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Case Report

3D-Guided Implant Surgery: A Case Report

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Abstract

Placing dental implants is much easier than it ever was thanks to advances in technology and increased use of computer-aided design and computer-assisted manufacturing (CAD/CAM). The location and angle of the neighboring teeth, laboratory simulations, computed tomography with CAD/CAM simulations, and surgical guides known as stents are used to determine the placement of implants. Every implant clinician must make the difficult decision of whether to use a surgical guide or to insert implants by hand. The use of surgical guides for implant placement can boost confidence and be predictable with proper technique. This case report provides an example of how 3D-guided technology was used in dental implant surgery for diagnosis, planning, and execution.

Key words: 3D planning, Computer-aided design and computer-assisted manufacturing, Dental implants, Flapless surgery, Surgical guides

INTRODUCTION

The advancement of computer-aided design and computer-assisted manufacturing (CAD/CAM) technologies in recent years has greatly improved all aspects of routine dentistry, particularly in the area of oral implant surgery.[1] The two key components of oral implant surgery – planning the optimal prosthetic solution for the specific anatomic circumstance and using 3D data of the bone topography – have been reconciled as a result of the introduction of digital tools into diagnostic procedures. By overlaying either an intraoral surface scan in a fully digital workflow or a surface scan of a cast model to the radiography in a partially digital workflow, the virtual planning is translated into reality.[2] Guided implant surgery (GIS) has a number of benefits, including step-back planning and three-dimensional connection evaluation of the relationship between final reconstruction and local anatomy. Incorporating this virtual knowledge into reality could assist prevent implant misalignment or damage to important anatomical components.[2]

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This case report demonstrates how to use a 3D cone-beam computed tomography (CBCT) for computer-assisted diagnostics, do virtual implant planning, create a stereolithographic surgical template, and insert a dental implant using a surgical guide in a pre-planned location.

CASE REPORT

A 28-year-old female patient reported in the Department of Prosthodontics and Maxillofacial Prosthetics, Dr. HSRSM Dental College and Hospital, Hingoli, Maharashtra with a chief complaint of missing upper right back tooth. Intraoral examination revealed missing 14, 15, and 16; with a history of extraction with 14 and 16, 6 months back due to abutment failure. After considering several options, the patient decided on a screw-retained implant-supported crown and GIS to replace her missing tooth.

The case was then planned and executed according to guided surgery protocol as proposed by Osstem Guided implant surgery kit and protocol.

Step 1 – Treatment Planning

Photos of the patient's edentulous area inside the mouth, photos of the patient's right and left excursive movements during occlusion, and photos of each arch's occlusal surface were also taken [Figures 1-4]. Maxillary and mandibular

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Figure 1: (a) Patient's edentulous area inside the mouth. (b) Intraoral photograph with missing 14, 15, and 16 teeth


Figure 2: Occlusal photograph of mandible


Figure 3: Occlusal photograph of maxilla

diagnostic impressions were created using irreversible hydrocolloid impression materials [Figure 5]. After being poured into Type IV gypsum product, master casts were created [Figure 6]. CBCT, orthopantomograph, and radioautography were used to assess the condition of the residual dentition as well as the bone foundation above the implant site. It was done to evaluate the hard and soft tissues inside the mouth. Our proposal for guided flapless surgery using a stereolithographic surgical template for implant placement is supported by the existence of
AQ2 sufficient keratinized tissue and bone width of ---- mm.


Figure 4: Left lateral view introrally


Figure 5: Master casts made of type IV gypsum products

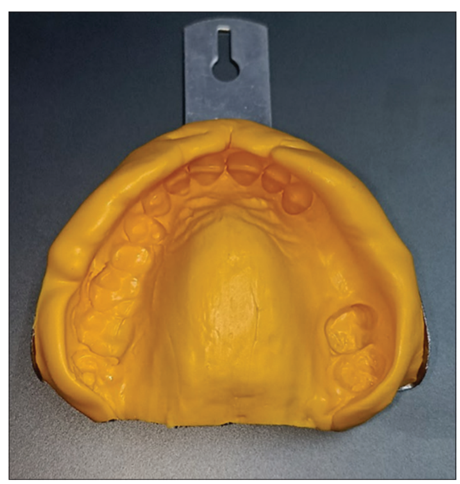
Figure 6: Impression made in elastomeric impression material

Step 2 – Scan Prosthesis Fabrication

Next, the cast was scanned using 3Shape Implant Studio Scanners to create a virtual model. The scan prosthesis was a radiopaque replica of the present clinical setting with the current arrangement of temporary teeth. The restoration of the prosthesis was planned on this virtual model. Once the alignment and design of the prosthesis were satisfactory, a soft copy STL file was created and saved for use in treatment planning with specialized 3D CBCT software.

Step 3 – CBCT Scanning

Soft copy images of the virtual prosthesis planned cast 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.

Step 4 – Software-based Planning and Fabrication of the Surgical Template (Open System Approach)

After the evaluation of the edentulous site in CBCT with a virtual prosthesis, with tooth region 14 Osstem/TSIII/Regular/4.0 × 11.5; with tooth region 15 Osstem TSIII Regular 4.0 × 10.0; and with tooth region 16 Osstem/TSIII/Regular/4.5 × 8.5 implants were planned [Figure 7]. For planning the surgical guide, the sleeve system of Sirona-CEREC Guide drill keys was selected. After confirmation of implant and surgical guide planning, the fabrication of the surgical template was done [Figure 8].

Step 5 – Surgery with OSSTEM-Guided Instruments and Guided Implant Insertion

After assuring the fit of the surgical template intraorally, the implant surgery was performed as per protocol with the guided instruments sets in the OSSTEM-Guided Surgery Cassette [Figure 6]. The surgical protocol provided, along with the surgical template recommended the sequence of instruments required to prepare each implant site. Under local anesthesia, the surgery was initiated with the mucosa punch (diameter 4.7 mm) at 15 rpm through the sleeves with a surgical template [Figure 7]. Mucosa punch allowed blade-free incision with minimum trauma. The next step was the use of a milling cutter to achieve a sufficient flat bone surface for the purpose of easy drilling in the following stage. The implant bed was then pre-drilled with the pilot drill (diameter 2.2 mm). Basic implant bed preparation was continued using the diameter 3 mm, 3.5 mm, and finally with 4.0 mm, 4.0 mm, and 4.5 mm in the tooth regions of 14, 15, and 16, respectively. This surgical guide assures correct osteotomy site preparation as pre-planned earlier.

After the completion of flapless implant bed preparation, OSSTEM implants with tooth region 14 Osstem/TSIII/Regular/4.0 × 11.5; with tooth region 15 Osstem TSIII Regular 4.0 × 10.0; and with tooth region 16 Osstem/TSIII/Regular/4.5 × 8.5 were placed.

After that, a closure cap was put in place, eliminating the need to suture the soft tissues surrounding the implant site. A post-operative radiograph was taken to ensure that the

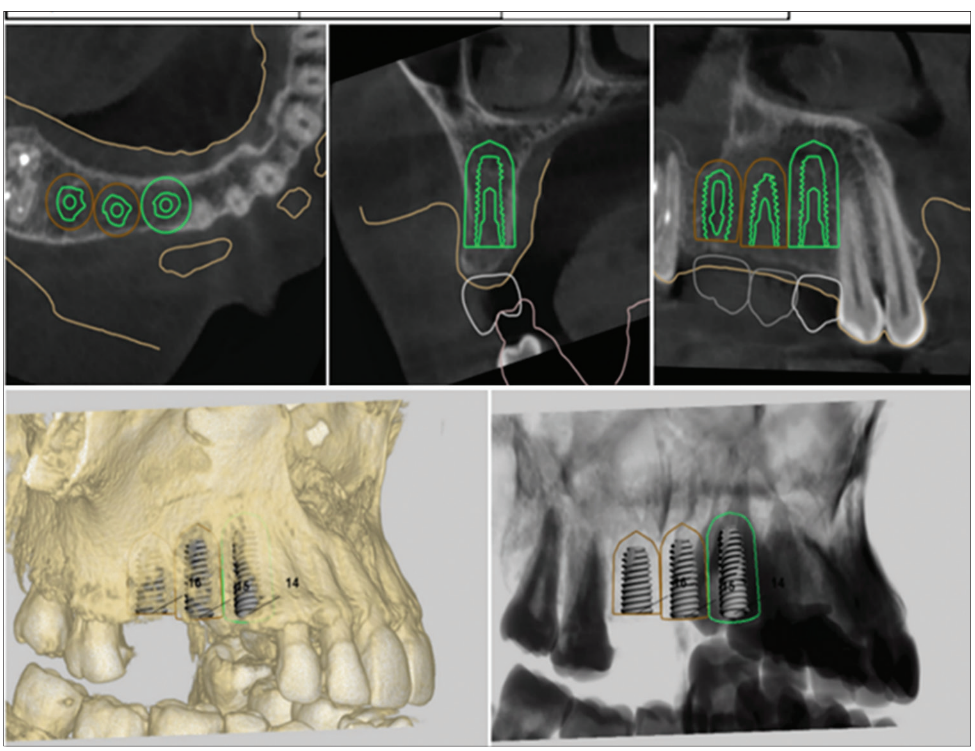

Figure 7: Digital planning of the implant placement

implant was placed according to design. The following day, the patient was contacted for follow-up. It was noted that there was no discomfort, bruising, or post-operative issues.

Step 6 – Prosthetic Procedures

The definite prosthetic procedure for this case was performed later after clinical and radiographic evidence of osseointegration. Screw retained crown with a solid abutment system was planned for this case.

Steps in the prosthetic phase included

- The splinting of the copings [Figure 9]
- Later, the assessment of the jig trial on the cast and sectioning of the pattern resin [Figure 10]
- Followed by the verification of the jig trial in the mouth [Figures 11 and 12]
- Verification of prosthesis on cast [Figure 13]
- Prosthesis loading in the mouth [Figure 14]
- Prosthesis evaluation in excursive and protrusive movements [Figures 15 and 16]
- Radiographic evaluation of the prosthesis [Figure 17].

DISCUSSION

Prosthetically driven implant surgery has been a subject of fundamental interest to the dental profession. Correct implant location provides clear benefits, including the potential to assure appropriate occlusion and implant loading, long-term stability of peri-implant hard and soft tissues as a result of straightforward oral hygiene,

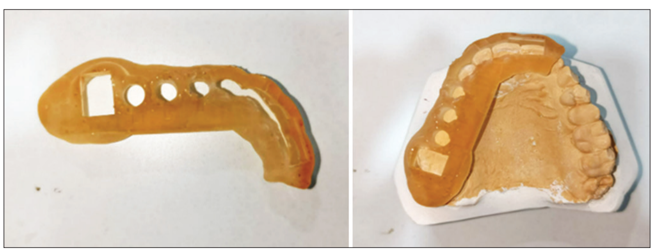

Figure 8: Digitally fabricated surgical guide, placed on master cast

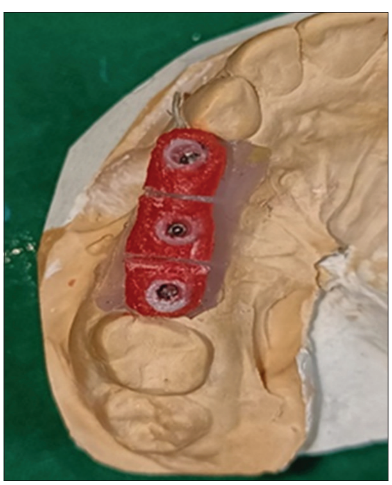

Figure 9: Sectioning of jig trail on casts

Figure 10: Verification of copings on casts

Figure 11: Verification of jig trial in the mouth- lateral view

Figure 12: Verification of jig trial in the mouth - occlusal view

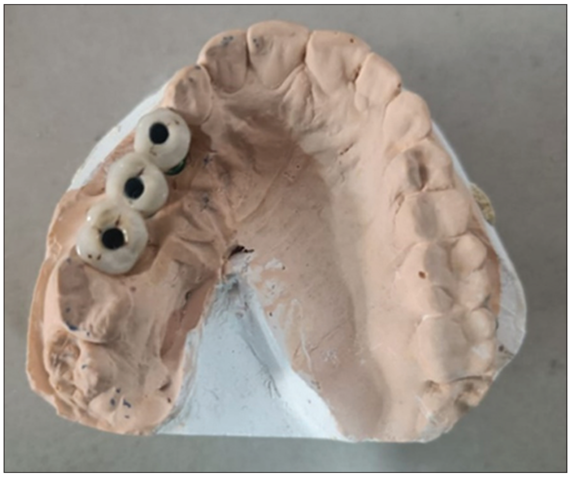

Figure 13: Verification of prosthesis on cast

Figure 14: Prosthesis loading in the mouth

Figure 15: Verification of prosthesis in mouth- left lateral view

and favorable esthetic and prosthetic outcomes.[7] Dental implant surgery has traditionally been done through raising flaps, until recently when flapless surgery was advocated.[14]

Figure 16: Verification of prosthesis in the mouth- right lateral view

Figure 17: Radiographic evaluation of the prosthesis

A relatively new idea is GIS, which plans the final position of the implants before the procedure and the prosthetic work is done, utilizing 3D CBCT and a stereolithographic surgical template.[1] One 3D printing method, called stereolithography, uses a laser-cured resin model.[12] However, because this is a relatively new idea, it is critical to comprehend the technique and final positioning of implants inserted without the help of a surgical template.[2] Three-dimensional computer-assisted interactive implant planning software tools have sufficient accuracy and reliability required for predictable clinical use. Two methods for a computer-based transfer are available: Direct navigation and stereolithographic drill guides.[9] The fabrication of a surgical guide, used in implant treatment, is determined by the patient's anatomy and local references, such as the numbers and locations of teeth in the arch to be treated or in the opposing arch.[10]

To direct the surgical location of the drills and implants, the surgical template comprises guided sleeves that are positioned in accordance with the treatment plan.[3] Drill keys are used throughout the drilling process to direct successive drills of various sizes in the right location and angulation by being placed into the sleeves within the guide. For some systems, the drill keys can be mounted on the drills.[8] The templates' stainless steel tubes perfectly direct the osteotomy drills, eliminating the requirement for pilot drills as specified in standard protocols.[11] They also stabilize the drilling procedure while the dental practitioner placing the implants performs the procedure by restricting the degrees of freedom of the drill trajectory and depth.[12] A trusted and well-known method for obtaining a fusion of anatomical data (CBCT) and prosthetic data (radiographic template) is the double scan technique.[6] This surgical protocol has the advantages of being minimally invasive, accurate implant placement, predictability, and a shorter recovery period.[15]

After overlaying a surface scan with CBCT to turn the virtual plan into reality, a higher level of surgical template accuracy is attained from a virtually designed and printed template. The accuracy may even increase if intraoral scans are employed in addition to surface scans of a cast model following impression production as the intraoral scan may lessen the sources of mistakes related to cast model preparation.[2] Planning prosthetically driven implants using a computer program is extremely effective and secure. This specialized program's three-dimensional view enables the selection of the ideal implant location, enhancement of the implant axis, and defining of the optimum surgical and prosthetic solution for the patient. Consequently, a protocol that combines a computer-guided technique with standard surgical techniques emerges as a viable choice.[5]

The creation of surgical guides (stereolithography) can be done immediately using the electronic data collected during the planning process. This method limits the need to raise a flap during the surgical installation of the implants.[5] Surgical drill guides may be placed on the remaining teeth or directly on the crest of the bone.[13]

Clinicians must be aware of potential variations that can happen while using a CAD/CAM surgical template to place implants to prevent anatomical hazards and prepare for the eventual prosthetic reconstruction. Numerous studies found comparable or superior clinical outcomes when comparing implants placed using CAD/CAM surgical templates with those placed using the traditional method.[2]

GIS, which evaluates the link between the final repair and local anatomy in three dimensions, has a number of benefits. By implementing this virtual knowledge in the actual world, it would be possible to prevent implant misalignment or damage to important anatomical structures.[2]

A quick surgical method and high implant precision help to minimize the impact on the patient and their morbidity. Patients' requests and preferences are met by reducing invasive surgical procedures, post-operative pain or swelling, and healing time.[5]

CONCLUSION

One of the solutions available on the dentistry market, smart fusion of conventional diagnostic data and computerized data superimposition combined with implant surgical guidelines, enables today's resolution of many challenging cases, formerly attainable only in expert hands. Improving a number of therapy procedures, especially in circumstances where treatment was previously impossible due to complicated anatomical restrictions.

In this case study, a dental implant-supported prosthesis was used to restore three lost maxillary teeth. The placement of dental implants was prosthetically planned using specialized implant planning software, 3D CBCT, and a virtual cast; the implant was then inserted flaplessly using a stereolithographic surgical template. The implant was successfully positioned in the intended location. The patient felt reduced discomfort and agony. The entire process took less time than the standard technique. In the upcoming evolutionary period, 3D GIS will be one of the standard practices for replacing lost teeth.

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