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Prosthodontics applications and Cone Beam Computed Tomography (Literature's Review)

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Abstract

Background: Cone Beam Computed Tomography (CBCT) has revolutionized the process of performing radiological examination. By using CBCT in the orofacial region can be accurately visualized in three dimensions images. The wider spread of CBCT devices is further encouraged by the faults of two-dimensional radiological methods, especially concerning dental implant. Aim: to outline the benefits and drawbacks of using CBCT devices with its applications in different branches in prosthodontics for diagnosis and treatment planning of implant, maxilla- facial, Temporo mandibular joint and in over denture treatment.

Main body: CBCT is now commonly used in several prosthodontics procedures. The primary causes are the smaller size, lower expense, and reduced radiation exposure when compared to computed tomography. Three-dimensional evaluation of the maxilla, mandible, skull and related structures is made possible by CBCT. Conclusion: Three-dimensional radiography, or CBCT is a diagnostic tool that dentists and dental specialist can use for a thorough examination and treatment planning.

Introduction:

Imaging is a crucial diagnostic tool that supports the clinical evaluation of the patient dental clinic (1).from the time that the "dental X-ray pioneers" took the first dental radiographs at the beginning of 1896 radiology is becoming a crucial part of the dental patient assessment process. (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 imaging maxillofacial .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 а multiple projection images in a single full scan around the area of interest using a twodimensional detector set on a rotating gantry. Maxillofacial imaging has been significantly impacted bv 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 projection panoramic or traditional 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 tomogra phy to other imaging modalities like CT s cans,intraoral imaging, and panoramic ima ging 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 t omography scanners is lighter and more c ompact(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 μ Sv 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 of CBCT in Prosthodontics •

1- Dental Implant

2- 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).

To determine the amount and quality of the residual 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, neurovascular 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 patient effort reduce to 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 <5 mm, an open sinus lift procedure is indicated. Preoperative CBCT or CT before open sinus lift surgery is used to evaluate certain factors like membrane thickness, presence of alveolar antral artery trajectory ,sinus septa, , and residual bone height (21) In a particular study researchers compared the accuracy of CBCT scanning Tom 3G) with intraoral type(New periapical radiography type (Dixi 2, Plan meca CCD sensor and Insight film) in order to identify of periapical bone lesions. In conclusion, the results of the study showed that the New Tom 3G was better than intraoral periapical radiography when evaluating the presence of artificially created periapical bone defects. New Tom 3G may be useful in cases of immediate implants intended to replace teeth with suspicion for possible existing endodontic pathology, or in candidate implant sites neighboring such teeth (22).

The following guidelines are provided by Harris et al(23)for clinical situations when patients may benefit from CBCT scan for diagnosis and treatment planning.

- 1- When important anatomical limits and the lack of disease cannot be sufficiently dem onstrated by the clinical examination or co nventional radiography.
- 2- Utilizing these images for reference can yield additional information not possible with traditional radiography procedures, helping to reduce the chance of harm to significant anatomical structures.
- 3- When a patient seems to have bone width and/or height restrictions for efficacious implant therapy which are clinical borderline conditions

4-wheras the biomechanical functional and esthetic treatment outcomes can be maximized by optimizing implant positioning(23) Fig (1).

2-Tempro-mandibular joint (TMJ) picturing:

CBCT has several benefits ,chief among them the ability to accurately determine the condyle real position in the fossa, hence enabling the detection of potential joint disk dislocation as well as the degree of condyle translation . With the use of CBCT the glenoid fossa, s roof can be measured with ease and the condylar head and the fossa's dimensio nal relationship can be shown. With these benefits, CBCT has emerged as the preferred imaging modality for condylar cortical /sub cortical erosion, cyst detection, fibro osseous ankylosis, pain and dysfunction and trauma (16,24,25).

Internal disc derangement or myofacial 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 real .resulting to the surgery 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 overdenture 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 Os 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

1-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.

2-new understanding of anatomic landmarks and structures —such as neurovascular structures-that are at danger while placing implants is partly to blame for this.

3-another factor contributing to the rise in CBCT scanning use the growing acceptance

of surgery using a computer guidance ,that use digital planning based on high quality CBCT images .

4-the reduced radiation dosage significantly increase the diagnostic efficacy, bringing this technique to the public eye and making a prosthodontics work day more laid back , straight forward and consistently more accurate.

Conflicts of interest:

The authors claim to have no conflicting interests.

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Fig (1): Implant in the mandible ⁽³⁴⁾.

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