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New Transference Technique of Position of Mandibular Reconstructing Plates Using Stereolithographic Models

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Stereolithographic models are commonly used to adapt reconstructive plates in patients who will undergo mandibular resection. However, the published reports have not explained exactly how to accurately transport this plate to the patient. The purpose of our report is to illustrate a new transference technique of mandibular reconstructing plates from the stereolithographic model to the patient, without the need for testing it before tumor resection. This technique involves coating the stereolithographic model with an acrylic guide that covers the dental pieces and also impresses the mandibular reconstructive plate (Fariña's splint). This firm structure, formed by the Fariña splint and the reconstruction plate, is taken to the patient after tumor resection has been performed. This technique reduces the operative time and results in the surgeon knowing in advance the exact position of the plate in the patient.

One of the basic principles of reconstructive surgery is to keep the remaining bone with the same relations as those previous to the resection of any tumor and, at the same time, to rebuild the hard and soft tissue using various types of grafts.[1]

Traditionally, the modeling of the osteosynthesis elements used for reconstruction (titanium plates) was performed during the intraoperative procedure, increasing the operative time and requiring extensive examination for an exposition of the bone segments to allow for the fixing of the titanium plate.

From a computed tomography (CT) scan, technological medical development has enabled the 3-dimensional reconstruction of the craniofacial anatomy in patients with several traumatic, tumor, or malformative pathologic findings.[2,3]

These models, called stereolithographic models, are created on the basis of axial cuts shown in the TAC, processed in a computer, and made with plastic materials, such as photopolymerizable acrylic resin.[4] An accurate diagnosis and treatment planning in 3 dimensions are the main contributions of stereolithography.[5-7]

Planning the resection of a mandibular tumor using the stereolithographic model allows one to estimate the length of the reconstructive plate, adapt it, and select the number and size of screws to be used, thus reducing the risk of damage to the dental pieces and to the inferior alveolar nerve. Also, it considerably reduces the operative time and the costs related to the operative procedure.[8,9]

The modeled plate in the stereolithographic model is adapted to the patient, fixing it with screws on the free bone sides of the tumor, bypassing the defect that will be generated by the resection (before eliminating the tumor). Minimal adaptation will be required, because great accuracy and fidelity exists between the stereolithographic model and the patient's anatomy.[3,4,10,11]

Several reports have shown favorable outcomes in the application of stereolithographic models in the surgical planning of mandible reconstruction. However, they have not detailed the method used to transfer the reconstruction plate from the model to the patient.[8,12]

In those cases in which it is not possible to partially resect the tumor, the development of a method to transfer the position of the plate from the stereolithographic model to the patient is very important. A

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reduction of the tumor contour is frequently performed to adapt and fix the plate before in-block resection of the mandibular segment. However, partial resection or reducing the external tumor surface is not feasible for neoplastic tumors that have a risk of spreading neoplastic cells over the operation bed or highly vascularized tumors that have a risk of abundant intraoperative bleeding.

The purpose of the present study was to report on a new transference technique of the mandibular reconstruction plates from the stereolithographic model to the patient, without the need for installing them before tumor resection.

Technical Design

Case 1 was a 13-year-old female patient, who presented to the maxillofacial surgery service of the Exequiel González Cortés Hospital with an aneurismatic bone cyst that had compromised the chin and was between the second lower premolars of both sides (Figs 1, 2).

Case 2 was a 12-year-old male patient, who presented to the Fariña clinic with a central giant cell tumor compromising the mandibular body from the right lower second premolar up to the left lower first premolar.

In both cases, a CT scan and clinical study was performed to plan the tumor resection and subsequent reconstruction. Stereolithographic models were made for reducing the external deformed and convex surface of the tumor; 2.4 titanium reconstructive plates were selected and modeled for each patient. The plates were located over the mandibular surface

FIGURE 1. Three-dimensional CT scan showing aneurismatic bone cyst, covering chin area to lower premolars on each side.

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FIGURE 2. CT scan showing great damage of vestibular and lingual surfaces.

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of the model, and the bicortical screws were fixed (screw selection was determined according to the bone width).

For an exact and replicable relation between the stereolithographic model and the reconstructive plate, 2 acrylic guides were built (1 for each side), with prints of the occlusal surfaces of the remaining pieces and the titanium plate, allowing the accurate replication of its position in the mandibular remnant (Fariña's splint; Figs 3, 4). This procedure allows for very accurate replication of the 3-dimensional position of the plate, without the need for partial resection of the tumor before fixing the plate.

In both cases, during the intraoperative process, degloving of the chin zone was performed through an intraoral approach. A block resection of the mandibular segment affected by the tumor was performed, according to the previously established margins (Fig 5).

The adjustment of the plate was done using surgery guides previously made, with particular care of the place where the titanium screws would be fixed. It is recommended to number the plate washers in the Fariña splints (Figs 3, 6).

Removal of the splints revealed that the stability of the plate was optimum, and the occlusion in both patients was the same as that shown before surgery (Fig 7).

Discussion

One of the objectives of mandibular reconstruction, after tumor resection, is a return to the patient's

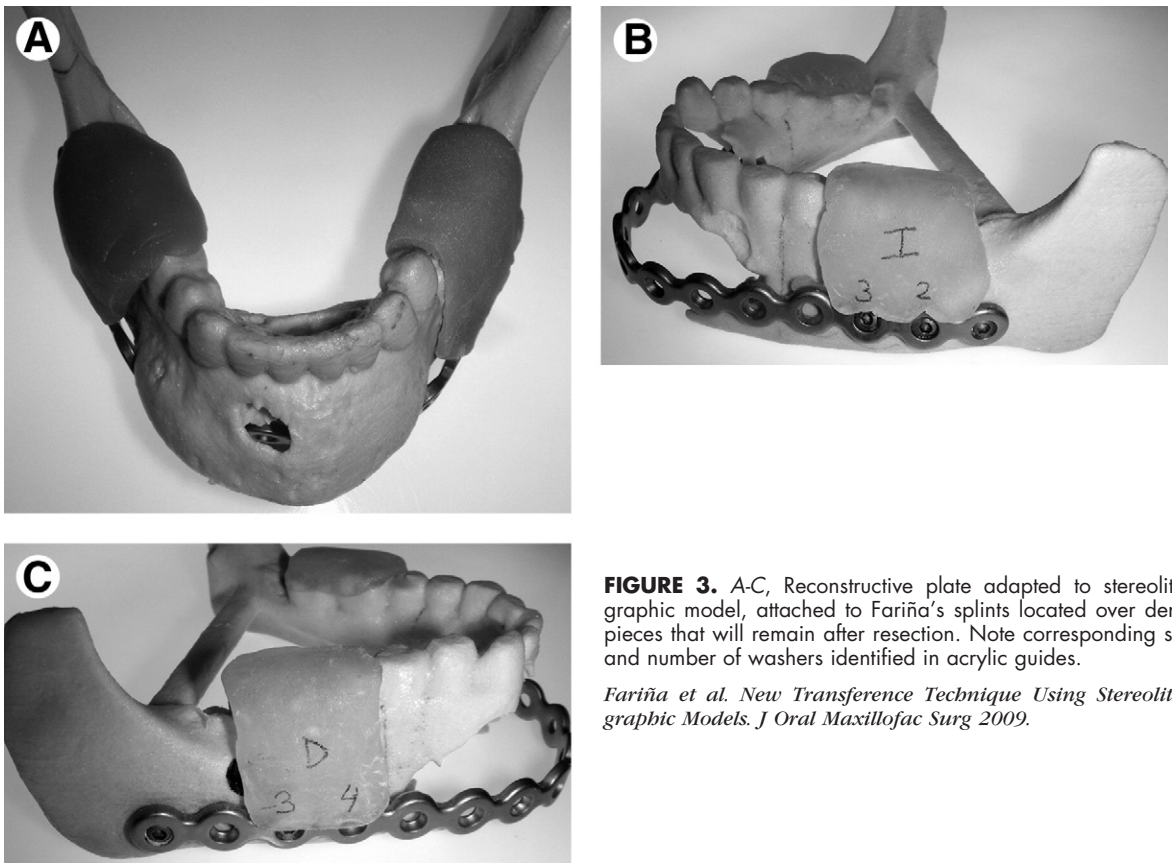

FIGURE 3. *A-C,* Reconstructive plate adapted to stereolithographic model, attached to Fariña's splints located over dental pieces that will remain after resection. Note corresponding side and number of washers identified in acrylic guides.

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original preoperative shape and function. The conventional treatment in these cases includes titanium reconstructive plates with free or microvascularized bone grafts.[4]

Because of the 3-dimensional anatomy of the skull and face, the success of such treatment depends not only on the technique used, but it is also essential to make an exact surgical plan of the patient to achieve suitable morphologic and functional reconstruction.[8-10]

The TAC plays a relevant role in providing exact and detailed information for the diagnosis and treatment planning.[1] From the TAC, it is possible to create a plastic complex that will allow a 3-dimensional representation of the bone tissue of the patient. This process starts by sending the TAC to a computer, in which specialized software programs process and send the information to volumetrically build the stereolithographic models in plastic materials such as photopolymerizable acrylic resin, cellulose starch, hydroxyapatite, or calcium phosphate cement, among others.[4,13]

The use of stereolithographic models in surgery planning has several advantages, including patient education, simulation of the tumor resection, selection of the osteosynthesis elements, and modeling the reconstructive plate before surgery.[7]

A review of the published scientific data revealed no publications showing, in a predictable, effective, and reproducible manner, how to transfer the position of the plate from the model to the patient.

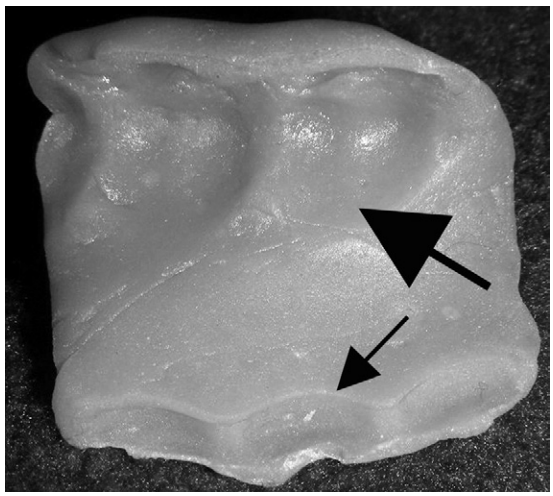

FIGURE 4. Fariña's splint with dental print *(thick arrow)* and reconstructive plate *(thin arrow)*. Note, print for plate has extension toward vestibular to allow for greater contact surface.

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Thus, we developed a very simple, fast, and secure method to allow the location of the reconstructive plate in the same place in which the stereolithographic model was fixed, with no need to first adapt it to the resection of the bone segment. For this purpose, an acrylic ferule was designed with an occlusal and plate impression (Fariña's splint).

Dental registers are not well defined in the TAC.[3] However, for the described technique, an exact reading of the dental anatomy is not required. Only a good definition of the position of it and an outline is necessary to allow the correct settling of the acrylic ferules, giving intraoral stability points, such as the case with the dental pieces of the remaining bone segments.

The technique we have developed has several advantages, including the performance of limited surgical approaches through a vestibulotomy, good access to the tumor site and the subsequent reconstruction, more esthetic results without affecting the subcutaneous tissue, and facilitating the delayed approach for reconstruction. Due to the high resemblance of the stereolithographic models to the bone tissue, the adjustments that must be made during surgery are minimal, considerably reducing the operative time, with all the benefits involved.[3,4] The good stability given by the splints (placed over the teeth) to the reconstructive plate, and the accuracy of the position of the plate transferred from the stereolithographic model to the patient, enable min-

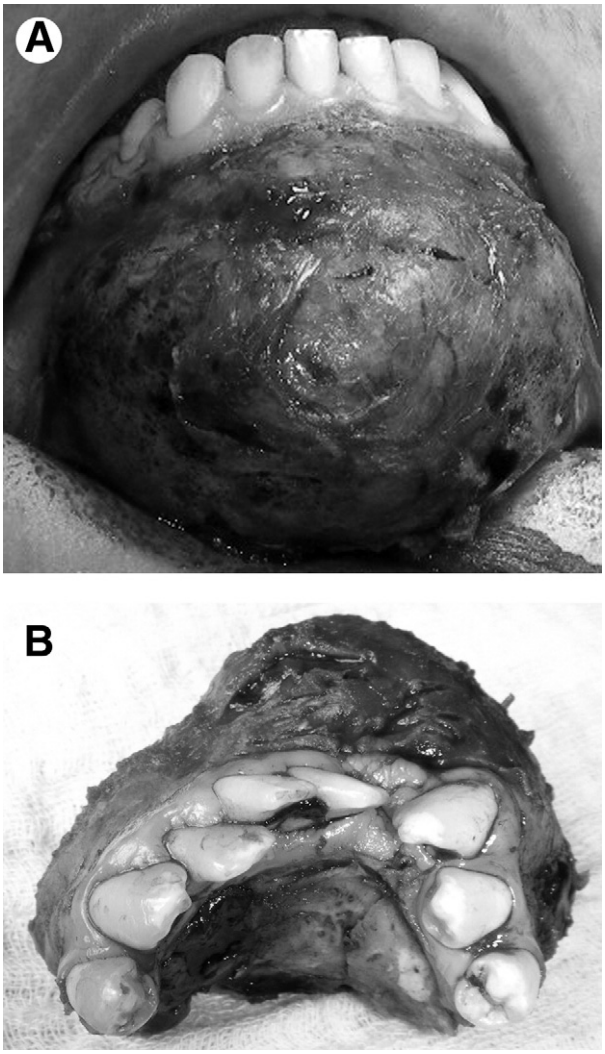

FIGURE 5. *A,* Access to aneurismatic cyst bone. *B,* Resected mandibular piece of central giant cell tumor.

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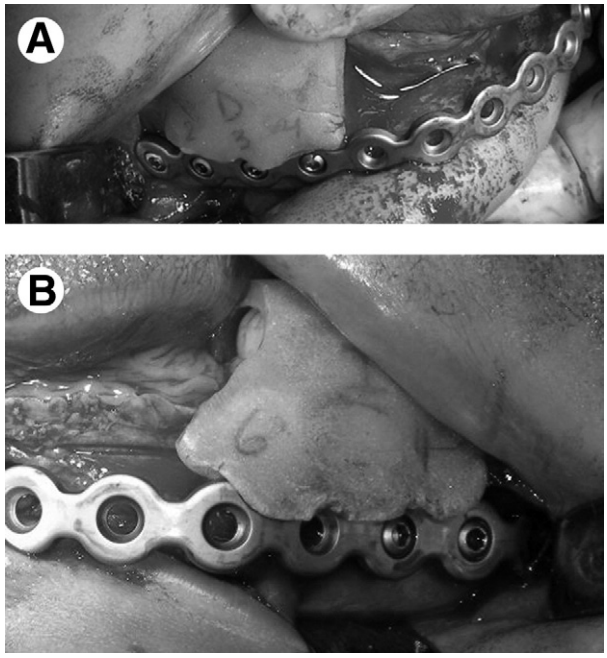

FIGURE 6. *A, B,* Reconstructive plate placed in position with Fariña's splints, without need to test its correct settlement in advance.

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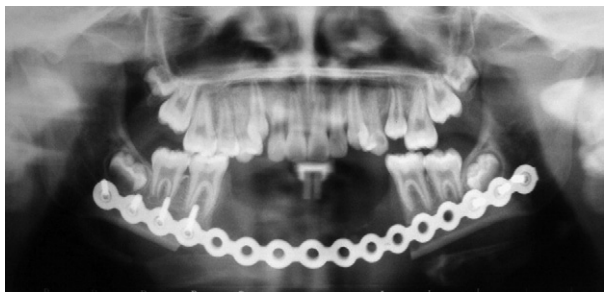

FIGURE 7. Control panoramic x-ray showing plate in good position without damage to the dental roots or alveolar nerve.

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imal plate handling during surgery, allowing a much more conservative surgical approach.

References

1. Papadopoulos MA, Christou PK: Three dimensional craniofacial reconstruction imaging. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 93:382, 2002
2. Winder J, Bibb R: Medical rapid prototyping technologies: State of the art and current limitations for application in oral and maxillofacial surgery. J Oral Maxillofac Surg 63:1006, 2005
3. Gateno J, James X: A new technique for the creation of a computerized composite skull model. J Oral Maxillofac Surg 61:222, 2003
4. Cunningham LL, Madsen MJ: Stereolithographic modeling technology applied to tumor resection. J Oral Maxillofac Surg 63:873, 2005
5. Chow LK, Cheung LK: The usefulness of stereomodels in maxillofacial surgical management. J Oral Maxillofac Surg 65:2260, 2007
6. Spagnoli DB: The use of stereolithographic models in oral and maxillofacial surgery. J Oral Maxillofac Surg 61:9, 2003
7. Beutel W: Utilization of 3-D models in maxillofacial reconstruction. J Oral Maxillofac Surg 60:8, 2002
8. Kernan BT, Wimsatt JA III: Use of a stereolithography model for accurate, preoperative adaptation of a reconstruction plate. J Oral Maxillofac Surg 58:349, 2000
9. Xia JJ, Phillips CV: Cost-effectiveness analysis for computer-aided surgical simulation in complex craniomaxillofacial surgery. J Oral Maxillofac Surg 64:1780, 2006
10. Xia J, Gateno J, Teichgraeber J: Accuracy of the computer aided surgical simulation system in the treatment of patients with complex craniomaxillofacial deformity: A pilot study. J Oral Maxillofac Surg 65:248, 2007
11. Gateno J: Clinical feasibility of computer-aided surgical simulation (CASS) in the treatment of complex craniomaxillofacial deformities. J Oral Maxillofac Surg 65:728, 2007
12. Toro C, Robiony M: Feasibility of preoperative planning using anatomical facsimile models for mandibular reconstruction. Head Face Med 3:5, 2007
13. Stoker NG, Mankovich NJ: Stereolithographic models for surgical planning: Preliminary report. J Oral Maxillofac Surg 50: 466, 1992