Case Report

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Computer-Assisted Mandibular Reconstruction with Monocortical DCIA Flap; A Case Report

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Recently, computer-assisted surgery is popular for performing well-planned operations. Computer-aided navigation system is helpful in maxillofacial surgery with real time instrument positioning and clear anatomic identification. Generally, segmental mandibulectomy and reconstruction flap surgery have done by extra-oral approach such as, submandibular approach. This case report describes performing intra-oral segmental mandibulectomy and reconstruction with monocortical deep circumflex iliac artery (DCIA) flap and CT guided implant surgery by using computer-aided surgical guide and navigation for managing ameloblastoma in a 31 years old female patient.

Key Words Computer-aided surgery · Navigation surgery · Mandibulectomy · DCIA flap · CT guided implant surgery.

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Introduction

Computer-assisted surgery is popular and useful in the field of oral and maxillofacial surgery, because of the possibility of simulation with a high accuracy (1). In all aspects of surgery, proper planning facilitates shorter surgical time and more predictable results. However, before the use of virtual planning using a 3-dimensional (3D) images, much of this relied on 2-dimensional (2D) imaging causing many surgical trial and errors (2). Recently in the field of maxillofacial surgery, especially for implant surgery, many clinicians are using various simulation softwares to develop a surgical guide by virtual implantation. Also, various methods are attempted to reduce the error between the treatment plan and the actual surgery. In addition, the use of a computer-assisted navigation system (CANS) has been recently acknowledged to be exceptionally helpful in maxillofacial surgery, as it allows the monitoring of the instrument's movements in real-time (3).

With treatment planning through computer-based virtual surgery simulation and the development of a surgical guide along with a navigation system that accurately locates the anatomical position can all be used for maxillofacial ablation and reconstruction, enabling a more precise surgery with reduced surgical time and donor site defect.

Case Report

A 31-year old female patient came with a swollen right cheek. Swelling of the right mandible was observed through oral examination, and radiolucency with ill-defined border was observed from the right mandibular canine to the right 2nd premolar from the panoramic view (Fig. 1A). The vitality of the affected teeth was normal through EPT. A facial cone-beam CT was taken for computer-based pre-operative lesion evaluation, simulation surgery, and surgical guide development, and a pelvic spiral CT was taken for virtual reconstruction surgery of the donor site. Buccal and lingual cortical bone perforation was shown from the facial CT image (Fig. 1B). Biopsy was performed and the lesion was diagnosed with follicular type ameloblastoma, A 3D image was developed to evaluate the borders of the lesion. For mandibulectomy, a safety margin was set 1cm from the border of the lesion on the 3D model and a virtual mandibulectomy was performed. The simulation surgery was performed using a 3D simulation software, GeoMagic Design X (3D systems, RockHill, SC, USA). After moving the mandible to the ilium (Fig. 2A), the incisal surface of the mandible was outlined on the ilium, thus fabricating a surgical guide for ablation and reconstruction (Fig. 2B). Matching the osteotomy line of the mandible with the ilium reduces error for bone reconstruction and later allows a more precise jaw relation. Also all of necessary information for ablation is set by the computer-based virtual surgical plan and is expressed by the surgical guide that includes the location of the osteotomy line, angle, and volume. This surgical guide allows the intraoral approach of mandibulectomy which previously was approached extraorally. The guide is placed after intraoral incision followed by ablation, then the inferior alveolar nerve was separated from the mental nerve and preserved for neuroanastomosis during reconstruction. Iliac ablation was also performed using a surgical guide, and the harvested iliac crest segment was stabilized using a 2.0 mm titanium plate (Osteomed, Dallas, Texas, USA). Also, reconfirming the incision location through the navigation improved surgical precision. And as the jaw relation was positioned equal to the pre-surgical location, displacement of the mandibular condyle was minimized (In2Vision, Cybermed, Seoul, Korea) (Fig. 4). For post-surgical evaluation, a facial cone-beam CT was taken and the amount of displacement was evaluated by matching the image with the pre-surgical CT image. From the

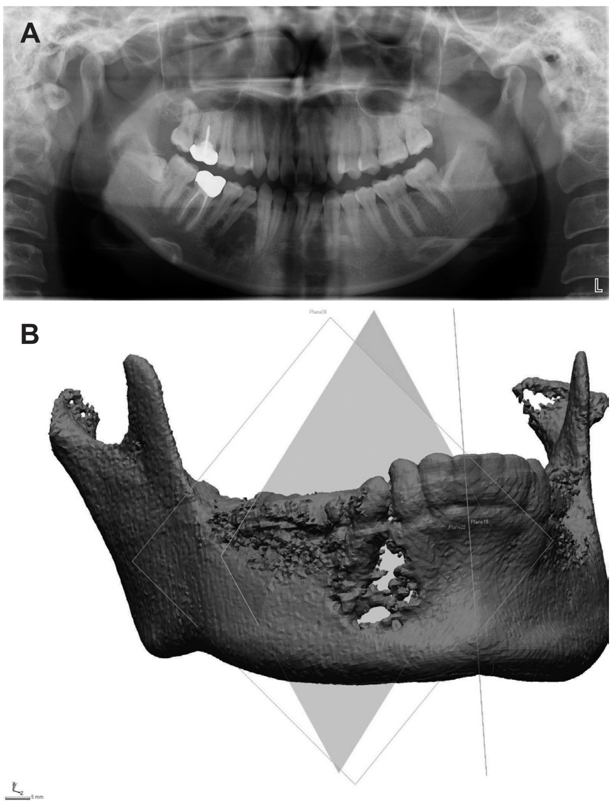

Fig. 1. Round radiolucency with ill-defined border between #43 and #45 was shown in panoramic view (A), buccal and lingual cortical bone perforation was shown in 3D CT images (B).

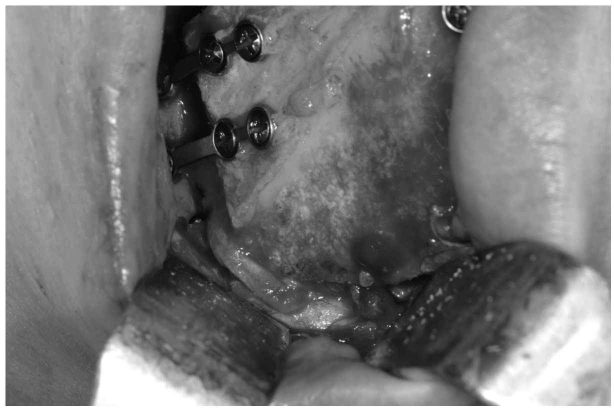

Fig. 3. The harvested iliac crest segment was reconstructed and stabilized using 2.0-mm titanium plates and screws.

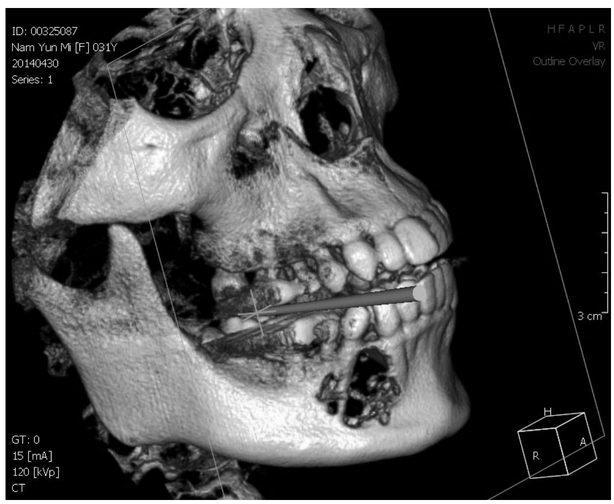

Fig. 4. Intraoperative navigation was used to assess the accuracy of the maxillary and mandibular relationship.

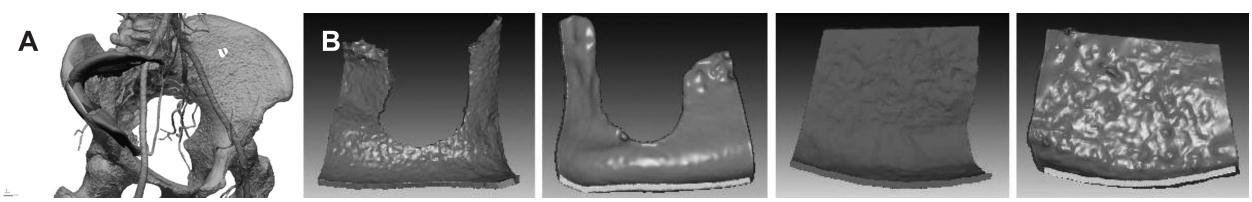

Fig. 2. Segmental mandibulectomy and necessitated bone graft reconstruction were outlined appropriately on the 3D models and mandible was moved to guide contouring of the iliac crest (A), fabricate surgical guide for ablation and reconstruction (B).

Fig. 5. The reconstructed mandible was shown maximal similarity with original mandiblular shape and also minimal deviation of condyle.

3D remodeled match of the two CT images, the reconstructed mandible was similar to the previous mandible and the displacement of the condyle was minimal (Fig. 5). Finally, The patient got the implant treatment with CT guided implant planning (Fig. 6A), and installed 5 implants at transplanted mandible after 10 months postoperatively (Fig. 6B).

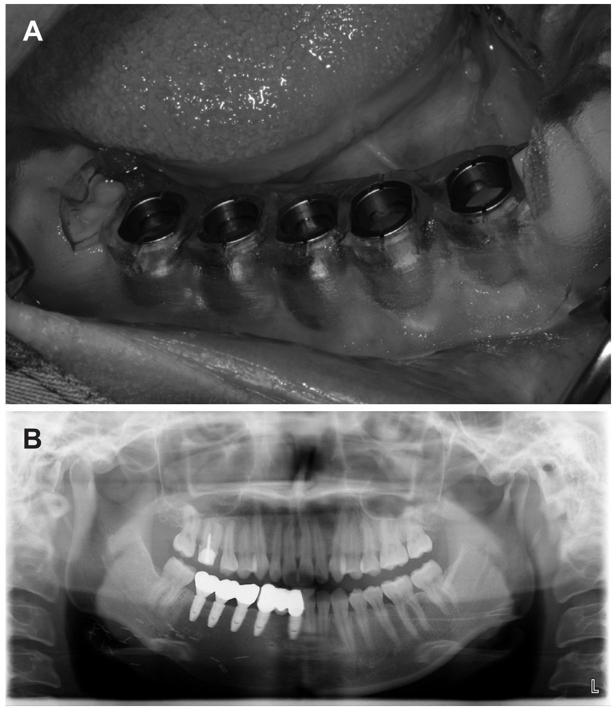

Fig. 6. Computer assisted prefabricated surgical guide was shown for implant surgery (A), and after delivered prostheses was shown (B).

Discussion

Maxillofacial surgery demands high precision, proper function, and esthetics. Also, the use of computer-based surgery on the anatomically complex head and neck area allowed a more precise surgery on a larger scale. The use of 3D images, virtual simulation surgery, and navigation system has greatly advanced surgeries from previous surgeries using 2D images (2). Computer-aided maxillofacial ablation and reconstruction surgery can be divided into four steps: pre-surgical planning, modeling, surgery, postoperative evaluation. First of all, for pre-surgical planning, the borders of the lesion is evaluated using 3D images and an appropriate osteotomy line is set. Also, the donor site is selected, and a virtual ablation is performed on the selected donor site for a proper reconstruction design. Secondly, the modeling step is the development step of the surgical guide. The next step is the application of surgery and the precise osteotomy line is set using the navigation system, and the bone from the donor site used for reconstruction is collected and transplanted. The stabilization of the transplanted bone is reconstructed by confirming the pre-surgical jaw relation and the location of the condyle using the navigation system. The last post-surgical evaluation step verifies surgical error by matching the pre-surgical and post-surgical images. The use of a surgical guide for computer-aided maxillofacial ablation and reconstruction can anticipate reduction in surgical time and an improvement in surgical precision. Also, it can reduce ischemic time during reconstruction compared to previous methods, and reduces shape modification for the recipient site which saves time. In addition, the precise bone collection minimizes complication on the donor site as it leaves less donor site defects, and allows better results for the reconstructed mandible form and jaw relation (4). Mandibulectomy may cause problems in mastication, swallowing, and pronunciation and the reconstruction of these defects are surgically difficult (5). For a successful mandibular reconstruction, reconstruction with microanastomosis preferred by its satisfactory results in both functional and esthetic aspects (6). Recently, for the reduction of scar formation, intraoral approach is commonly used compared to previous methods of the lower jaw skin incision, However, intraoral approach faces difficulty in terms of ablation precision (7). But, the effort of the clinician performing this type of surgery can be the best treatment for the patient. For the computer-aided surgery in this case, it is different from previous methods as the resected surface is set after moving the mandible to the ilium. In other words, it is different from the previous method, of which the fibula is moved to the mandible to design the shape during free vascularization fibula flap. By moving the mandible to the ilium, the normal form of the mandible and the proper donor site can be found and bone osteotomy for proper bone height for implants is possible. The use of the surgical guide and navigation system to improve surgical precision showed that ablation with an intraoral approach is possible by checking the borders of the lesion, osteotomy line, and tooth location through anatomically checking the instrument's location. Also, the use of the navigation is exceptionally useful in checking occlusion and allows minimum condyle displacement.

Conclusion

Computer-aided surgical techniques are widely used in the maxillofacial region. Computer-aided surgery is not only the most effective way to reduce failure and error, but also the most objective method to evaluate surgical results.

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