Simplifying Zygomatic Implant Site Preparation Using Ultrasonic Navigation: A Technical Note

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Zygomatic implant site preparation could be considered a challenging procedure because of the use of a very long twist drill that could sometimes be difficult to control due to the need for drilling the malar bone on an oblique surface. Ultrasound was recently suggested to achieve better control, but the specific long tips required are not readily available, and the elongated tip also tends to reduce the efficacy. This technical note describes a proposal of a novel computer-aided technique to simplify the procedure of zygomatic implant site preparation. This method uses a standard-length ultrasonic tip to prepare the crestal bone and the zygomatic bone in two individual steps. The desired implant trajectory can be achieved during preparation using a real-time tracking navigation system. The combined use of the navigation system and the ultrasonic tips could aid the surgeon, during the first steps, in achieving optimal control of the instruments employed for the implant site preparation and keeping the planned zygomatic implant position. If the efficacy of the procedure is confirmed through clinical trials, this technique could also contribute to reducing the invasiveness of the procedure, promoting a smaller flap, and reducing the soft tissue damage. Int J Oral Maxillofac Implants 2018;33:e67–e71. doi: 10.11607/jomi.6270

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Zygomatic implants have been used as an alternative to bone augmentation and conventional implants for atrophic arch rehabilitation in several recent clinical cases. The survival rate of zygomatic implants is approximately 95%. The original Brånemark technique[1] was modified recently to improve prosthetic loading and patient comfort and to reduce the risk of infection of the maxillary sinus.

In 2000, the slot technique was proposed, which involves lateralizing the position of the body of the zygomatic implant by creating a slot on the external surface of the lateral sinus wall.[2]

Some years later, different authors[3–5] proposed an extra-sinus technique that attempts to keep the implant outside the sinus by anchoring the apical part onto the malar bone. This procedure requires concave anatomy to be performed correctly. At the moment, there is no evidence in terms of success between the different techniques, and there are few reports regarding the palatal emergence of the implants.[6]

A dynamic navigation system can simplify the surgical procedure for zygomatic implants[7] in patients with an atrophic arch[8] or oncologic defects.[9] A static drill guide is also used to place the implant in a preplanned position.

Despite the evolution of the surgical techniques and the introduction of the computer-aided approach, zygomatic implant placement remains a complex surgical technique, reserved for experienced hands.

Implant site preparation is very different for zygomatic implants than for conventional implants. First, a very long drill (> 6 cm) is required to prepare the external zygomatic bone (Fig 1). Correct implant positioning depends on the surgeon's expertise, which renders the procedure difficult to reproduce. Additionally, some parts, such as the sinus wall or inferior border of the malar bone, must be prepared on an oblique surface.

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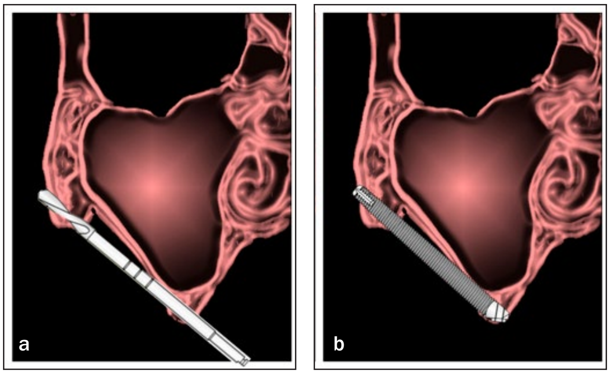
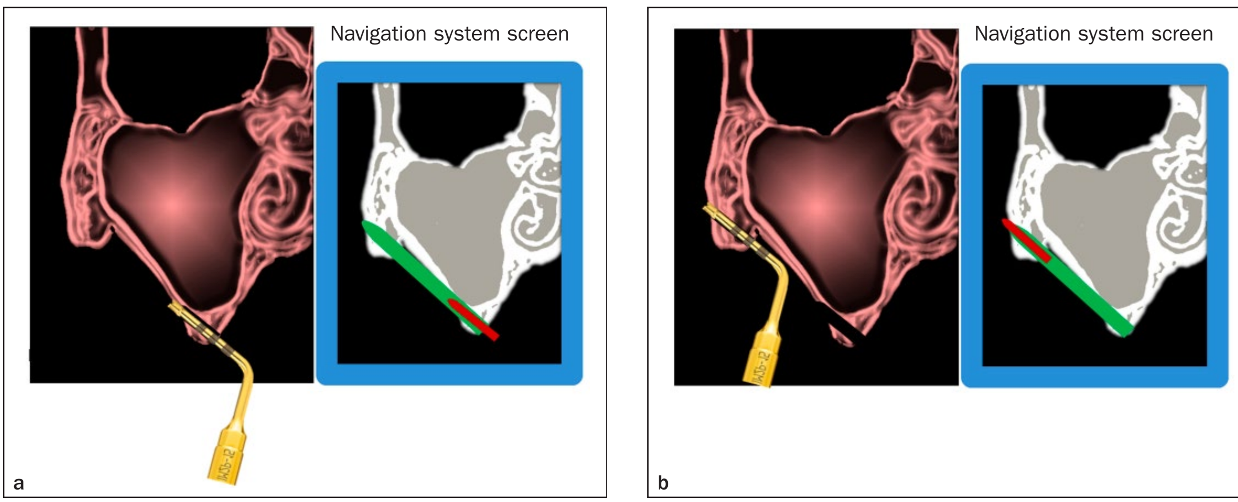


Fig 1 Conventional zygomatic implant site preparation using *(a)* a very long drill and *(b)* an extra-sinus implant placement technique.

Fig 2 *(Below)* Two-step zygomatic implant site preparation using an image-guided system and an angled standard-length piezosurgery tip: separate preparation of *(a)* the crestal bone and *(b)* the zygomatic bone. The planned implant trajectory *(green)* can also be followed on the navigation system screen with the ultrasonic tip position and axis.



Ultrasonic tips[10] can increase the control of the surgical instruments during implant site preparation, somewhat simplifying this difficult procedure. However, few companies currently produce the ultrasonic tips needed for the zygomatic technique. In addition, these tips are longer than the standard tips, which can decrease the efficacy of the ultrasonic waves.

In addition to the benefits recently proposed for conventional implants,[11] the use of a navigation system combined with ultrasonic implant site preparation could also offer some benefits for zygomatic implants.

The aim of this technical note is to describe a new technique for zygomatic implant site preparation, combining the advantages of a dynamic navigation system with the employment of the ultrasonic tips commonly used for conventional implant site preparation. The navigation system allows the surgeon to monitor the position of the cutting instrument, while piezosurgery[12] provides maximum control. In this way, a standard-length tip can be utilized in dual-step preparation of the crestal (Fig 2a) and zygomatic (Fig 2b) bones because the longer implant axis can be followed.

MATERIALS AND METHODS

An edentulous woman aged 71 years was referred to the Oral and Maxillofacial Division of the Department of Biomedical and Neuromotor Science, University of Bologna, Italy, for maxillary rehabilitation. The patient presented with advanced atrophy of the maxilla but was otherwise healthy based on a clinical exam and previous radiographs. The patient presenting a maxillary anatomy classifiable as zygoma anatomy-guided approach (ZAGA) type 3,[6] after obtaining informed consent, was enrolled in a zygomatic implant clinical trial approved by the Ethical Committee of S. Orsola Malpighi Hospital, University of Bologna.

Navigation System Protocol for an Edentulous Patient

Under local anesthesia, a provisional implant 3.25 mm in diameter was placed in the median part of the maxilla to support the reference plate of the ImplaNav Navigation system (BresMedical). The intraoral reference plate of the navigation system was screwed onto the provisional implant, and a computed tomography

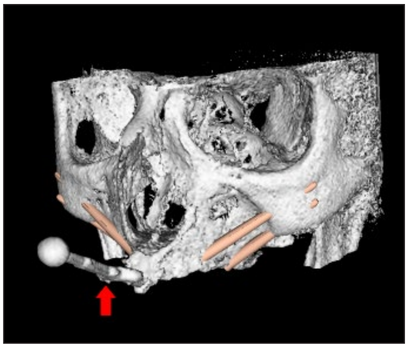


Fig 3 3D virtual planning based on CT scan data with an intraoral navigation system reference plate in situ *(red arrow)*.

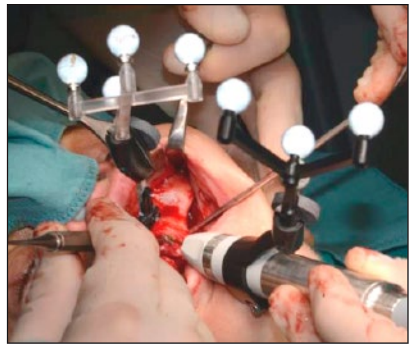


Fig 4 Intraoral patient reference tool (RTp) and handle reference tool (RTh) used during surgery.

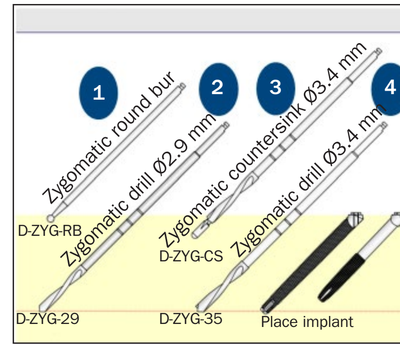


Fig 5 Usual zygomatic drilling sequence recommended by the implant manufacturer.

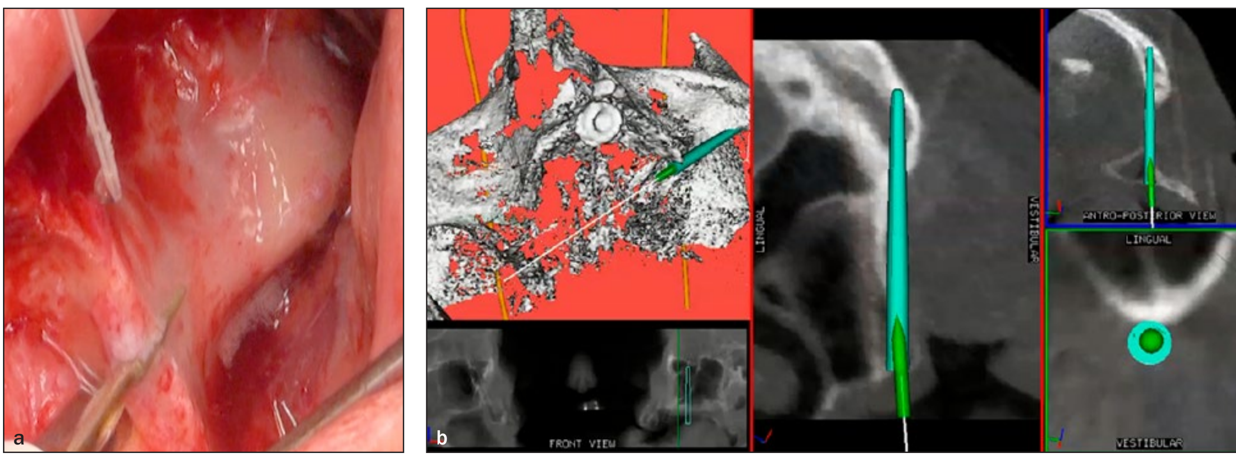


Fig 6 First step: Crestal bone preparation with *(a)* an IM1AL piezosurgery tip *(b)* using the navigation system. The virtual real-time position of the tip *(green)* following the planned implant trajectory *(light blue)*.

(CT) scan was taken. Afterward, the reference plate was unscrewed, and the provisional implant was kept in situ. Any contact with the full-arch mobile prosthesis already used by the patient was corrected. The Digital Imaging and Communications in Medicine (DICOM) data obtained from the CT scan were analyzed using the navigation system software, and the two zygomatic implants were planned virtually (Fig 3).

Next, under general anesthesia, the reference plate was again placed in situ, and the patient reference tool (RTp) was fixed onto the same intraoral support, allowing the system camera to identify the patient's position. A second reference tool (RTh) was fixed onto the piezosurgery handle (Fig 4). In this way, the navigation system could identify and communicate the position of the ultrasonic tip. The system was calibrated using a specific piezosurgery tool (Mectron Srl).

Zygomatic Implant Preparation Technique

During the initial steps, to avoid the long uncomfortable twist drills used in the conventional protocol (Fig 5), an alternative technique was used to prepare the zygomatic implant site. This novel method uses an innovative image-guided system and an intraoral reference tool, which allows the surgeon to track the depth of the instrument while entering the bone. Using the navigation system and ultrasonic instrument simultaneously grants optimal control while preparing the atrophic alveolar ridge and zygomatic bone. The first step is crestal bone preparation with an IM1AL (or IM1S) piezosurgery tip (Fig 6a). The navigation system displays the virtual position of the tip in real time, guiding the implant trajectory (Fig 6b). Then, under three-dimensional (3D) image guidance with an extra-sinus technique (in this case), the second step is preparation of the zygoma bypassing the crestal bone. This procedure used a standard-length angled piezosurgery tip (IM1S), which allowed the surgeon to work directly on the zygomatic bone (Fig 7a). Both steps were performed with the IM2P15 tip to complete zygoma preparation up to the emergence of the tip through the external cortical wall (Fig 7b). Finally, the implant site was refined using the standard zygomatic long twist drill of 3.5 mm in diameter (Fig 8). This procedure (Fig 9) was simplified because the primary implant hole had already been created. The

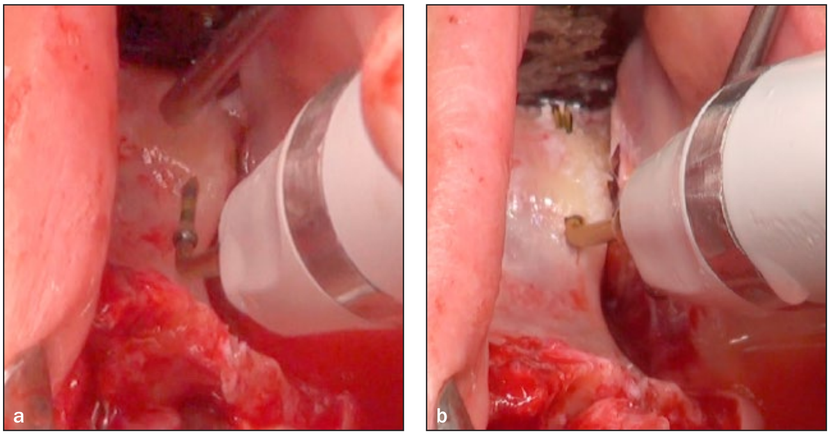
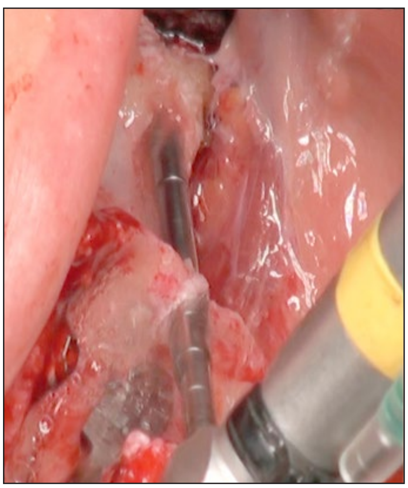


Fig 7 Second step: *(a)* Following the same image-guided procedure, zygoma preparation, bypassing the crestal bone, and using a standard-length angled piezosurgery tip (IM1S) directly on the zygomatic bone. *(b)* Using the IM2P15 tip to complete zygoma preparation up to emergence of the tip through the external cortical wall.



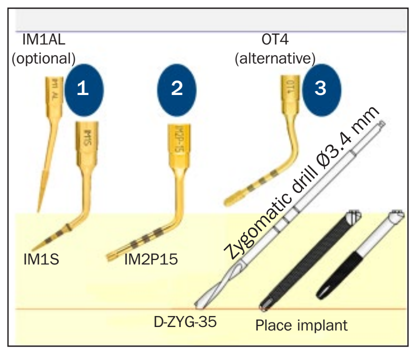
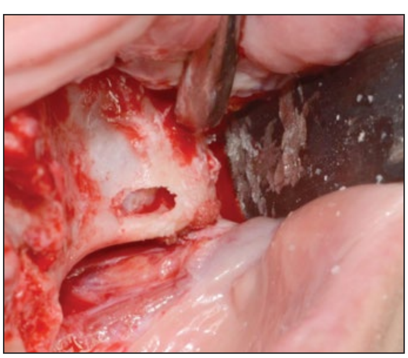


Fig 8 *(Left)* Refining the implant site with only a standard zygomatic long twist drill.

Fig 9 *(Right)* The ultrasonic-navigated two-step technique sequence involves the use of the IM1S tip first (optionally the IM1AL could be used for the crestal bone). Then, the IM2P15 completes the preparation up to reaching the external cortical wall. Finally, the refining can be performed with the last zygomatic drill of 3.4-mm diameter or, alternatively with the OT4 tip, using the 3D piezo-navigated implant site preparation technique.[10]



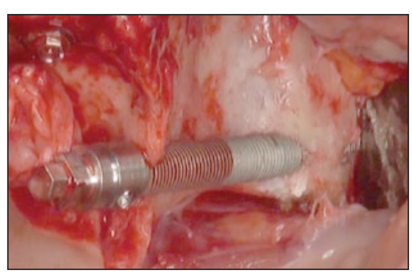


Fig 10 *(Left)* Zygomatic implant site prepared using the extra-sinus technique.

Fig 11 *(Right)* Zygomatic implant placement.

employment of a long twist drill, described in the last step, could be completely avoided using the 3D piezo-navigated implant site preparation technique.[10] This method, already described for conventional implants, involves the use of a specific ultrasonic tip (OT4) with a three-dimensional cutting edge. Via the live tracking of the tip, circumferential implant site preparation could be performed. Following the virtual implant volume into the zygomatic bone, the preparation could be completed up to reaching the planned implant diameter. Additionally, when the anatomy is suitable, an extra-sinus technique can be performed (Fig 10). The zygomatic implant (Southern Implants) was placed with a torque-controlled handle at a maximum torque of 40 Ncm and then screwed into position with a manual insertion tool (Fig 11). A total of four zygomatic implants were placed and four straight conical abutments were mounted before suturing. After surgery, an impression was taken to allow loading of the implants within 72 hours (Figs 12a to 12c).

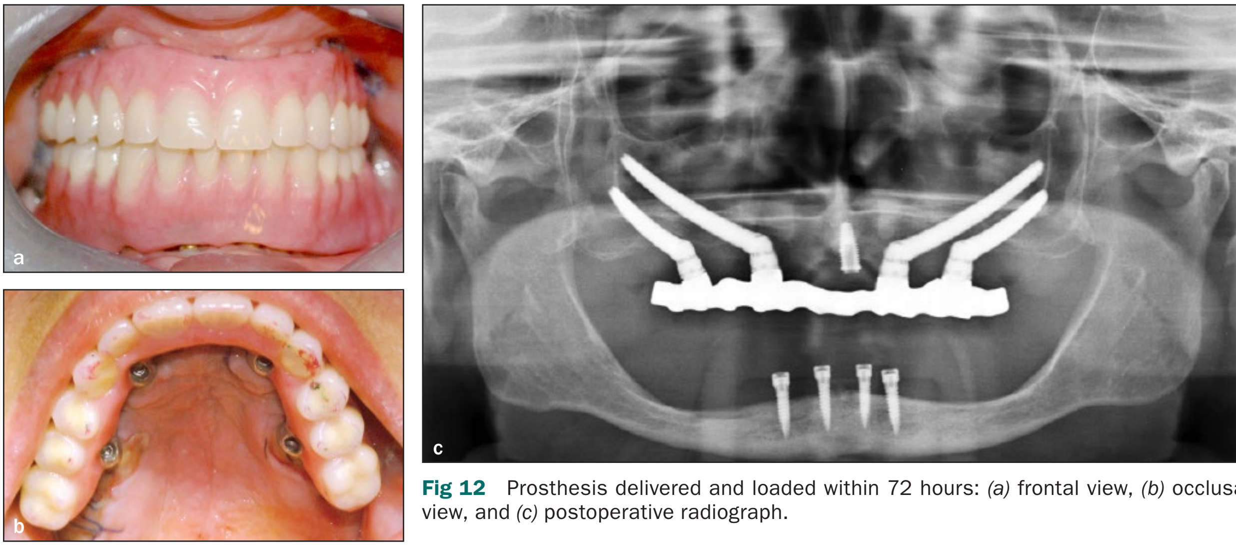


Fig 12 Prosthesis delivered and loaded within 72 hours: *(a)* frontal view, *(b)* occlusal view, and *(c)* postoperative radiograph.

DISCUSSION

Zygomatic implant rehabilitation depends largely on the surgeon's expertise. The very long twist drill used in the conventional technique for zygomatic implants is often difficult to maneuver. The computer-aided approach for zygomatic implants seems to be useful for the treatment of atrophic maxillae and post-oncologic defects. Three-dimensional technology and navigation systems allow surgeons to plan the intervention and perform the procedure much more accurately and safely due to real-time monitoring of the insertion depth, and ultrasonic instruments have recently been introduced to gain better control during implant site preparation. Employing a navigation system along with piezosurgery facilitates use of a standard-length tip, further simplifying the zygomatic bone approach. This promising method should be explored via clinical trials that compare its ease of use and results to those of the conventional technique. This technique, after an adequate clinical evaluation to validate the efficacy, could permit a smaller flap and decrease soft tissue damage.

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