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CLINICAL REPORT

Dental Implant Placement using C-arm CT Real Time Imaging System: A Case Report

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Abstract C-arm computed tomography (CT) is a new and innovative imaging technique. In combination with two-dimensional fluoroscopic or radiographic imaging, information provided by three-dimensional C-arm real time imaging can be valuable for therapy planning, guidance and outcome assessment in dental implant placement. This paper reports a case of two dental implant placement using Artis zee C-arm CT system first time in field of implantology.

Keywords C-arm CT system · Dental implant · Real time imaging

Introduction

Implantology is one of the fastest emerging discipline in dentistry. The success of a dental implant depends on precise location of the surgical site which is directly related to the imaging systems being used. Encouraging results have been reported using the latest imaging modalities like CT and Cone Beam CT in implantology. But none of these systems can provide a three-dimensional (3D) real time imaging.

3D C-arm computed tomography (CT) is a new and innovative real time imaging technique. Also referred to as C-arm CT, it uses two-dimensional (2D) X-ray projection data acquired with flat-panel detector [1], which has been in use in medical specialities like orthopaedic surgeries, cardiovascular surgeries etc. for long time.

C-arm CT is a dynamic radiograph, or radiographic movie, and differs from conventional dental radiography which is static. While physicians can observe these live imaging events, only possibility of a dentist to monitor treatment progress, is by taking radiographs before and after the procedure. As a result, routine maxillofacial surgeries, endodontic treatments and conventional dental implant placement are invariably blind procedures [2].

So, introduction of C-arm systems with the added advantage of real time imaging to implant placement in dentistry will be a giant leap and definitely will provide a cutting edge over existing methods.

In the following case report, Artis zee C-arm real time imaging system (Siemens AG, Healthcare Sector, Forchheim, Germany) was used (Fig. 1).

Case

A 35 year old male patient reported to our clinic with a chief complaint of edentulous area in the upper and lower right back region of jaw. Intra-oral examination revealed the absence of 46 and 16, with sound residual ridge and adequate interarch space. Pre-operative radiographic assessment of the bone in the edentulous area using digital radiography and Artis zee C-arm real time imaging system revealed sufficient amount of bone density. The length, diameter and depth of the implant site were assessed using Artis zee C-arm CT real time imaging system. Dental implants of dimension 11.5 mm length × 4.2 mm diameter for 46 and 10 mm length × 4.2 mm diameter for maxillary 16 (Adin Implant System, Israel) were selected.

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Fig. 1 Implant placement procedure with Artis zee C-arm real time imaging

Fig. 2 Preoperative view of edentulous space in 46

A full thickness mucoperiosteal flap from distal of 45 to mesial of 47 was elevated after giving a crestal incision. The area was isolated and pilot drill of 2 mm diameter was used initially to prepare the site to a length of 11.5 mm followed by 2.5, 3.2 mm diameter drills to the same length and final drill of 3.65 mm diameter up to one-fourth the final length was used with a hand piece speed at 750 rpm and torque 35 Ncm [2]. Implant was placed in the prepared site and ratcheted to the required length (Figs. 2, 3, 4, 5). The cover screw was placed and surgical site was sutured.

Fig. 3 Drilling for implant in 46

Fig. 4 Ratcheting of placed dental implant in 46

The same protocol was followed for the tooth 16. A full mucoperiosteal flap was raised after giving a crestal incision from distal of 15 to mesial of 17. The selected implant was placed in the prepared site and ratcheted to the required length (Figs. 6, 7, 8). Cover screw was placed and surgical site was sutured as it was done in 46.

Artis zee C-arm system was used for real time imaging during pilot drill placement and implant placement with the strict adherence to minimum radiation exposure (ALARA)

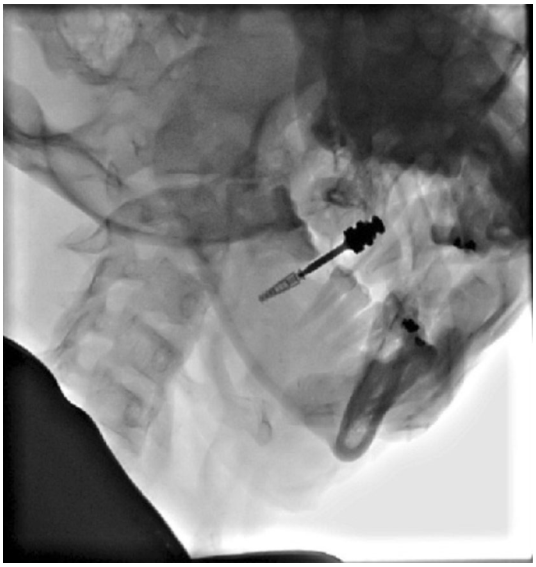

Fig. 5 Placement of healing cap in implant in 46

Fig. 6 Postoperative view of Implant in 46 and edentulous space in 16

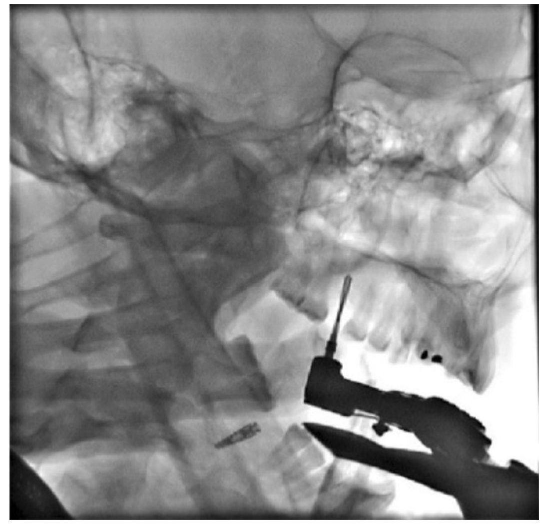

Fig. 7 Drilling for implant in 16

Fig. 8 Ratcheting of placed dental implant in 16

protocol for both the patient and the operator using thyroid collars and lead aprons.

Post implant placement radiographic images were obtained using Artis zee C-arm CT real time imaging system.

Discussion

The results obtained after literature search in Pubmed data base with the words " C-arm CT in Dental Implant" yield no results whereas with "C-arm CT in Dentistry", 4 results and with the word "C-arm Fluoroscopy in Dentistry", 6 results and in Cochrance data base none of the above words yield any results.

In-office C-arm CT has helped to fulfil a growing demand for minimally invasive procedures in traumatology, orthopaedics, endoscopy, paediatrics and urgent care medicine [3]. Today, C-arm CT accounts for 35 % of the medical imaging market [4].

C-arm cone beam CT uses state-of-art C-arm flat-panel fluoroscopy systems to acquire and display 3D images. C-arm cone-beam CT provides high and low contrast soft tissue (CT-like) images in multiple viewing planes, which constitutes a substantial improvement over conventional single-plannar digital substraction angiography and fluoroscopy [5].

Since the introduction of image intensifying principles in 1942, and first image intensification unit in 1953, the harmful effects of radiation have been considerably reduced [6, 7]. An image intensifier, in combination with the use of low milliampere levels, lower patient and operator dose, provides dynamic real-time imaging and allows the operator to position the patient to visualize anatomical of interest. Video images recorded this way or by digital detectors are stored in a computer, where they can be viewed on a monitor in real time or printed to film. To keep the radiation dose from becoming a health hazard, the exposure rate in C-arm CT image intensification is several orders of magnitude lower than in radiography [8].

To obtain 2D radiographic projection data, the C-arm performs a sweep around the patient e.g. over 2,000. Up to several hundred images are acquired depending on the acquisition protocol selected. Reconstruction of 3D voxel data sets from 2D raw projection data is performed using a 3D cone-beam reconstruction algorithm. Resulting voxel data sets can be visualized either as cross-sectional images or as 3D data sets using different volume rendering techniques [1, 9–11].

3D C-arm imaging comprises a stand and a C-arm to which the detector, X-ray tube and collimator are attached. The C-arm keeps the X-ray tube, collimator, and a flat-panel detector exactly aligned under varying view angles. This design maximizing the number of degrees of freedom for movements while minimizing the required space for the gantry itself, C-arm systems achieve high positioning flexibility and provide excellent patient access. [1, 12, 13].

Intra-operative complications like labial/lingual perforation, impavement on anatomical structures like maxillary sinus perforation during implant placement can be avoided because of dynamic real time imaging of this system which offers advantage of on the spot decision for any alteration required.

The currently used system was found to be advantageous as the multi-axis stand facilitates greater flexibility, more accurate, faster movements and better patient coverage [1, 14, 15].

Radiation exposure with Artis zee C-arm CT systems with automated exposure control adjust X-ray exposure parameters such that the detector entrance dose remains constant. Detector entrance dose is the X-ray dose measured behind the anti-scatter grid. System dose is the detector entrance dose evaluated at a reference detector zoom format. System dose is an important set-up parameter for C-arm CT imaging protocols on Artis zee systems. Due to internal adjustments, the detector entrance dose for C-arm CT is about half the system dose [1, 16, 17]. The radiation exposure with C-arm system is 60–80 % less as compared to Spiral CT [18]. As per the manufacturers, the maximum radiation dose for the present system used is 0.25 mSv.

As reported by Strobel et al. C-arm CT dose for head region with a scan time of 5 s with 2×2 binning is 0.3 mSv which provides 133 + 133 frames. Whereas in CBCT effective dose is between 0.03 and 0.4 mSv and in conventional CT scan of maxilla it is equivalent to 2.1 mSv [19, 20].

In the present case report, the images obtained and the real time imaging provided a three dimensional viewing of involved tooth along with the intricate anatomical details for improved quality of treatment. Regarding the limitations of this system in implantology is that, it requires complete supine position of the patient and moderately higher exposure protocol for real time imaging and the design that suits a large volume of tissue to be scanned. So, a limited view chair side C-arm real time imaging system with radiation guidelines is the need of the hour.

In India, the cost incurred by a patient for routine implant placement irrespective of the systems used is in the range of INR 15,000–25,000. The expected cost for a C-arm Scan for implant placement is within the range of INR 1,000–1,500. The cost to benefit ratio in such cases using C-arm will fall within the normal expense.

Conclusion

Imaging modalities for a dental implant should provide the maximum diagnostic information, help to avoid unwanted complications and maximize treatment outcome while delivering minimum possible radiation dose to the patient. Introduction of C-arm CT imaging system will definitely help the implantologist to achieve this goal for a successful implant placement.

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