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Review Article

MRI in implant planning: A future towards radiation free imaging

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ABSTRACT

Since the past few years, dental implants have gained popularity as best treatment option for missing teeth. Accurate diagnosis and treatment planning plays a key role in successful implant placements. Radiography is the most widely used method for assessing quality and quantity of bone in implant site. Selection of proper diagnostic imaging modality and their adequate interpretation is very important in implant planning. With the evolution of different imaging techniques ranging from two dimensional radiography to sophisticated three dimensional imaging modalities, proper selection of technique has become a challenge for the clinicians. However, cone beam computed tomography is the most commonly used technique for implant planning. But the serious effects caused by its radiation dose are also a concern. This article gives a short review about the uses of dental magnetic resonance imaging over cone beam computed tomography in implant planning.

1. Introduction

Within the present scenario, dental implants are extensively used and taken into consideration to be one of the most promising treatment choices for replacement of missing tooth. A dental implant is generally a titanium screw or cylinder, the surface of which is expected to be incorporated via living bone through osteoblastic reactions in surrounding tissues and this is referred to as Osseo integration.[1] The fulfillment of a dental implant relies upon on its ability to combine with surrounding tissue. But, that is in turn dependent on many elements together with implant material, bone quality and quantity and implant loading situation.[2] To develop the idea and particular remedy plan for implant sufferers, diagnostic imaging is obligatory. It is very critical to pick out the type of imaging method with high-quality dimensional accuracy as they play key roles in pre-surgical, surgical and prosthetic implant planning.[3] Conventional radiographic strategies have been changed through computed tomography [CT] and cone beam computed tomography [CBCT] to attain the most accurate records for implant. So as to determine the exceptional imaging modality for an intraoral implant placement, it is very important to identify the advantages and disadvantages.

2. Three-Dimensional Implant Planning

To draw up a correct and scrupulous remedy plan for dental implants, 3-D imaging of edentulous jaw bone vicinity is integral.[4] Inside the year 2000, the Yankee Academy of Oral and Maxillofacial radiology targeted that traditional pass sectional tomography have to be employed in implant patients.[5] Presently, the most broadly used 3D imaging era for implant planning are multi slice computed tomography or cone beam computed tomography.

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Guided implant surgical treatment or prosthodontically pushed backward planning is currently gaining fundamental significance in implant surgical procedure.[6] This technique determines the 3-D function of implant by using highest quality designing of prosthetic healing. It is far transferred to affected person by means of the usage of a surgical guide .[6] Implant surgeons continually favor to use CBCT instead of conventional multi slice CT. The blessings of CBCT over CT consist of small length, low prices, and decreased radiation dose. But, CBCT also has certain risks inclusive of insufficient smooth tissue comparison and shortage of standardized gray scale cost. For that reason, CBCT can be coupled with laptop guided making plans that offer implant designs that is appropriate for a particular implant site in terms of type, period, diameter, entry point and angulation of implant.[7] A meta-analysis diagnosed the capacity lifetime dangers for thyroid cancer and meningioma due to repeated x-ray imaging in dentistry.[8] If we evaluate with 2D radiography like panoramic radiographs, radiation dose of CBCT is 200 times higher.[9] In this example, dental MRI is a non-ionizing imaging modality and may be a promising opportunity for assessment or making plans of implant site

3. MR-Based Implant Planning

Magnetic resonance imaging [MRI] is of latest origin in the discipline of implantology. This is a non-invasive diagnostic imaging modality without the use of ionizing radiation.[10] MRI is used for the imaging of soft tissues inclusive of vicinity of inferior alveolar canal. It is also used as a secondary imaging method when primary imaging modalities fails to differentiate inferior alveolar canal or neurovascular canal from adjoining trabecular bone carrying fats in trabecular bone.[11] Therefore, many conventional MRI techniques in dentistry were used for imaging pulp, periodontal membrane, and surrounding gentle tissues, oblique imaging of teeth and dentin through comparison produced by means of MRI-seen medium.[12] Many in vitro researches have proven that geometric accuracy of MRI is similar to CT and can be used as an imaging modality for dental implantology.[13]

Hilgenfeld et al [2020] conducted an examination to illustrate the usefulness of MR imaging in dental implant planning. They performed a take a look at to evaluate the medical feasibility of 3-T MR imaging for dental implant making plans by comparing results between MR and CBCT based PC guided planning in 45 implant sites from 30 patients. Their study concluded that MR-based planning is satisfactorily accurate for realistic functions.[6] The recently developed approach of guided implant surgery with the usage of intraoral floor scanning and 3D printing demands an imaging modality with enough visualization of mucosa.[14]

MRI is the gold trend in visualization of smooth tissues and organs in medication. Positive committed MRI strategies consisting of extremely-short echo time[UTE] or zero echo time[ZTE] can be used for evaluation of bone, teeth and mucosa for implant planning functions.[15] Many authors have extensively utilized these days advanced MR imaging techniques with teeth surface reconstruction algorithms that lets in integration of MR imaging statistics immediately into digital workflow. This does not require additional software program and makes use of a coil of small size specialized for dental use together with suppressing susceptibility artifacts from dental metals,. Those strategies have advanced exceptional accuracy for dental implant making plans.[4] However, research focusing at the medical use of MRI and completely guided implant surgical treatment should be conducted in human beings for further evaluation.

4. Dental MRI over CBCT

Radiation dose with CBCT is an extreme problem for younger generations.MR based dental implant making plans can be used as an alternative to conquer this problem.[16]

Many preceding researches have proven the reliability of MR imaging in evaluation of bone water concentrations, bone marrow compositions and bone mineral densities. Some of these elements can have an effect on the bone tissues concerned in host reactions and rigid supports for dental implants.[17]

Inside the workflow of completely guided implant placement the use of drill guides, there is acquisition of CBCT and optical scans of tooth and mucosal surfaces. Unfortunately, the imaging artifacts in CBCT originating from enamel surface can create mistakes within the alignment of each statistics sets. However, in edentulous patients, MRI may be a possible opportunity as it overcomes the fundamental predicament of lacking facts on smooth tissues in CBCT.[18]

5. Future Challenges

The important destiny mission of using MRI in implant making plans is the phenomenon of ferromagnetism. This may outcome in the development of artifacts within the picture if the additives of implant are ferromagnetic in nature. This proves to be a main difficulty for the usage of MRI as an imaging modality after implant placement.[19] Another disadvantage is that the exposure of dental implant to MRI can lead to heating of implant which may additionally affect osseo integration.[13] Different factors that limits using MRI in dentistry include high cost, confined availability, requirement of giant hardware and in particular skilled radiologists. In addition technologic advancements are needed to pave the manner for MRI in dentistry.

6. Conclusion

In the present situation, CBCT is in the center of the game and may continue as the main implant imaging modality in the intervening time. The contemporary studies are dropping light to enhance the capacity of excessive resolution MR imaging in implant making plans. But, many extra sophisticated technologic innovations must be executed for the medical use of MR primarily for implant planning. Many studies and researches have to be performed in future by keeping in mind that MR based implant planning without radiation dose can be a better alternative to CBCT.

7. Source of Funding

None.

8. Conflict of Interest

None.

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