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Expanding Horizons of CBCT in Prosthodontics: Diagnosis and Planning in Implant, Maxillofacial, TMJ, and Overdenture Therapies (A review)

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ABSTRACT

Background: Cone Beam Computed Tomography (CBCT) has revolutionized radiological examination. The use of CBCT in the orofacial area allows for precise three-dimensional visualization. The shortcomings of two-dimensional radiological technologies, particularly in terms of dental implants, motivate the widespread use of CBCT equipment. Aim: To highlight the benefits and limitations of employing CBCT equipment in various disciplines of prosthodontics for diagnosis and treatment planning of implant, maxilla-facial, temporomandibular joint, and overdenture therapy.

CBCT is currently widely utilized in many prosthodontic treatments. The key reasons are its smaller size, lower cost, and decreased radiation exposure when compared to computed tomography. CBCT allows for three-dimensional examination of the maxilla, mandible, skull, and other relevant structures. Conclusion: Three-dimensional radiography, or CBCT, is a diagnostic tool that dentists and dental specialists may utilize to conduct a complete examination and arrange treatments.

Introduction

Prosthodontics has witnessed remarkable advancements with the integration of advanced imaging technologies, particularly Cone Beam Computed Tomography (CBCT). Unlike conventional two-dimensional radiography, CBCT provides volumetric imaging with precise anatomical detail, enabling clinicians to make informed decisions in complex cases (1). This review discusses the diverse applications of CBCT in prosthodontics, evaluating its diagnostic benefits and limitations in clinical practice (2). In the past 20years, there have been significant advancements in radiologic diagnosis and evaluation. The development of new technologies is ongoing getting easier to access for the dental and medical fields. Dental radiology has been increasingly important in establishing diagnosis ,treatment strategy and prognostic value due to the growing range of imaging technique (3). New technologies have recently been introduced and developed in 1982 for angiography and subsequently applied to maxillofacial imaging ,Cone Beam Computed Tomography (CBCT),useful and well liked diagnostic tool in dentistry, are made possible by the necessity for three dimensional (3D)images (4).The head and neck structures are seen on CBCT without overlap . It permits the radiologists to clearly distinguish the features(5). Even though CBCT is now widely use in dentistry, makes use of the transverse axial scanning concept to produce a three-dimensional image. (6). It utilize a cone or divergent form of radiation ionizing with a multiple projection images in a single full scan around the area of

interest using a two dimensional detector set on a rotating gantry. Maxillofacial imaging has been significantly impacted by CBCT technology . It is currently being used for therapy applications after being used for diagnostic in all areas of dentistry, it is not appropriate to use CBCT in place of panoramic or traditional projection radiography application but rather as a complementing method for a particular use(4). This review's objective is to give readers a n understanding of 3D imaging using CB CT technology, including an overview of i ts , benefits, drawbacks, and prosthodontic s applications. Advantages CBCT Comparing cone beam computed tomography to other imaging modalities like CT scans, intraoral imaging, and panoramic imaging reveals a number of advantages. Its w ide applications in the dental sector can be attributed to these advantages. Particularly, because: 1-Cone beam computed tomography provide horizontal, vertical and axial views of structures. It was successfully utilized in various fields like dental implants , endodontics, pathology and orthodontics cases(7). 2-CT scanners are more expensive than CBCT scanners , it was about three-five times less expensive. 3 The equipment for cone beam computed tomography scanners is lighter and more compact(4). 4-Better spatial resolution is achieved using CBCT scanners (smaller pixels)(4). 5- CBCT is more better in the picturing of facial skeleton (due to the difficult nature of the anatomy and the machine design) than CT(8.) 6- lower dosage: Depending on the kind and model of CBC T equipment, the effective dose can vary b etween 29 and 477 µSv contrast to CT scan (9-10-11),in contrast to patient doses documented for traditional CT imaging of the mouth and maxillofacial regions , approximately 2000 mSv(12). 7- CBCT scanners are easy and simple to use(4).

Restriction of CBCT

Affected visual clarity is caused by:- 1- Artifacts: mistakes or errors in the picture that is irrelevant to the area of study .An artifacts are happened because : a- Hounsfield or beam hardening (dark bands or strips) , b-Patient-related an artifact (Patient movement caused lack of sharpness in the created image c-Scanner-related an artifact (ring shaped or circular) d- Cone beam-associated artifact (partial estimation of volume, under sampling, and effect of cone-beam)(13). 2- The high radiation volume during CBCT s canning is the cause of image noise .Imaging degradation is a result of this extra x ray detection, which is known as noise (14). 3-Bad contrast of soft tissue: Compared to CBCT devices, CT units hav e better soft tissue contrast (15). Applications Prosthodontics • 1- Dental Implant 2- of CBCT in Tempro -mandibular joint (TMJ) picturing in three dimension 3-Maxillofacial prosthodontics 4-Universal management in over denture patients(16). 5-Cleft lip and palate estimation 1-dental implant and CBCT: In order to replace lost teeth, dental impla nts are used ,the preferred picturing technique prior to dental implantation is CBCT .It can be applied to the creation of surgical guides for guided surgery as well as through digital treatment planning(17). residual To determine the amount and quality of the bone, a radiographic examination is necessary as well as guarantee the proper implant pl acement in the alveolar bone without jeop ardizing crucial anatomical structure ,like :adjacent teeth, neuro vascular architecture and sinuses of maxilla(18). The choice to order a CBCT should be made solely on the basis of the needs for treatment planning and diagnosis, as with all radiological exams, with a careful effort to reduce patient radiation exposure(19).Features unique to the local patient , such as the type and amount of bone present at the implant location are critical when evaluating the efficacy of dental implant. There are four categories for bone quality. Any implant positioned in weak ,low-density trabecular bone within extremely thin cortical bone type 4 having a greater likelihood of failing. This kind are usually situated in the maxilla ,s posterior region and many studies report higher rates of setback in this area(20). If there is insufficient bone between the m axillary sinus floor and the ridge crest are pain are the most common causes of TMJ complains in patients and radiography typically dose not reveal additional useful information in these cases .Rheumatoid arthritis and condylar osteoarthritis can both be identified with CBCT(18). 3-Maxillo facial Prosthodontics Cone beam computed tomography plays an important part in craniofacial defect reconstruction, much like standard computed tomography dose. With the aid of DICOM data software, CBCT May produce 3D augmented virtual models for practical application when preparing the patient's face bone structures and teeth for therapy. a well recognized protocol known as "digital compatibility"(DICOM) was created to transfer data in a way that minimizes distortion and preserve the original , accurate picture. The graft ,s shape and placement

within the defect can be virtually planned and coordinated before to the real surgery ,resulting in the defect's virtual reconstruction. Likewise, if necessary the graft can be completed in accordance with the implant ,s placement. Identifying any region of airway blockage is always a challenge. With the use of CBCT, a precise volumetric study can also be performed by representing the airway and surrounding structures in three dimensions. The anatomy of complicated airways can be accurately analysed with the use of CBCT images(26-28). 4-Universal management scope in over denture patient The idea of keeping teeth and roots in plac e for over denture was first presented 150 years ago.Clinicians discovered in the 195 0s that there was constant alveolar bone re sorption following tooth extraction, which left very little support for complete dentur es and made them difficult to put on . The resorption rate peaked during the initial six months after tooth ex traction, however differences were seen because of a variety of biological and mechanical reasons. . The rationale was taken from earlier research, which showed that the typical bone loss in the mandible after 25 years of wearing dentures measured between 9 and 10mm in height vertically rather than 2 3 mm on maxilla. When over-dentures are carefully planned, CBCT can be used in conjunction with a number of third-party software programs to improve the prognosis(29-31). Regarding individuals with cleft lip and palate, CBCT was helpful for regarding therapeutic additionally with preoperative assessments. When evaluating cleft palate cases, the scan picture for many planes and parasagittal sections by the numerous applications for the imaging volume. When used in conjunction with 3D navigation systems, three-dimensional reconstructions of images enable preoperative assessments of the cleft palate , including measurements of the bone defect s volume, location and the existence of extra teeth as well as an analysis of the morphology of the alveolar bone and permanent teeth(32). For research was done by Albuquerqu et al(33), it comes to the volumetric evaluation of bone defects in the palatal and alveolar regions, CBCT was found to be comparable to multi slice CT and determining the donor region and the amount of bone transplant that will be utilized during the cleft patient, s rehabilitation.

Conclusion

a well- respected radiographic modality for dental implant treatment planning, CBCT imaging is being utilized more and more widely throughout the world in oral health care.

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