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Case Report

A comminuted dento-alveolar fracture with premaxillary dental avulsion. Pilot-drill guided implant-prosthetic rehabilitation: a case report and an overview of guided implant placement

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ABSTRACT

In modern dentistry, implantology is widely used; implants have a survival rate of 96.4-96.9% at 10-year follow-up. In order to obtain aesthetic, health, and performance results of implant restorations, virtual pre-surgical prosthetic planning is essential. For proper planning, the patient's CBCT data is matched to the prosthetic design in order to virtually plan the three-dimensional positioning of the implant before surgery. The patient, following trauma, had avulsion of elements 1.2, 1.1 and 2.1. The fracture is treated conservatively, and after 3 months, three implants are placed with guided Pilot-Drill surgery and prosthetically guided implant design. To achieve a clean transmucosal path and create good aesthetic profiles, the prosthetic connection's depth was adequate. Periodic professional oral hygiene recall has been essential for the long-term maintenance of the implants. At the follow-up of 6 years, perimplant bone stability and aesthetic and functional satisfaction of the patient were detected. In the field of dental implant placement, bone data, and anatomical restrictions can be processed by guided implant software. In combination with wax-up scans, implant planning will improve the predictability of implant placement. The ideal placement of implants in prosthetically guided implantology is not solely determined by bone anatomy but also by the final position and features planned for the prosthesis. A hybrid solution between traditional and total computer-guided surgery is achieved by Pilot-Drill Guided Surgery, which can combine the advantages of fully guided and free-hand approaches. The Pilot Drill Template implantology is a compromise that combines the benefits of fully guided and traditional surgery while also eliminating their limitations.

INTRODUCTION

In modern dentistry, implantology has developed into an emerging therapy in the treatment of partial or fully edentulous patients (1). Implantology has been designed to rehabilitate masticatory function and replace missing teeth and nowadays is strongly supported by systematic reviews and meta-analyses that report a survival rate of 96.4-96.9% at 10 years of follow-up (2, 3). The long-term success of dental implants can be attributed to the optimal implant position in relation to the dental arch, the alveolar ridge, anatomical structures like the maxillary sinus, inferior alveolar nerve, and adjacent teeth, and performing the surgical procedures correctly (4). Although in the past, the success of implant-prosthetic rehabilitation was primarily linked to the concept of function, today, it is not a sufficient condition, and success is evaluated according to aesthetic-functional standards (5).

The implants are not positioned only where bone is present. Still, they must be placed according to precise depth, inclination, and position criteria, leading to the correct positioning of the prosthetic implant-supported crown with aesthetic, functional, and cleanable features (6). The operator is at risk of making mistakes that could compromise the final prosthetic result by not predicting the correct positioning of the implant following criteria and performing free hand surgery (7).

Accurate prosthetic planning is necessary for implant placements, as it optimizes the aesthetic, health, and performance outcomes of implant restorations. Implant placement that is not adequately planned with prosthetics can interfere with vital anatomic structures, make restoration more complex, and may lead to more significant marginal bone loss. Different methods are available to determine the final position of the implant, ranging from free-hand positioning, simply guiding the pilot drill, guided preparation of the implant cavity, to full-guided insertion of the implant (8). With the Nobel Clinician® software, the patient's Cone Beam Computed Tomography (CBCT) data is overlapped with the final prosthetic rehabilitation model so that the clinicians can virtually plan the three-dimensional placement of the implant before the surgery. The preoperative virtual plan aids in transferring the surgical template fabricated using computer-aided design and computer-aided manufacturing (CAD-CAM) technology to the actual surgery (9). The purpose of this study is to present a Pilot-Drill guided surgery case report and highlight the advantages and disadvantages of this technique when compared with fully guided surgery.

MATERIALS AND METHODS

Following a road trauma on 10 March 2017, the patient arrived at the emergency service of the Department of Maxillo-Facial and Dentistry of the University Hospital of Verona, reporting dental-alveolar fracture with avulsion of elements 1.1, 1.2, 2.1 (Fig. 1) and a complicated crown fracture of tooth 1.3 and enamel-dentin fracture of tooth 2.2 (10).

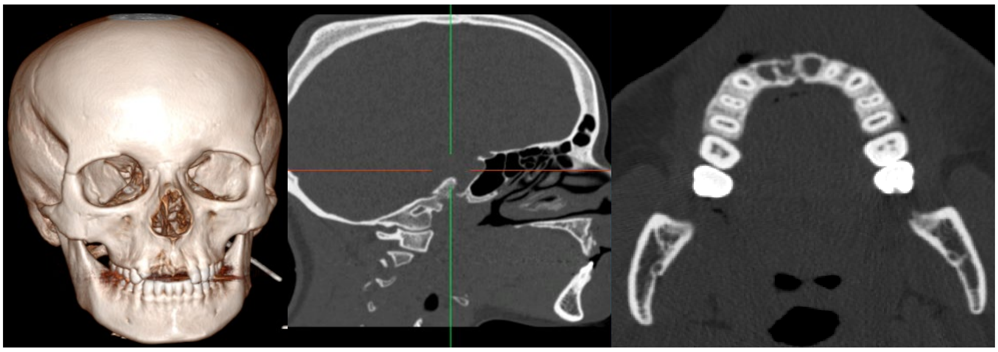

Fig. 1. *CBCT axial, coronal, and 3D trauma reconstruction.*

The study was conducted in accordance with the Helsinki Declaration of 1975, revised in 2013, and the protocol was approved by the Local Ethical Committee (1935CESC).

A 19-year-old patient with a negative medical and pharmacological history. On the oral examination, the complete avulsion of the above elements was detected; the patient was sutured with Vicryl 5.0 and medicated. The comminuted alveolar fracture was treated conservatively (Closed treatment). At the same time, endodontic treatment was done on element 1.3, and a temporary composite reconstruction was performed on element 2.2.

After two weeks, the sutures were removed. Due to the loss of dental substance and the need to provide the patient with a temporary fixed anterior prosthetic bridge, elements 1.3 and 2.2 were prepared (Fig. 2).

Fig.2. *Preparation of the prosthetic abutments of elements 1.3 and 2.2.*

The temporary prosthesis was designed and built with ovate pontics at levels 1.2, 1.1, and 2.1 to condition the soft tissues and preserve the gingival architecture in the area of missing teeth. A waiting time of 3 months has been observed for the complete stabilization of the bone at the level of the alveolar fracture. At this time, an alginate imprint of the two maxillaries was detected, and a wax-up of the edentulous area was created to redefine the morphology and the correct occlusion of missing elements. The models were scanned and processed with Nobel Procera®, with and without wax, to convert them into nxa. files.

The pre-surgical CBCT was performed with a cotton roll between the two jaws, which were separated during the scan, avoiding overlapping dental structures. The master model and diagnostic wax were then scanned to provide the data in STL format (11). STL was uploaded with the patient's CBCT into the Nobel Clinician® software for virtual implantology programming. The aim is to identify the best implant position, considering the anatomy of the patient and the diagnostic wax, for the realization of the surgical template, following the principles of prosthetic-guided surgery (Fig. 3).

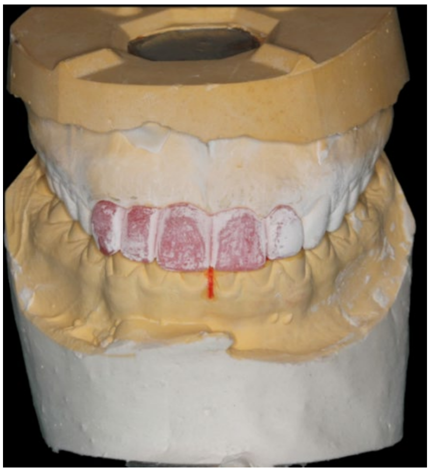

Fig. 3. *Diagnostic wax.*

The choice of the length and diameter of the implants was based on the available bone volumes, preserving its shape and its relevant anatomic structures. A virtual Pilot-Drill Template was projected, establishing a 2mm diameter bushing for each implant (Fig. 4).

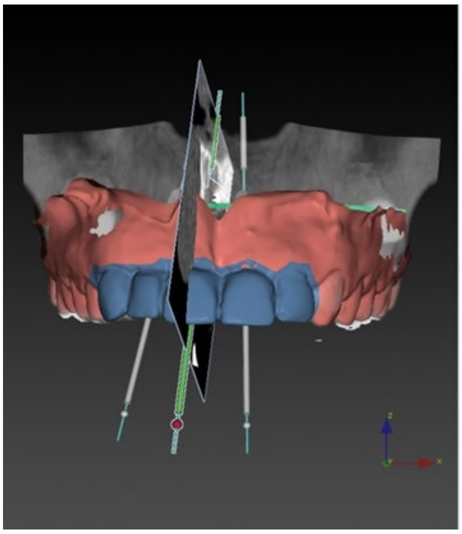

Fig. 4. *Virtual scan of pre-surgical design of the final prosthesis.*

The surgical template was realized by the Nobel Biocare® industry through the SLA technique (Stereolithography) with photopolymer material made of acrylate; later, it was sent to the dental-surgical team (Fig. 5). The accuracy of the template was checked on the master model.

Fig. 5. *Surgical template.*

Before surgery, the patient was rinsed with 0.20% chlorhexidine for 1 minute. Local anesthesia was performed with 1,8 ml of mepivacaine HCl 2% with 1:100,000 epinephrine. The surgical template was placed on the teeth, and the correct fitting was verified. The template was removed, and a crestal incision was made with an elevation of the sub-periosteal flap. The template has been repositioned; the Guided Twist Drill Ø 2.0 has been used with the stop fixed on the virtually planned length (13.5 mm) (Fig. 6). The depth and parallelism of the plant site were verified using pins.

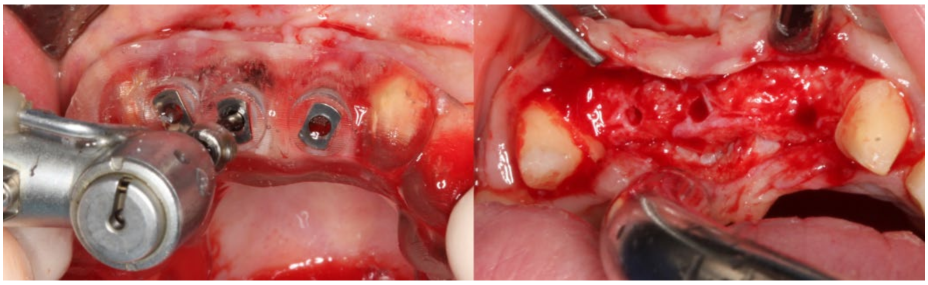

Fig. 6. *The Pilot-Drill surgical template with Ø 2.0 mm pilot drill.*

The preparation of the implant site has been completed with the next diameter drill. Three 3.5mm x 11.5mm Nobel Active® dental implants were placed. After inserting the implants, an intraoral X-ray was taken, covering screws were placed, and sutures with absorbable sutures (Vicryl 5.0) were performed (Fig. 7).

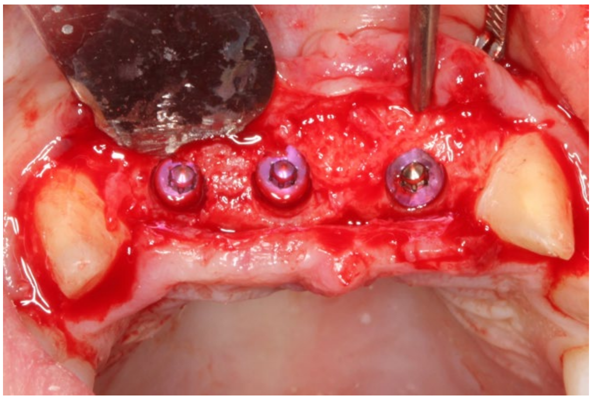

Fig. 7. *Implant placement with covering screws.*

Finally, the temporary bridge was cemented. The patient was examined at 7 days for postoperative control and at 14 days for suture removal. After 4 months, a follow-up intraoral X-ray. With local anesthesia (1,8 ml of mepivacaine HCl 2% with 1:100,000 epinephrine), a crestal incision was performed, and the healing caps were placed; the suture was performed with Vicryl 5.0 (Fig. 8). The sutures were removed 7 days after surgery (12, 13).

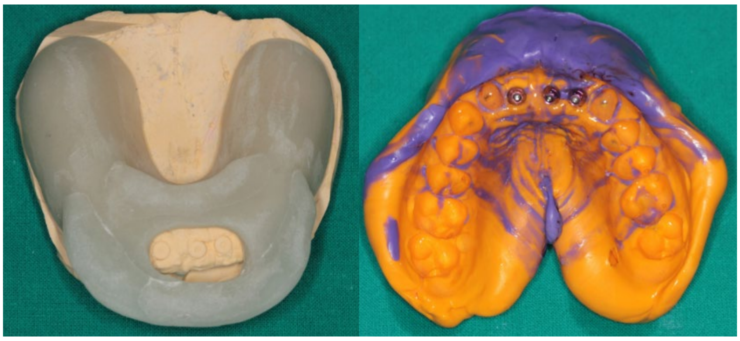

Fig. 8. *Temporary bridge.*

The imprint in alginate was taken to construct the individual impression tray. At 7 days, the transfers are screwed, and with the individual impression tray, the imprint was taken with a precision silicone with a mon ophasic technique (Fig. 9).

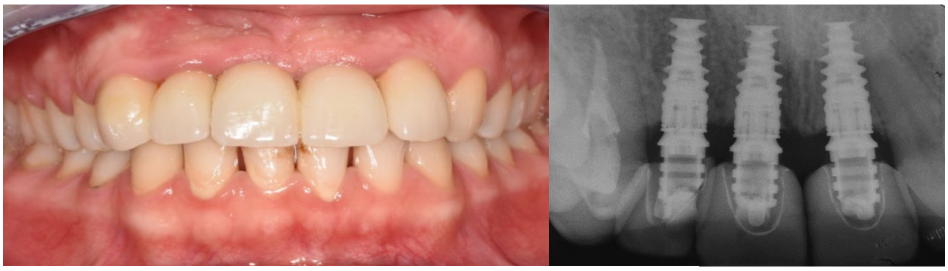

Fig. 9. *Impression tray and silicone impression (monophasic technique).*

After 7 days, single crowns in PMMA have been fitted. The crowns 1.1, 1.2, and 2.1 are screwed to the implants, and the crowns at the stumps 1.3 and 2.2 are cemented with Zinc-oxide eugenol (ZOE). After 1 month, once the aesthetic and functional goals were achieved, based on the clinical outcome and patient feedback, the temporary prosthetic manufacture was replaced with the definitive in lithium disilicate. After 20 days, the patient was re-examined to evaluate possible inadequacy (Fig. 10).

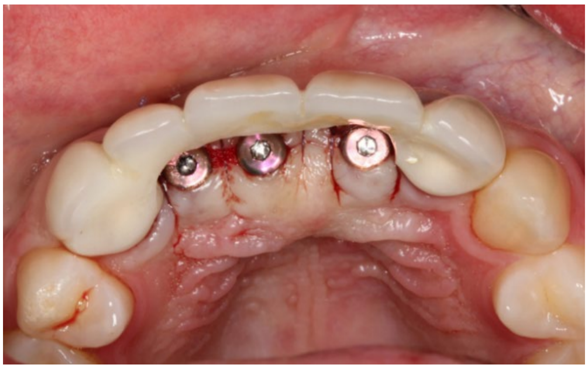

Fig.10. *Lithium disilicate single crown and intraoral radiograph.*

RESULTS

Three implants 11.5mm long and 3.75mm in diameter with Pilot Drill Surgery were placed to replace the missing elements 1.1, 1.2, and 2.1. After the first drilling with the Guided Twist Drill, a mucoperiosteal flap was performed. It was evaluated with positioning pins that modifying the preparation parameters, such as length and diameter, would not have been necessary.

Matching the final data with the virtual planning, it was considered that the three implant insertion axes allowed to place of three screwed prosthetic teeth not linked to each other, with an access hole for the driver, palatal compared with the incisal margin. It was observed that the depth of the prosthetic connection was adequate to obtain a cleanable transmucosal path and to create good aesthetic profiles.

The literature has reported that the recall of professional oral hygiene is fundamental for the long-term maintenance of implants (14). Therefore, every 6 months, the patient receives professional oral hygiene visits, which provide motivation and instructions on home hygiene from the dental hygienist (15, 16). Clinical and radiographic examination showed the stability of soft tissues and peri-implant bone levels during the patient's follow-up visits. At 6 years of follow-up, the aesthetic and functional satisfaction of the patient and the stability of the prosthetic implant rehabilitation (Fig. 11).

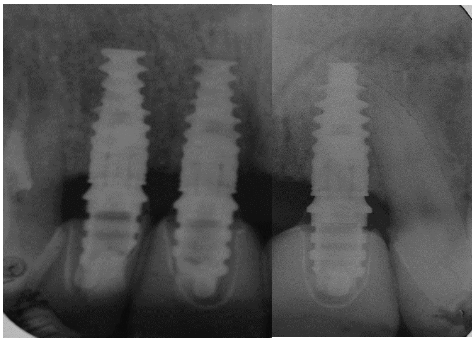

Fig. 11. *6-year follow-up intraoral radiographs.*

DISCUSSION

Specific dental skills are necessary to treat traumatic dental injuries. The teeth most commonly affected are the maxillary central incisors, with an incidence of up to 80% (17). Closed repositioning and non-internal fixation (closed treatment) are usually used to treat most segmental alveolar fractures. Cases where there is a lack of blood supply to the alveolar segments may also require closed treatment. Open reduction with or without internal fixation with plates and screws can be used to manage more extensive alveolar fractures (Open treatment) (18).

Other reasons for open reduction with or without internal fixation are dentoalveolar fractures, which cannot be reduced using closed methods, and/or those where postoperative MMF (maxillo-mandibular fixation) is undesirable. In our case, we chose closed treatment to preserve the periosteum attached to the bone fragments, ensuring sufficient blood supply to the pre-maxilla. This is mandatory to avoid bone necrosis and a consequent reduction of bone volume that could result in insufficient residual bone for implant rehabilitation (19).

Nowadays, the placement of osteo-integrated dental implants is a standard procedure in clinical dental practice, which is more predictable when implants are fully inserted into the bone. The integration of digital diagnostic technologies and tools has become a fundamental aspect of decision-making, guiding both diagnostic and therapeutical phases (20).

The most widely used 3D diagnostic technique in dentistry is CBCT (21, 22). This system must always be used in implant surgery, as it acquires detailed information and can also produce a stereolithographic model to analyze the anatomical situation. Data on bone volume, quality, or anatomical restrictions can be processed and evaluated in virtual implant simulation software.

The use of CBCT three-dimensional anatomical images and the prosthetic information obtained from the diagnostic wax-up scans, in combination with implant planning software, has improved the predictability of implant placement (23). Computer-assisted, model-driven implantology is one possible technique that makes implant placement more accurate (24). The virtually designed implant position is transferred to surgery with a drill guide, made using CAD-CAM technology in a production center, specialized dental laboratory, or in-office (6).

The literature has reported that three-dimensional guided implant surgery protocols can position dental implants more accurately than conventional free-hand implant surgery (25). A systematic review by Moraschini et al. and Laleman et al. reported a cumulative survival rate of 97,2-97,8% after 1-4 years of follow-up implant placement with guided surgery (26, 27). Moreover, Velasco-Ortega et al., in a recent study on guided implantology, reported that the cumulative survival rate of 198 implants was 97.5% (28).

In a study by Bernard et al., there was no statistical difference in three-year survival between implants placed by guided surgery and free-hand (29). The systematic review of Hultin et al. concluded that survival rates for placement of implants with and without guided surgery appear to overlap (30). However, it is known that the aesthetic success of the prosthesis and the long-term survival of dental implants strongly depend on proper placement in the bony space (31). Computerized surgery allows the clinician to place the implants in their ideal position, anatomically and prosthetically, reducing the risk of possible complications (25).

It is possible to categorize static surgical guides into fully-guided, half-guided, and Pilot-drilled protocols. A surgical guide is utilized in Fully guided surgery to assist the clinician in every procedure stage, from the initial drill to implant placement, using guide sleeves attached to the guide. The Half-guided protocol is the same as the guided one except for the final stage, where the guide is removed, and the implant is installed independently. In the Pilot-Drill guided surgery, a surgical guide is used for the initial drill, which can be stopped using an integrated guide sleeve, either with or without stopping the drill (31).

When the cumulative mismatch at the implant base and tip is detected in the comparison between the fully guided and Pilot-drill guided protocols, it is found that the Pilot-Drill group has a more significant mismatch in both areas (1, 31). On the other hand, a systematic review by Tahmaseb et al., considering only partially edentulous patients, fully guided and Pilot-Drill templates showed similar outcomes, allowing a precision of implant placement compared to a virtual design (32). In relation to our clinical experience with the Pilot Drill Template, the possible causes that could lead to a lower precision of the first drilling compared to virtual planning are:

- a greater difficulty inserting and positioning the drill in the posterior area in patients with a limited mouth opening. A possible solution to this problem is to insert the drill inside the template before placing it in the patient's mouth.
- a slight change of position that Guided Twist Drill can go through during the surgery has been observed.
- anatomical conditions such as low bone density can lead to the change in position of the drill, difficulties during the virtual planning to determine with precision the maxillary sinus, and the presence of an accessory branch of the inferior alveolar nerve can be perceived by the patient and can force the surgeon to modify the path of the implant.

It is important to underline those possible changes in length, diameter, type, and tilt of the implants during surgery may not be necessarily linked to the already mentioned criteria; suboptimal pre-surgical planning is associated with the clinician's normal learning curve during the first phase in approaching to a new method.

However, pilot-drill-guided surgery is a hybrid solution between traditional and total computer-guided surgery, and it can combine the advantages of fully guided and free-hand approaches (30). The pilot drill template offers several benefits if compared to a fully guided one: greater freedom of treatment and visibility, possibility to perform contextual osteoplasty or regenerative procedures, accurate torque perception, lower cost, easy use, less operator-dependent intervention, and reduction of overheating (33).

CONCLUSIONS

A limited number of articles concerning pilot drill surgery have been published in the literature, and this topic is claimed to be a valuable area of research. Pilot Drill Template implantology represents a compromise between Full-guide and traditional surgery and proposes to keep both advantages and overcome their limits. Adequate pre-surgical management can lead to successful implant-prosthetic rehabilitation with a good result both in terms of aesthetics and survival. The predictability of the prosthesis also makes computer-guided surgery a successful choice in the aesthetic areas (34, 35). Further studies are necessary to confirm the accuracy of computer-guided surgery with the Pilot Drill Template (36).

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