Role of Cone Beam Computed Tomography System in Implant Dentistry- An Overview

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A B S T R A C T

The Cone Beam Computed Tomography (CBCT) system in all fields of dentistry is well known. This is a technology based evolution with transition from two dimensional to three dimensional imaging in the maxillofacial region. It is used in planning dental implant treatment as it assesses the bone and the hard dental tissue with respect to the quality and quantity. Hence, appropriate diagnosis at initial stages is important factors in determining the success of dental implants. This paper provides an overview based on assessment of ridge morphology, available bone quality and quantity and technology based guided implant placement.

Introduction

The Cone Beam Computed Tomography **(**CBCT) system was developed in the 1990s by Arai *et al*. in Japan[1] and Mozzo *et al*. in Italy[2]. However, for replacement of missing teeth with dental implants, more precise measurements are required to bypass damage to vital anatomical structures. This problem has overcome with CBCT which give more accurate measurements at a lower dosage and is a more preferred option nowadays. Subsequently, more precision and accuracy is achieved with the 'Software Constructed Surgical Guide'[3]. As the selection of case and execution of treatment plan is based on reliable information. Hence, high implant success is predictable.

Role of cone beam computed tomography (CBCT) system

Assessment of ridge morphology

The buccolingual ridge pattern is difficult to assess on two-dimensional imaging system, but CBCT system presents the alveolar ridge morphology. The images provide the appearance of ridge patterns, such as irregular ridges, narrow crestal ridge form or knife shaped ridges. The loss of cortical bone and associated concavities can be seen.

Mc Ginvney *et al* and Schwartz *et al* concluded that the 3D images more accurately showed true osseous topography, and considered it a valuable diagnostic aid[4].

Assessment of quality of bone

The term "bone quality" is commonly used and found in reports on implant success and failure[5]. Bone quality encompasses skeletal sizes, bone architectures, the three-dimensional orientation of the trabeculae, and bone matrix properties. Bone quality defined mineral amount and its structure. Hence, it is an important patient based factors in determining the success[6].

Bone quality is of four types: Types 1–4 (Bone Quality Index)[7]:

- 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.

Type 4 bone is commonly found in the posterior maxillary region and associated with higher failure when compared with the other types of bones[4,5].

Bone density can be defined by the CT units and expressed as Hounsfield units (HU). X-rays, used for diagnostic imaging are non-monochromatic, are composed of high energy photons. So the tissues HU value obtained from one CT system is not same as that with a different CT system, or even with the same machine, if different technique-related factor is used[8]. Unlike CT system units, CBCT system units don't consider as an appropriate scaling system. Various methods proposed to convert CT system numbers measured on CBCT scans to Hounsfield units[8]. Several factors like metallic restorations, hardening of the beam, and scattering causes heterogeneity of CT system numbers on CBCT scans.

With advancement in CBCT software, the accuracy of CBCT HU values is enhanced in bone density determination.

CBCT-guided implant surgery

Software-Constructed Surgical Guides can be fabricated nowadays. Various parameters to ensure successful implant surgery can be assessed such as implant length and diameter, position, relationship of a final prosthesis with adjacent teeth and/or implants, vital structures. Software-Constructed Surgical Guides indication:

- Multiple implants in a quadrant,
- Approximation to vital anatomic structures,
- Proximity of adjacent teeth,
- Insufficient bone volume,
- Flapless procedure,
- Multiple full-arch restorations.

Software-constructed surgical guides Vs conventional surgical stents

Conventional method of surgical stents preparation has been used for many years. Here, the guide made from vacuum form sheets with the buccal or palatal facings of the planned restorations. But there appear marked disparities in the appliances to predict the planned position and the underlying anatomy of bone. However, with the use of software-constructed surgical guides, this disparity can be nullified. Traditionally, various material used were gutta-percha, barium sulfate, and lead foils for conventional surgical guides. However, their application seemed limited in the presence of hard and soft tissue defect[9].

There are three types of software-constructed surgical guides in use:

- Tooth-supported,
- Mucosa-supported,
- Bone-supported.

Tooth-supported surgical guides are used for partially edentulous cases and designed for accurate seating. Mucosal-supported are used in edentulous situation and are designed to rest on the mucosa. Accurate bite registrations are must for preparation of this guide. Bone supported surgical guides used in both cases, but they are primarily used in edentulous cases with significant ridge atrophy where seating of a mucosa supported guides posed problem. Currently, only SimPlantR manufacture bone supporting surgical guides.

During radiographic imaging, CT system causes the highest radiation dose to the salivary glands, whereas the CBCT system delivered the lowest dose[9,10].

Conclusion

The CBCT is considered a far superior as the imaging system that facilitate planning and guidance during the surgical phase. Evidence based research still needs to evaluate its applications and effect on the dental implant based treatment outcome.

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