue.
2. X-ray beam can get diverged
3. Artefacts based upon inherited flat panels

2. Conclusion

Cone beam computed tomography is enhanced, accurate and established radiographic modality in predicting the treatment plan for various oro – facial procedures, like placing implant, bone augmentation procedure, determining the exact position and extent of the bony defect. Its use is increasing day by day in the field of oral health care. Another reason for boom of cone beam computed tomography in present scenario in the oral health care is fabrication of templates for surgical guide. Another point in favor of CBCT is it provides sharp, accurate images with very much low radiation dosage to the patient.

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4. Conflict of Interest

The authors declare they have no conflict of interest.

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