Mandibular Reconstruction for Dental Implants with a Variation of Tent Pole Technique: Use of Computer-Aided Planning and Intraoperative Surgical Guide

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Craniomaxillofac Trauma Reconstruction Open 2017;1:e43–e48.

Abstract

This report describes the use of a computer-aided planning and intraoperative surgical guide for dental implants placement in the tent pole surgery. The surgical planning was established using DentalSlice program and the surgical guide for intraoperative surgical drilling and dental implants insertion was made by Bioparts. The surgical access was performed with a transcutaneous submental approach and using sequential drilling, suitable perforations and dental implants insertion were performed using the same surgical guide, without complications. The use of the proposed intraoperative surgical guide made from a computer-aided planning can minimize the matter of an improper angulation of dental implants in the tent pole technique, providing more appropriate positioning and angulation of these implants.

Keywords
- mandibular reconstruction
- dental implants
- surgery
- computer-aided

Dental implant rehabilitation of edentulous patients with resorbed mandible presents significant challenges for both the prosthodontist and surgeon.[1] For these patients, augmentation procedures can be used to obtain sufficient bone volume for dental implants insertion and prosthetic rehabilitation. However, many of these procedures may lead to morbid complications, such as bone graft failure, progressive bone resorption, infection, sensory nerve disturbances, and chronic pain.[2]

In 2002, Marx et al[3] presented a technique called soft tissue matrix expansion, in which four to six dental implants were used as "tent poles" with a concomitant autogenous bone graft from the iliac crest, through a transcutaneous submental approach. In all cases, concentrated platelet-rich plasma (PRP) was added to the bone grafts.

The tent pole technique, however, due to its entirely extraoral technique, can cause improper angulation of dental implants. A traditional intraoral surgical guide for dental implants placement cannot be used once the surgery is performed completely outside the oral cavity.[4] This technical note describes the use of a computer-aided planning and intraoperative surgical guide for accurate placement of dental implants in the tent pole surgery.

Case Report

A female patient, 60 years old, was referred to Oral and Maxillofacial Surgery Department of Piracicaba Dental School —State University of Campinas, reporting instability and lacked retention of dental prosthesis. Intraoral clinical examination

received February 27, 2017
accepted after revision October 27, 2017

DOI https://doi.org/10.1055/s-0037-1609053.
ISSN 0000-0000.

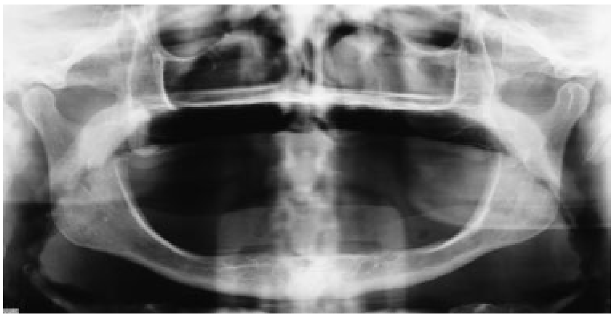

Fig. 1 Preoperative panoramic radiography showing bone atrophy in maxilla and mandible with an adequate maxillomandibular relationship.

Fig. 3 A surgical guide for intraoperative surgical drilling and dental implants insertion was designed and printed by Bioparts, corresponding to the length of dental implants portion that would remain above the bone after complete insertion.

revealed poor retention and support of complete dentures in maxilla and mandible, and a significant bone resorption of mandibular residual ridge (►**Fig. 1**). The cone-beam computed tomography (CBCT) showed a vertical bone height of 10 mm in the anterior mandible. After the initial clinical and radiographic evaluation, maxillary and mandibular models were made from the duplication of patient dentures. A bite registration with additional silicon impression was also made for maintenance of the interocclusal relationship without superimposition of occlusal guide surfaces during the CBCT achievement. The inferior guide was perforated for the insertion of gutta-percha, which was used as a reference for the visualization of the duplicated prosthesis on CBCT.

The surgical planning was established using DentalSlice program to evaluate the CT and to plan the position, angulation, and length of the dental implants used (►**Fig. 2**). A surgical guide for intraoperative surgical drilling and dental implants insertion was made by Bioparts (Bioparts Prototipagem Biomédica) (►**Fig. 3**). The surgical guide had the height correspondent to the length of dental implants portion that would remain above the bone after complete insertion. Dental implants planned to be inserted had Morse cone connection, with 3.75 mm of diameter and 11 mm of height (Neodent), which 5 mm stayed endosseous and 6 mm remained extraosseous.

The surgical access was performed in a similar manner to that described by Marx et al,[3] with a transcutaneous submental approach, to maintain the integrity of attached gingiva intraorally and prevent a bone graft or titanium mesh exposure with dehiscence soft tissue in postoperative period. The buccal and occlusal surfaces, including periosteum, were

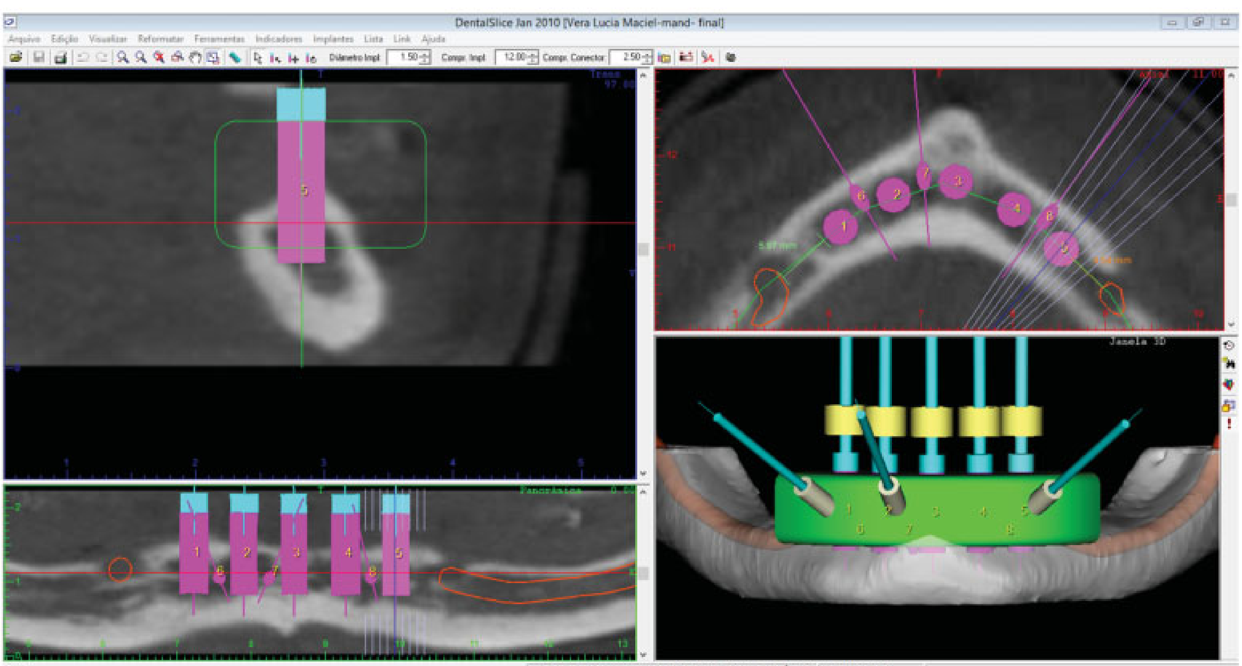

Fig. 2 DentalSlice program with CT to plan the position, angulation, and length of the dental implants.

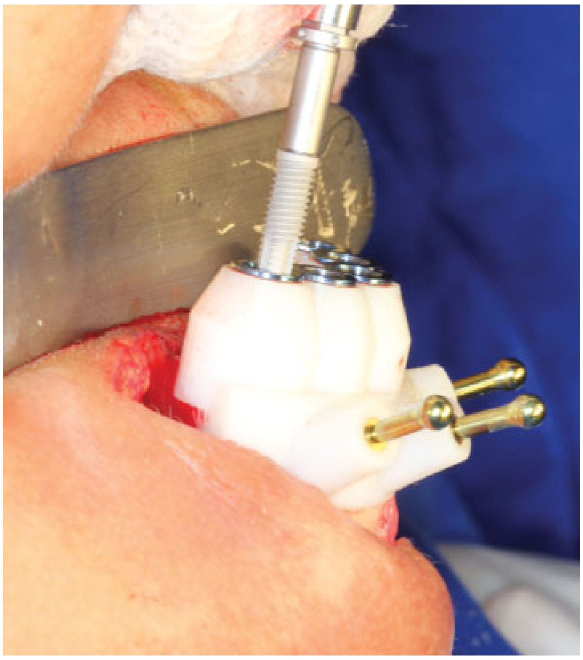

Fig. 4 Dental implants perforation and insertion was performed with the surgical guide still in position in the anterior region of the mandible.

reflected and the surgical guide was fixed to mandible using three pins. Using sequential drilling, suitable perforations and dental implants insertion were performed using the same surgical guide. For each surgical drill, there are corresponding rings, which are coupled to surgical guide perforations. The rings presented different colors and their internal diameter corresponded to surgical drill diameter. Dental implants insertion was performed with the surgical guide still in position (►**Fig. 4**). The surgical guide was removed and the implants were covered by particulate autogenous bone graft from iliac crest (►**Fig. 5A**). A titanium mesh can be optionally used to overlay the bone graft, an alternative chosen in the present case (►**Fig. 5B**). The patient followed without complications after surgery and in short- and medium-term postoperative period. No alterations such as suture dehiscence and inflammatory or infectious processes were observed, and healing occurred within the normality range.

After 7 months, the titanium mesh was removed (►**Fig. 6A**), as well as the abutments were installed, evidencing osseointegration of the dental implants (►**Fig. 6B**). The final prostheses were installed and clinical and radiographic images with 1 year of function (►**Fig. 7A–C**) show the bone maintenance and the success of the treatment.

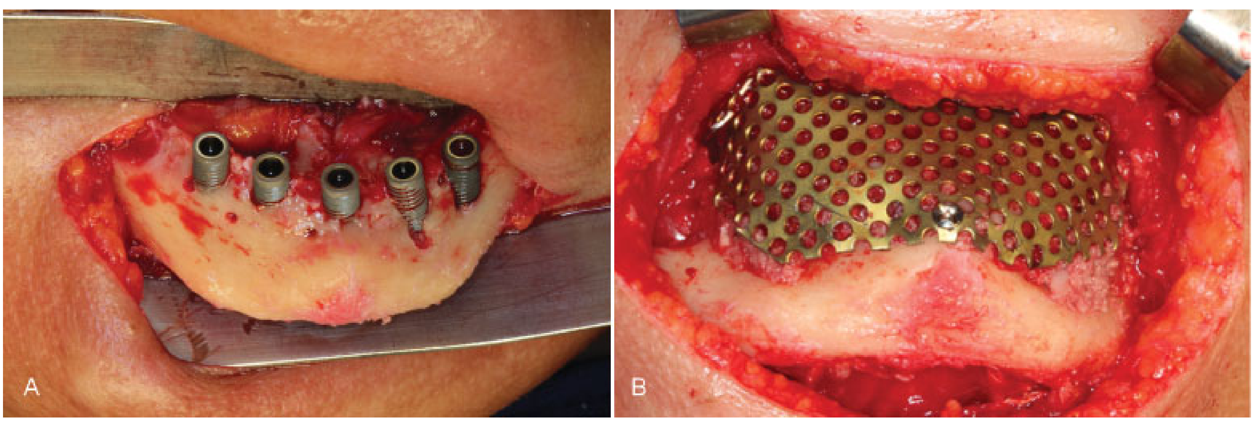

Fig. 5 (**A**) The surgical guide was removed and the implants were covered by particulate autogenous bone graft from iliac crest. (**B**) A titanium mesh was used to overlay the bone graft to provide a barrier and physical support of the soft tissue.

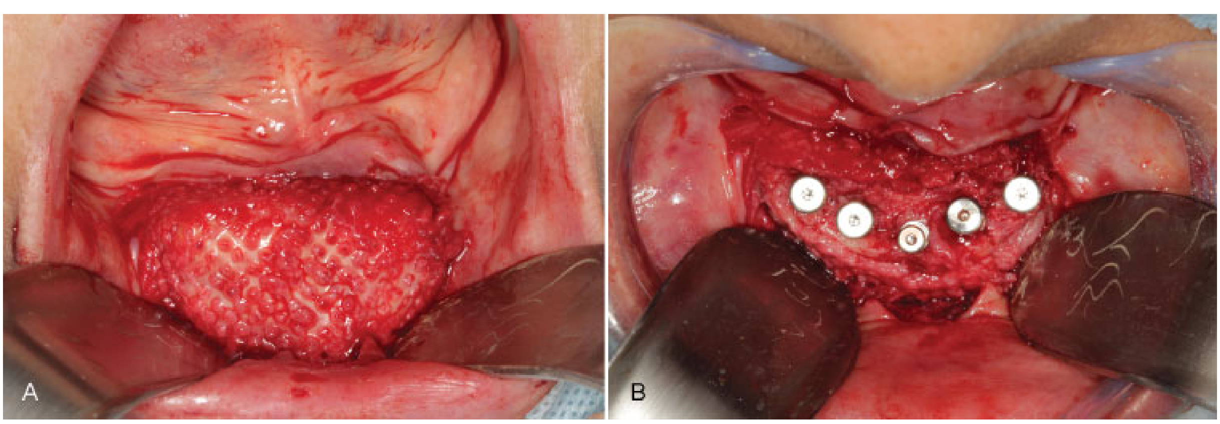

Fig. 6 (**A**) Removal of titanium mesh, evidencing bone formation at the local site with soft tissue superficially. (**B**) Abutments installed, indicating osseointegration of dental implants.

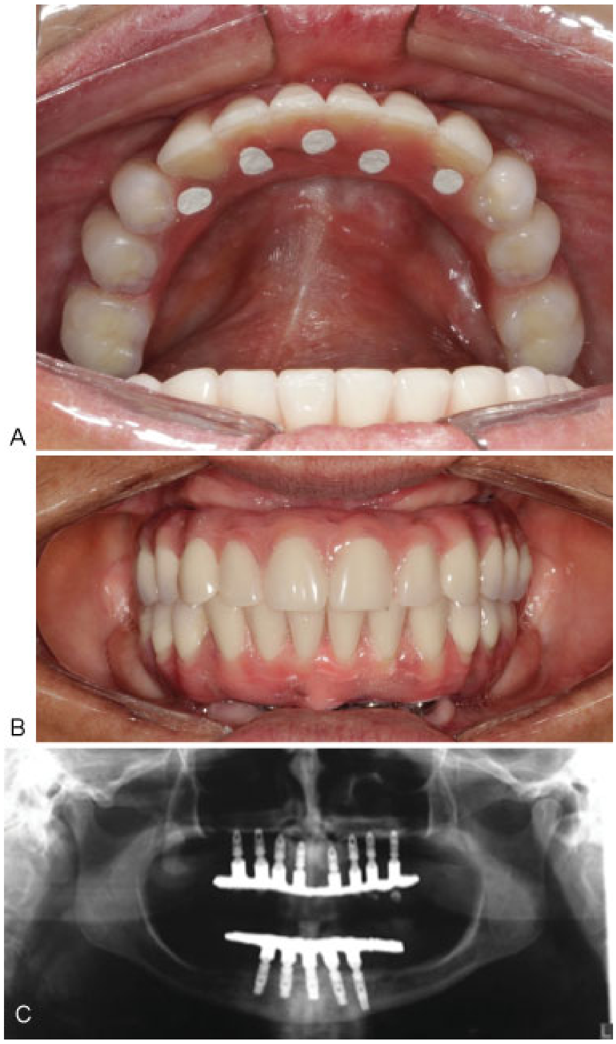

Fig. 7 (**A**) Occlusal view of the final inferior prosthesis installed (**B**) Final prosthesis installed with 1 year of function. (**C**) Postoperative panoramic radiography evidencing the maintenance of the bone tissue and the success of the treatment.

Discussion

Since the first description of the innovative technique for reconstructive treatment of atrophic jaws by Marx in 2002,[3] several authors have reported the use of this one-stage procedure.[1,2,4–7] In 2012, Korpi et al[2] presented a follow-up study of 22 edentulous patients with severe mandibular bone atrophy treated with bone grafts harvested from the iliac crest and dental implants used as tent poles. Different approaches for tent pole technique have already been performed for mandibular reconstruction and oral rehabilitation, such as defects secondary to tumor resection,[8] mandibular pathologies,[9] and atrophic mandible fractures.[5,10]

Many advantages may be enumerated with the use of soft tissue matrix expansion; however, there are also limitations. Placement of the dental implants in the correct axial inclination and in the proper buccolingual location requires extra attention from the operator[2–4,11] and may impair the oral rehabilitation by the prosthodontist.

Manfro et al[12] used stereolithography essay for treatment planning of dental implants insertion using the tent pole technique and pointed as advantages of its use in the easily identification of the mental foramina, selection of the implant site, and preservation of the areas with low bone volume, reducing the risk of bone fracture. Kudyba et al[1] suggested the use of a surgical guide as an important strategy for a better positioning and placement of dental implants, regardless of an intraoral or extraoral surgical approach. The guide is used to ensure proper location of implants within the arch, as well as guidance for implant angulation. They described the use of an extraoral guide that required a facial impression and subsequent cast of the lower face to serve as the guide platform. According to them, an extraoral surgical guide in intimate broad contact with the external surface of the mandible would serve as a platform for implant orientation during tent pole surgery. The technique used by the authors, however, is time consuming, presents limitation in planning dental implants insertion, and does not guarantee correct angulation during surgery.

The use of an intraoral guide was already proposed by Cillo et al,[4] who described the use of computer-aided planning and intraoperative stereolithographic direct-bone-contact surgical splints for the soft tissue matrix expansion graft procedure. The authors used different guides during procedure, according to the sequential drills. In the present article, author presented the use of only one surgical guide, which can be used for all drills and also for dental implant insertion. The use of only one guide optimizes surgical time and guide fixation to bone by the horizontal pins provided stability during the entire procedure.

Although the surgical guide is gross, the soft tissue dissection required for surgical guide placement is similar to the one employed in the traditional technique proposed by Marx. The greater volume of the surgical guide used is mainly due to its increased height, since the height of the guide corresponds to the length of the segment of the dental implants that will remain above the bone level. Further dissection toward the floor of the mouth was not required in this case and the transcutaneous submental approach provided adequate exposure of the mandible buccal and occlusal surfaces without the need of a more extensive tissue dissection for the installation of the guide.

The dental implants positioning with the prototyped guide respects the virtual planning performed. Nevertheless, possible errors can occur in the process of virtual planning, prototyping, and implants installation, which may impair the treatment. For D'haese et al,[13] errors in positioning of the surgical template, as well as overheating during osteotomy, are categorized as procedure-related errors, whereas the accuracy or stiffness of the surgical template and the suprastructure are product-related. Deviation between the planning and the implant position might occur at any stage in the treatment: during CT scanning, during transfer of the planning data, during the manufacturing of the surgical template, during positioning the surgical guide, and while installing implants. In the case reported, it was observed that the distal dental implant at left side was not perfectly aligned in postoperative panoramic radiography. The virtual planning was made carefully but during surgery it was observed that the guide presented an inferior overextension in the lingual portion that caused a maladaptation to the bone. Despite the remodeling performed, the guide was probably not perfectly adapted in the left side and may have caused this altered angulation of the distal dental implant. Care must be taken so that the guide does not have extensions that may lead to maladaptation and generate interferences in the final result.

Cassetta et al[14] related that in a single-type stereolithographic surgical guide with at least three fixation pins, the mean angular deviation between the planned and placed implants was 3.93 degrees. When guide tubes were interposed to the surgical handpiece, the angular deviation between the planned and placed implants decreased to 2.02 degrees. For the authors, this modified system by sliding in two opposing tubes to guide the drill reduces mechanical tolerance and prevents any contact between the drill and the guide tube, decreasing the possibility of error. In the present case, three pins were used for guide stabilization and different rings were sequentially attached to the guide. The internal diameter of each ring corresponded to the surgical drill diameter. Cassetta et al,[15] in 2014, stated that the error in positioning implants using a single mucosa-supported stereolithographic surgical guide in edentulous patients may be reduced by accurately positioning the surgical guide and fixing it. It is important to note that the guides used for Cassetta et al[14,15] were mucosa-supported and in this case report the guide used was bone-supported. The soft tissue of the lingual area, which should not be completely detached in the "Tent Pole" technique, prevented the perfect adaptation of the bone-supported guide at lingual region, culminating in the previously described.

Another limitation of "Tent Pole" technique that needs to be mentioned is the possibility of bone loss around implants, especially involving the distal area of the latest implant, where the principle of tent pole does not function properly. The use of titanium mesh is not mandatory, but it is an interesting choice, since it acts as a barrier and physical support of the soft tissue, mainly in the region already mentioned. The mesh could prevent resorption of the graft and maintain the shape because of its rigidity. Sverzut et al[16] proposed a different manner of using the titanium mesh, although with the same intention. The authors used two additional implants and titanium mesh "shelters" that were positioned after implants placement, in the posterior portion of the mandibular body, to "protect" the bone graft and increase the bone mass volume in this area.

Alternative treatment plans have been indicated for rehabilitation of advanced mandibular resorption, including onlay or interpositional grafts, short implants, transmandibular implants, inferior alveolar nerve lateralization, and osteogenic distraction.[10] Torsiglieri et al[17] made biomechanical experiments on artificial polyurethane atrophic mandibles with short and long implants and suggested that, when fixed bars were used, four long and thin implants in the anterior mandible (3.3×14mm) should be the first choice in relation to four short implants with thick design (4.8×8mm), to minimize the risk of fracture. Lamas Pelayo et al[18] cite the risk of atrophic mandible fracture as a trans or postoperative complication of implant insertion in the interforaminal region and the implant diameter and design, as well as the degree of atrophy, are vital to assess the risk of fracture, since the quality is not consistent throughout the bone and the functional demands have high variability. Nevertheless, the use of autogenous bone grafts is still the gold standard for reconstruction of the jaws and conventional mandibular reconstruction is considered a predictable treatment option, although it takes a longer time for final rehabilitation. With tent pole technique, the bone graft is placed at the same surgical time as dental implants are installed, reducing treatment time and the risk of pathological jaw fracture.

Conclusion

The use of the proposed intraoperative surgical guide made from a computer-aided planning can minimize the matter of an improper angulation of dental implants in the tent pole technique, providing more appropriate positioning and angulation of these implants.

Conflicts of Interest
The authors confirm that there are no conflicts of interest in the present study.

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