REHABILITATION OF MISSING MAXILLARY MOLAR WITH 3-D GUIDED IMPLANT SURGERY IN A COMPLETE DIGITAL WORKFLOW: A CASE REPORT

[1]Dr Abhishek Hirwani, [2]Dr Karthik Krishna M, [3]Dr Saswati Mohanty

[1,3]PG Student, [2]Head of Department
Department of Periodontology
Rungta College of Dental Sciences and Research
KohkaBhilai 490024, district-Durg, Chhatisgarh, India

***Abstract*- The dental implant has been accepted as one of the most predictable approach for the rehabilitation of missing teeth. Correct implant positioning is of critical importance. To this end, radiographic techniques imparting 3D information and guided surgical strategies, both static and dynamic, were developed. With the evolution of newer materials and advancement in virtual technology, particularly in computed tomography, implant planning software and guided implant surgery, the outcomes and success rates in implant dentistry have become more predictable. Computer-aided design (CAD) technique is being integrated into treatment planning, and computer-assisted manufacturing (CAM) is gaining popularity for rehabilitation procedures. Thanks to 3D-guided implant surgery, we can significantly reduce the risk of complications by predetermining the optimal location for implants as well as their angle and depth. This case report presents the diagnosis, planning and application of 3D-guided technology in dental implant surgery.**

***Index Terms*- Dental implants; Oral surgery; CAD/CAM.**

1. INTRODUCTION

Implant therapy is the treatment of choice for the replacement of missing teeth [1], as long-term follow-up of patients rehabilitated with implants has shown satisfactory results in a large number of patients [2]. The placement of implants should be as precise as possible, as they are located very close to vital structures (maxillary sinus, vessels and nerves) [3], so pre-treatment planning is essential [4]. Nowadays, implantology uses techniques that provide three-dimensional information for the optimal placement of implants taking into account the prosthetic parameters. These strategies are computed tomography (CT) and cone beam computed tomography (CBCT) as well as 3D implant planning software and CAD/CAM [2,5,6,7,8]. All these advances have made the development of navigation surgery or computer-guided surgery possible [7,8,9,10]. These techniques can be classified into static and dynamic surgery [10,11,12]. With the rapid development in computer technology in the last few years, the developments of computer aided design/computer assisted manufacturing (CAD/CAM) technologies have brought a great revolution in clinical dentistry, more specifically in oral implantology [13,14]. One of the recent approaches to this revolution is 3D Guided Surgery. This treatment concept has been developed with the aid of three-dimensional (3D) computed tomography (CT) scan images and computer aided design/computer aided manufacturing (CAD/CAM) technology. Special software allows clinicians to plan implants in the virtual 3D image that is constructed from CT data. This enables clinicians to make a treatment plan with anatomical and prosthetic considerations. The planned data of implant placement are then transferred to fabricate computer guided stereolithographic surgical template. This template makes it possible to place implants in a pre-planned position without raising a flap [15,17]. The advantages of 3D Guided surgical protocol are its minimally invasive nature, accuracy of implant placement, predictability and less post surgical discomfort. It also reduced the time required for definitive rehabilitation in comparison with conventional implant placement procedures. The available bone can be evaluated and used optimally by avoiding bone graft, or at least planned beforehand to achieve the best clinical result [16]. This case report explains the use of computer-assisted diagnostics by 3D CBCT, performing virtual implant planning, fabricating the stereolithographic surgical template and placement of the dental implant in a pre-planned site with the help of a surgical guide then immediate 3D printed temporary restoration.

2. CASE REPORT

A 45-year-old male patient reported to the Department of Periodontics and Implantology, Rungta College of Dental Sciences and Research, Bhilai, Chhattisgarh India, with a chief complaint of missing upper right and left back tooth region. Intraoral examination revealed missing, with a history of extraction five months back due to endodontic failure (Fig.1). After discussing various modalities for the replacement of his missing tooth, the patient optioned the implant-supported crown with guided surgery on the upper right back tooth region. The case was then planned and executed according to guided surgery protocol as purposed by Neodent Straumann® Guided Surgery.

Step 1 – Treatment plan

Maxillary and mandibular diagnostic impressions were made with irreversible hydrocolloid impression material, poured in Type III dental stone and diagnostic mounting was done. An intraoralperiapicalradiograph (IOPA) and Orthopantomograph (OPG) were made to evaluate the bony foundation over the implant site, proximity of vital structures and overall status of the remaining dentition. Intraoral evaluation of hard and soft tissues was performed. The presence of adequate keratinized tissue and bone width of 6 mm support our plan for guided flapless surgery with a stereolithographic surgical template for implant placement.

Step 2 – Intraoral Scanning

The intraoral scanning using Straumann® Virtuo Vivo Intraoral Scanner and a virtual model was achieved. The scan images are duplicate of the current clinical situation. This soft copy file was saved for treatment planning using a dedicated 3D CBCT software.(Fig. 2)

Step 3 – CBCT scanning

Full mouth CBCT was made with. Galileos, Orthophos XG, Dentsply Sirona, Charlotte, North Carolina, United States, CBCT was then evaluated with a Pro-digident Implantation, dedicated software for the possibility of rehabilitation with an implant-supported prosthesis. Soft copy images of the virtual Scanned intra-oral images and 3D images of CBCT images were then merged together with the help of certain common reference points for definite planning of fixture length, diameter and angulations(Fig 2).

Step 4 – Software-based planning and fabrication of the surgical template

After the evaluation of the edentulous site in CBCT, Straumann Neodent GM Helix Aqua implant of 4.0 mm in diameter and 11.5 mm length was planned (Fig. 2). For planning the surgical guide, the sleeve system of Neodent Straumann Guide drill keys was selected using H-9 surgical protocol. After confirmation of implant and surgical guide, the soft copy of the case plan was sent to the dental lab for 3D printing of the surgical template and provisional prosthesis. A stereolithographic (STL) 3D Printer was used to print the surgical guide in resin. (Fig. 3)

Step 5 – Surgery with Straumann® Neodent guided instruments & guided implant placement

After assuring the fit of the surgical template intraorally, the implant surgery was performed as per protocol with the guided instruments sets in the Straumann® Neodent Guided Surgery Cassette.

The surgical protocol, provided along with the surgical template recommended the sequence of instruments required to prepare each implant site. Under Local Anesthesia Septocaine® Septodont USA (4% Articaine with 1:100000 Adrenaline), the surgery was initiated with the mucosa punch (diameter 4.0 mm) with 25 rpm through the sleeves with the surgical template.

Mucosa punch allowed blade-free incision with minimum trauma. The bone was then drilled with the Pilot Drill (diameter 2.0 mm). Basic implant bed preparation was continued using the diameter 2.0 mm, 3.5 mm and 3.75 mm twist drill using the corresponding drill T handles. The correct cylinder of the drill handle and the respective drill length as indicated in the surgical protocol recommended by the software was taken into consideration. This surgical guide assures correct osteotomy site preparation as pre-planned earlier. After the completion of flapless implant bed preparation. StraumannNeodent GM Helix Aqua Implant (4.0 mm diameter and 11.5 mm length) was placed with 15 revolutions per minute using the implant motor surgical handpiece and final torquing was performed using a torque wrench.. GM Exact Ti-base abutment collar height of 3.5 mm was then placed, there was no need of suturing the overlying soft tissues at the implant site and temporisation was done immediately after implant placement and occlusion was checked according to the immediate implant loading protocol. The patient was recalled the next day for follow-up. It was observed that there was no pain, swelling or post-surgical problems. (Fig. 4)

Step 6 – Prosthetic procedures

The definite prosthetic procedure for this case will be performed later after clinical and radiographic evidence of osseointegration. Ti-Base Screw Cement retained crown has been planned after 4 months for this case. (Fig. 5)

3. DISCUSSION:

Guided implant surgery using 3D CBCT and Stereolithographic surgical template is a relatively new concept intended to facilitate the placement of dental implants by planning the final position of the implants prior to the surgery and the prosthetic work. However, as this is a fairly new concept, it is important to understand more about the technique and the final positioning of implants placed with the aid of a surgical template.[19]Even if the duration of the surgical intervention may be shorter with flapless guided surgery compared to conventional techniques, it seems that much more time has to be invested in preoperative planning.[17]Clinicians need to learn about possible variations that could occur when placing implants with a CAD/CAM surgical template, to avoid anatomical risks, as well as for the final prosthetic reconstruction. When comparing clinical results from implants placed with CAD/CAM surgical templates with the conventional approach, many studies showed similar or better results. Higher accuracy of the surgical template is achieved from virtually designed and printed template after superimposing a surface scan with CBCT in order to transform the virtual plan into reality. If intraoral scans are additionally used the accuracy may even improve as the intraoral scan may reduce the sources of inaccuracies associated with cast model preparation.[18]Sebastian et al in 2015 stated that high accuracy can be achieved using printed templates for guided implant surgery[20]Susanne et al in 2011 showed precise transfer of implant replica position by means of simulated guided implant placement into a preoperative cast.[21]The use of a computer program for planning prosthetically driven implants is highly efficient and safe. The three-dimensional view in this dedicated program allows the determination of the best implant position, the optimization of the implant axis, and the definition of the best surgical and prosthetic solution for the patient. Thus, a protocol that combines a computer-guided technique with conventional surgical procedures becomes a promising option.[22] In the study by Barter et al in 2010, patients were treated with flapless guided surgery to avoid a secondary exposure of earlier grafted sites. The implant survival rate was 98% and all prostheses were in use after 4 years.[17]Static fully guided implant navigation surgery has the highest accuracy for transmitting the presurgical positioning planning to the patient, followed by static half-guided surgery, while freehand implant placement provides the least accuracy.[12]

4. CONCLUSIONS:

The modern digitalisation of various procedures has found its way into the field of implantology and patient care. Ideal treatment planning, fast and minimally invasive implantation, and prosthetic rehabilitation are essential for an overall successful treatment. Today's digital possibilities not only allow exact planning but are also a great help in the ideal placement of the implant body. This results in reduced surgery times and therefore favours an optimal treatment outcome.

5. ACKNOWLEDGMENT

The authors like to express special thanks of gratitude to Dr Karthik Krishna M. my guide and Dean Rungta College of Dental Sciences and Research Bhilai for his immense support.

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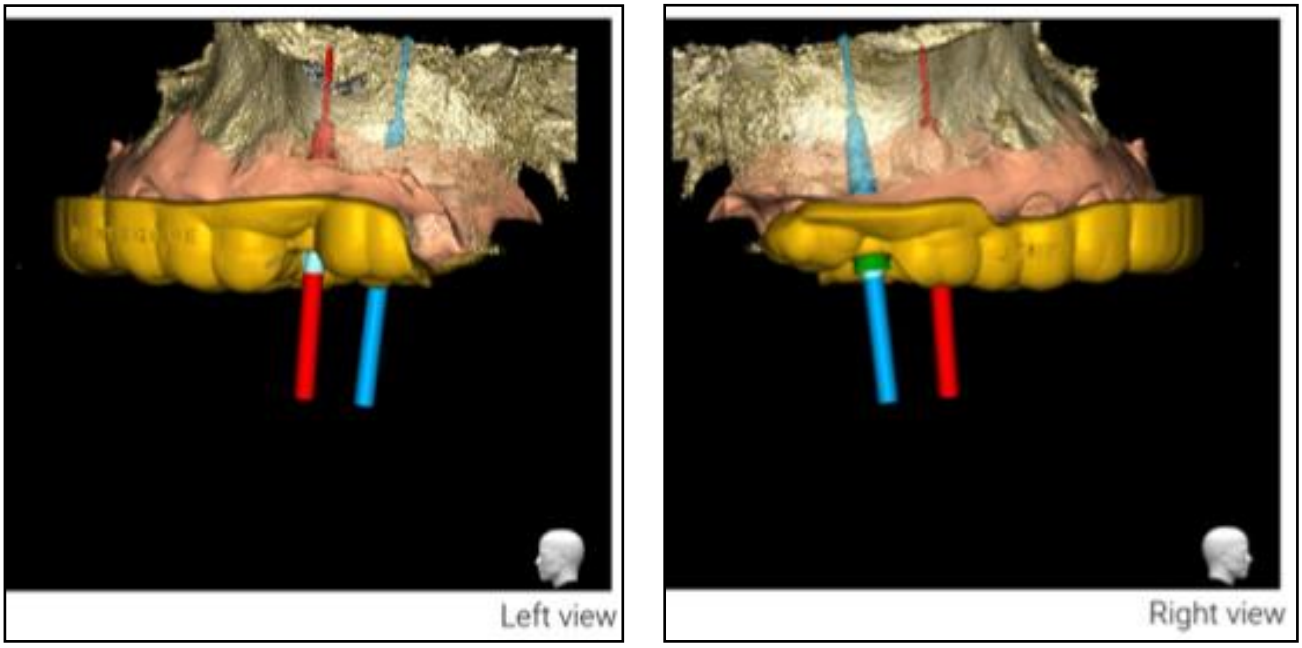
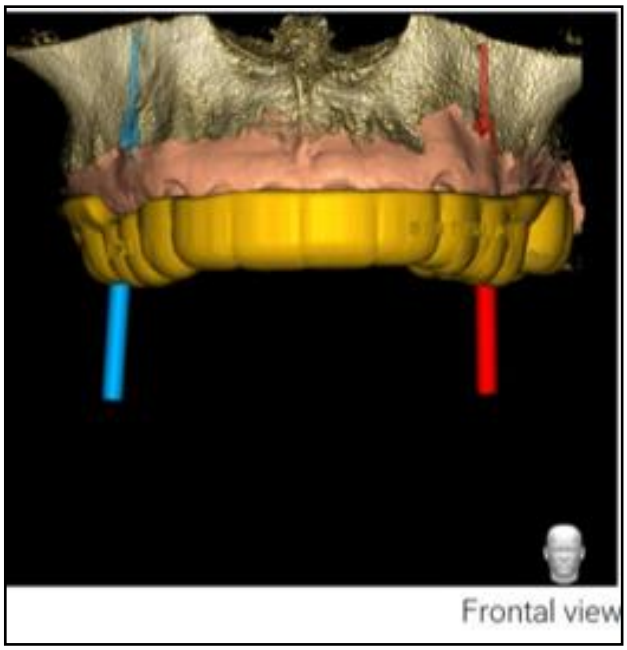
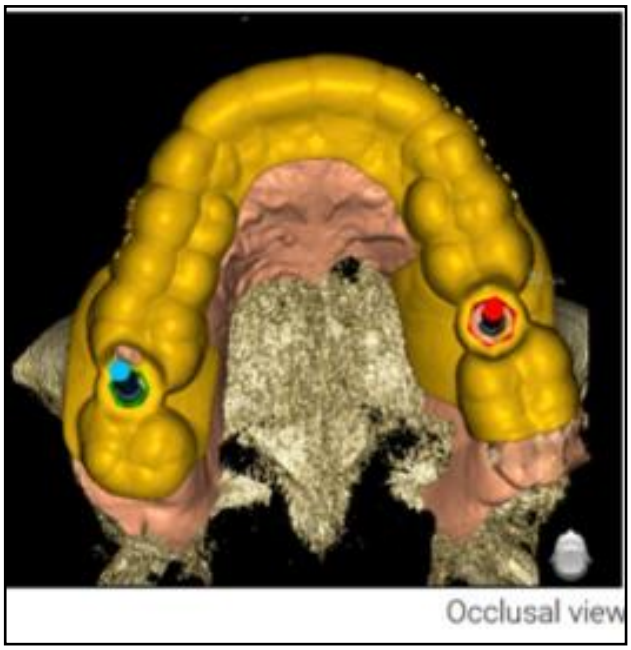
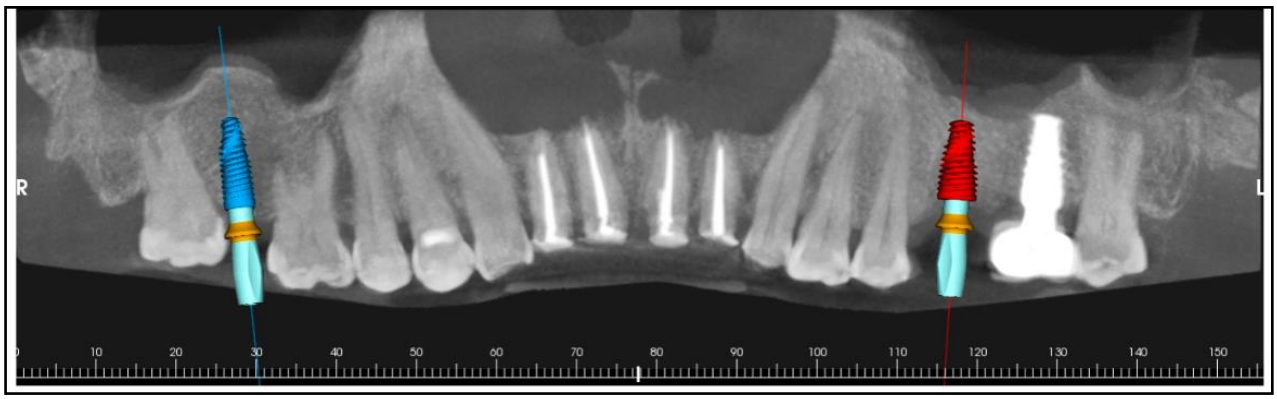
Fig.1 Intraoral examination




Frontal view


Occlusal view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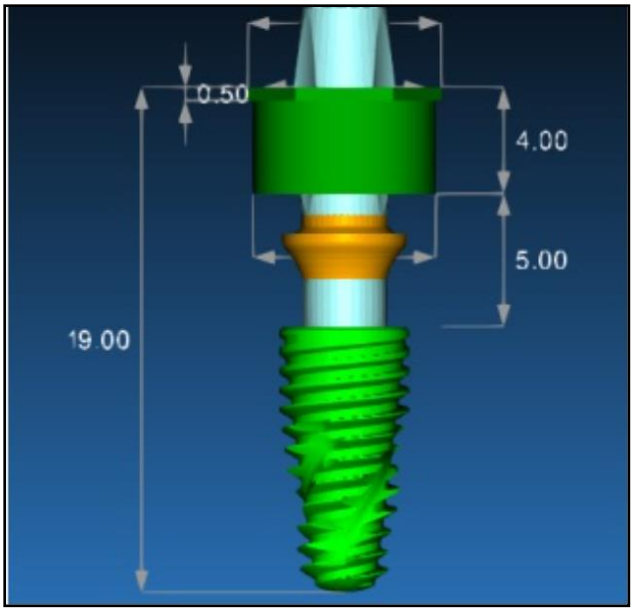
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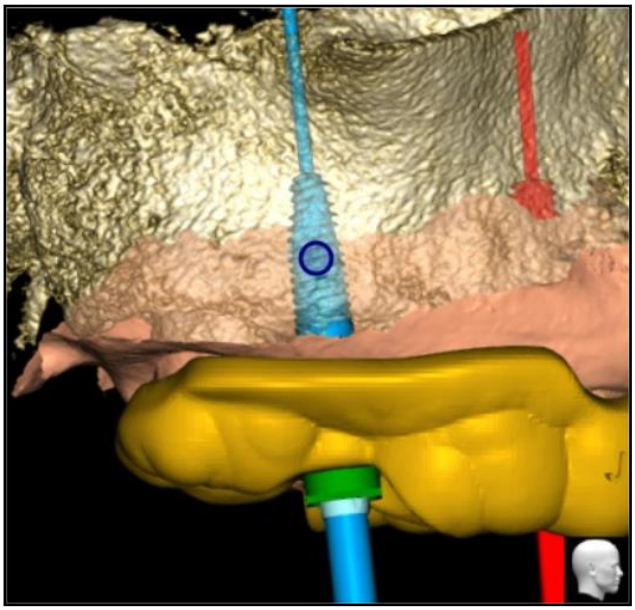
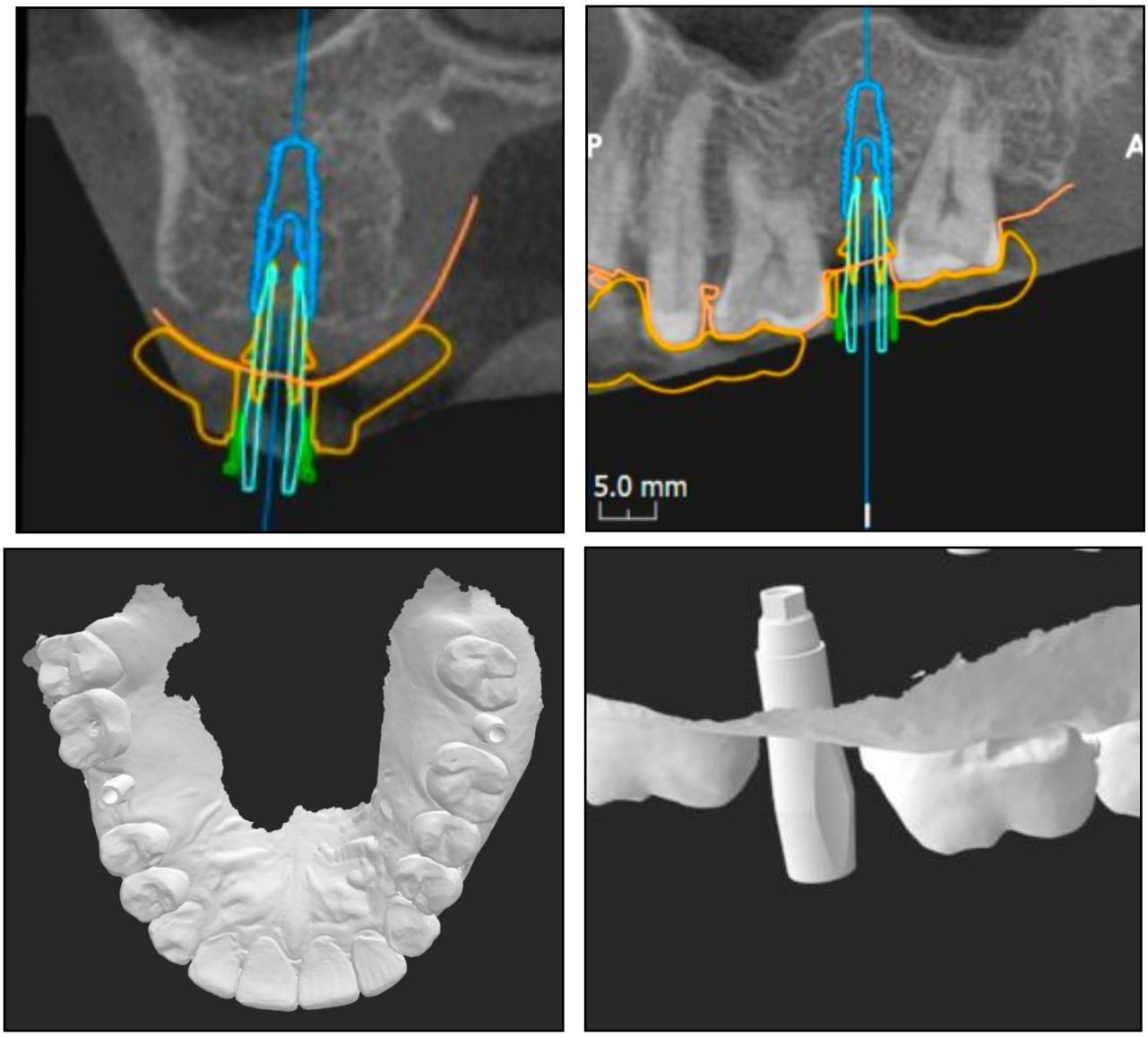




Abutment	Abutment size	Sleeve	Collision warnings
GM Exact Abutment	CH 3.5 mm [115.240]	neodent_[CUSTOM]	No collision

Position	Manufacturer	Model	Size
17	Neodent	GM Helix Acqua	4 x 11.5 mm [140.984]

Fig.2Digital 3-D Guide, Implant and abutment planning and generation of STL file

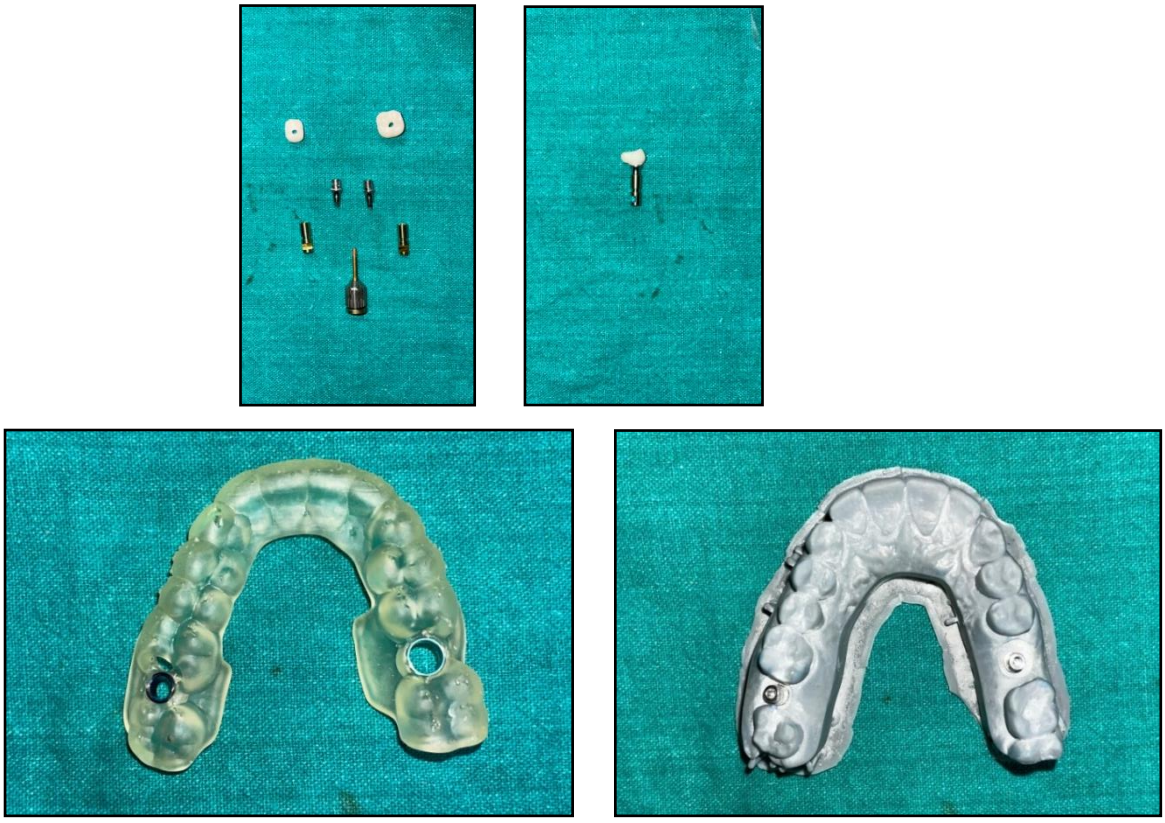
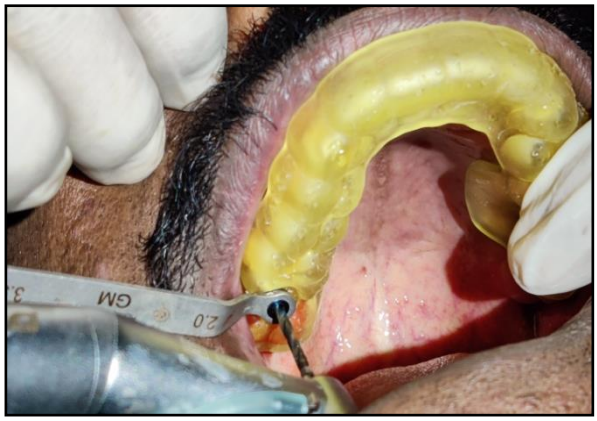


Fig.3 3-D printed surgical guide, 3-D printed surgical model with digital implant analog and 3-D printed PPMA crown


Grand Morse
NEODENT



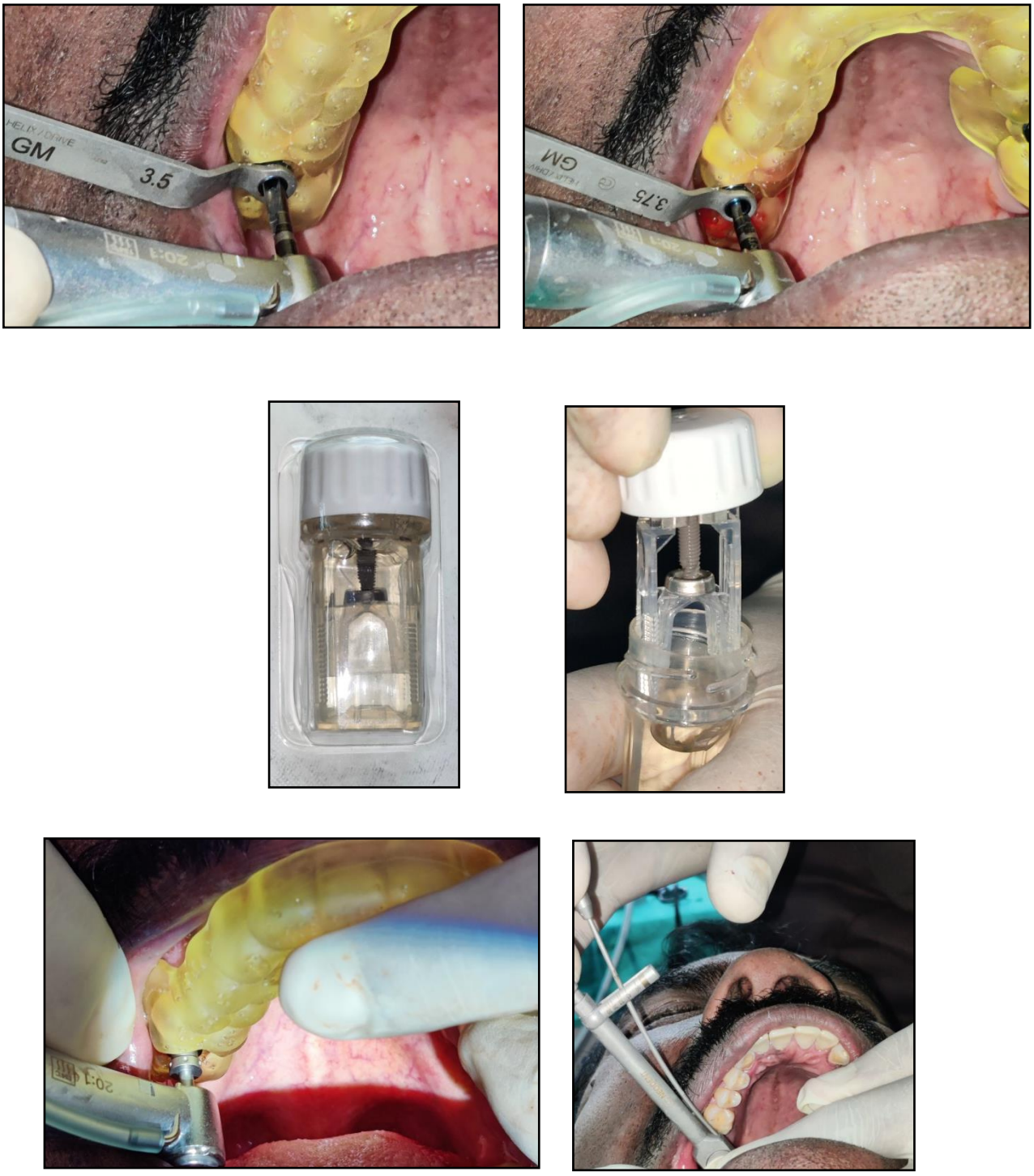


Fig.4 Implant surgical procedure with guided surgical protocol and n placement of hydrophilic implant at the maxillary right second molar

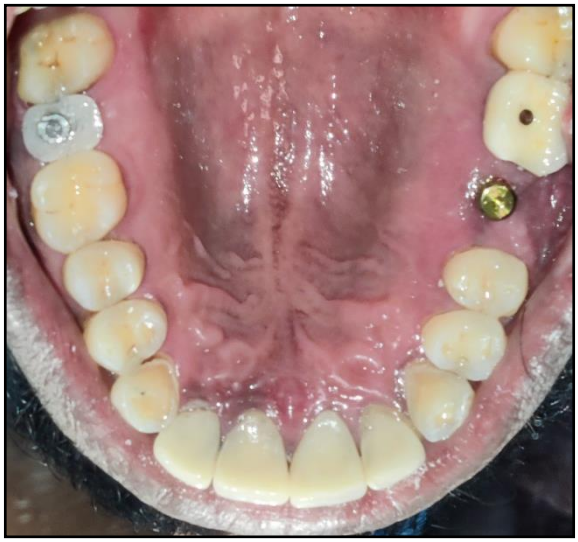


Fig5 3-D printed PPMA crown placed immediately at the maxillary right second molar