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Case Report

Mandibular reconstruction with single barrel vascular free fibula flap and implants-borne fixed prosthesis: usage of a modified healing abutment

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Abstract: Recent developments in computer-aided surgical planning and manufacturing provide a promising solution to large-scale maxillofacial reconstruction. However, proper dental prosthetic rehabilitation based on osseointegrated implants in cases with single barrel fibula flap is still a challenge. We report one patient with recurrent mandibular ameloblastoma underwent large-scale mandible resection and reconstruction with single vascular free fibula flap. By using computer-aided surgical planning, 6 implants were precisely placed on the fibula graft with limited bone quantity. To address soft tissue hypertrophy and recurrent mucositis, we fabricated a computer-aided design and computer-aided manufactured (CAD/CAM) screw-retained tooth-like healing abutments, which efficiently helped the transepithelial tissue formation of the implants. Finally, the patient was restored using a screw-retained fixed prosthesis with CAD/CAM titanium frame. A 24-month follow-up showed that all implants were in normal function with no obvious peri-implantitis or prosthesis failure. Although further investigation on this technique might be needed, this report illustrated the successful treatment strategy of a computer-aided mandibular reconstruction with single barrel vascular free fibula flap and implants-borne fixed prosthesis.

Keywords: Computer-aided surgery, mandibular reconstruction, vascular free fibula flap, customized healing abutment, Implant-borne fixed prosthesis

Introduction

The mandible is essential for many complex functions in maxillofacial region. Mandibular defects due to atrophy, trauma or tumor resection, may lead to significant facial deformity and oral function impairment [1]. In 1989, Hidalgo et al [2] reported the successful restoration of 12 mandibular defects using vascular free fibula flap. Since then, the vascular free fibula flap has been widely accepted as the gold standard for large-scale mandibular bone reconstruction. However, according to the review by Anne et al [3], implants-borne fixed prosthetic rehabilitation on vascular free fibula flap is still a clinical challenge, mainly caused by vertical bone discrepancy and high susceptibility to peri-implantitis.

To reduce the vertical bone discrepancy between fibula grafts and adjacent mandible, several techniques such as double barrel grafting, distraction osteogenesis, on lay grafting, were proposed to provide sufficient bone quantity [4-8]. However these procedures may significantly increase the medical and financial burden, and may not be accepted by patients with recurrent mandibular tumors or large-scale mandibular defect occasionally. Notably, Seemann et al [9] conducted a multicenter prospective cohort study to determine the effectiveness of 4 ultrashort implants-borne fixed, fiber-reinforced resin bridges in severely atrophic edentulous jaws and fibula bone grafts with limited bone quantity. All 10 patients were successfully restored and the bone levels remained stable during the observation period, pushing us to a hypothesis that implants-borne fixed prosthetic rehabilitation may still be an option for selective cases reconstructed with single barrel vascular free fibula flap.

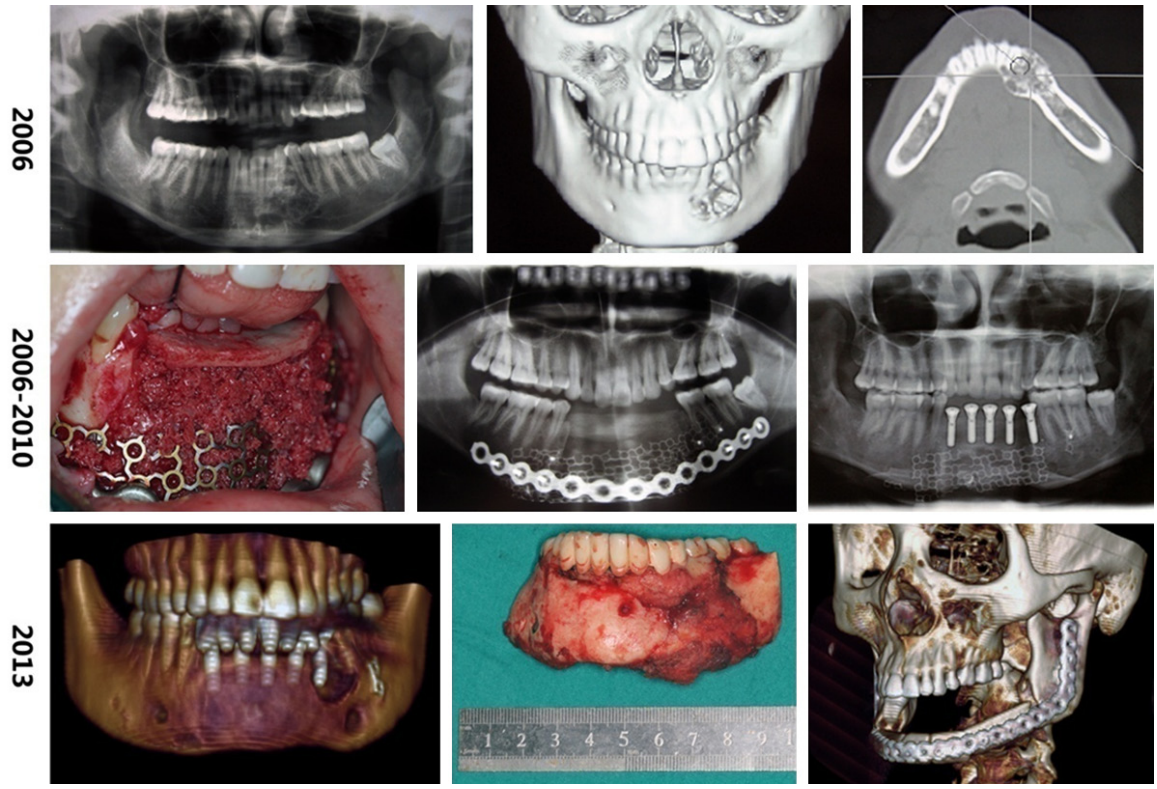

Figure 1. The patient underwent ameloblastoma resection, iliac bone grafting and dental implants based prosthetic restoration from 2006 to 2010. Recurrence of the mandibular ameloblastoma was found in 2013. Immediate en-bloc mandible arch resection and single barrel vascular free fibula flap grafting was performed.

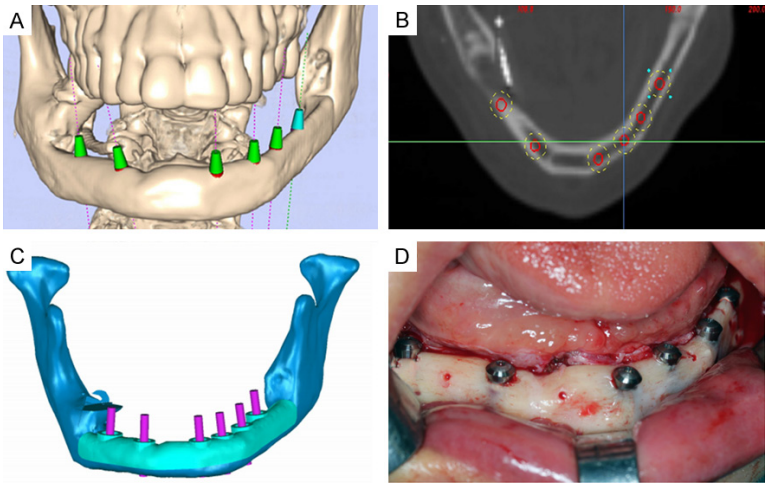

Figure 2. A. 6 dental implants were planned digitally using Tooth implant software. B. Relative position of the implants. C. Based on the virtual implantation planning, a bone supported surgical guide was fabricated. D. 6 implants (Straumann, Switzerland) were placed.

In this article, we report the computer-aided reconstruction of one recurrent mandibular ameloblastoma case using single barrel vascular free fibula flap and implants-borne fixed prosthesis with a 24-month follow-up. Our management protocol and the functional outcome are presented in detail.

Case report

The female patient was initially diagnosed as left mandibular ameloblastoma in 2006. From 2006 to 2010, she successively underwent ameloblastoma resection, iliac bone grafting, dental implants placement and prosthetic restoration. However, recurrence of the mandibular ameloblastoma was found in 2013. The treatment strategy and risks of en-bloc mandible arch resection, single barrel vascular free fibula flap grafting and implants-borne fixed prosthetic rehabilitation was well informed and chosen by the patients. Before the surgery, high-resolution computed-tomography (CT) sc-

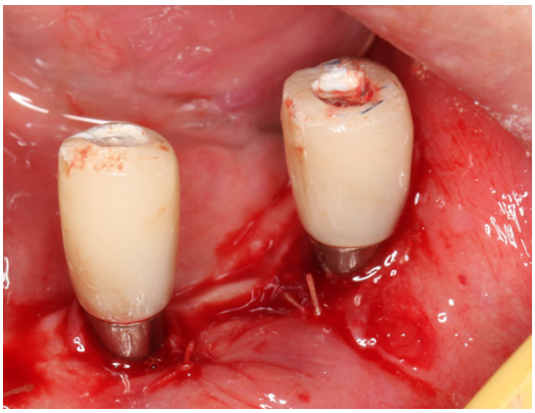

Figure 3. Customized screw-retained temporary tooth-like healing abutments.

ans were converted into 3D structures for virtual resection and fibula flap reconstruction using SurgiCase CMF software (Materialize, Belgium). According to the virtual surgical plan, stereolithographic models with bone cutting guides were fabricated to pre-bend the titanium plates. Subsequent extensive mandibular resection and immediate reconstruction were performed as previously described [4, 10-15]. The treatment process was shown in **Figure 1**. Followed by 1 year's observation and Ti-plates removal, CT scan showed that the average width and height of the fibula graft at six random cross sections was 8.67 mm and 13.16 mm, respectively. 6 dental implants were planned digitally using Tooth implant software (Hengdasheng Co. Ltd, China) (**Figure 2A**, **2B**). Based on the virtual implantation planning, a bone supported surgical guide was fabricated and the implants (Straumann, Switzerland) with 10 mm length and 3.3-4.1 mm diameters were placed subsequently (**Figure 2C**, **2D**). After an osseointegration period of 3 months, secondary surgery was performed to expose the implants and insert the healing abutments. For implants covered by thick mucosa, a CAD/CAM screw-retained tooth-like healing abutments was utilized for stable transepithelial tissue formation (**Figure 3**). After implant-level impression and bite record were taken, the patie-nt was restored using a screw-retained fixed prosthesis with CAD/CAM titanium frame. A 24-month follow-up showed that all implants were in normal function with no obvious peri-implantitis or prosthesis failure (**Figure 4**). The patient was satisfied with the surgical outcomes in terms of the facial contour, dental occlusion, masticatory function and speech (**Figure 5**).

Discussion

Since the 20th century, the application of vascular free flaps has provided a powerful tool to restore complex maxillofacial defects. Among the many options, vascular free fibula flap is the golden standard for reconstruction of extensive mandibular defect [16]. Thanks to the fast development of computer-aided design and computer-aided manufacturing technology, dental implants-borne fixed prosthetic restoration on the reconstructed mandible are becoming routine in clinical practice [3]. In this report, we present our successful experience of computer-aided large-scale mandibular reconstruction with single barrel vascular free fibula flap and implants-borne fixed prosthesis in one case.

The implants supported prosthesis has been widely accepted as the best solution for dental rehabilitation in reconstructed mandible with free fibula flaps, showing high success rates ranging from 86% to 99%, and even up to 100% in non-radiated cases [3]. However, the feasibility of implants-borne fixed prosthesis in reconstructed mandible with single barrel vascular free fibula flap was still not clear. Although several surgical teams reported the successful implants-borne prosthetic rehabilitation based on single barrel vascular free fibula grafts, details of treatment outcome and follow-up are still limited [10-15]. Notably, several finite element analysis showed the stress distributions of implants-borne fixed prosthesis in the single barrel fibula models were comparable to those in the mandible model and the implants showed predictable biomechanical behavior in their function [17-19]. Moreover, Ramin et al [20] studied the compatibility of five commercially available dental implant systems for placement in single barrel fibula. Both 2D and 3D character of human fibula bones was analyzed, showing an average bone width more than 13 mm in 90% of the samples. Hakim et al [21] investigated the primary implant stability and morphologic features of dental implants inserted in 40 fibula bones of 20 cadavers. They found sufficient primary stability in all inserted implants and the minimal and maximal bone height of the clinically relevant segments of the fibula bone measured 9.06±0.45 mm and 15.46±0.78 mm. Both of the two studies indicated sufficiency of implants placement and implants-borne dental rehabilitation in single barrel fibula graft. Likewise, we found the aver-

Figure 4. Photos of one-year and two-year following the prosthetic restoration. The X-rays and intraoral photos showed that all implants were in normal function with no obvious peri-implants bone resorption or prosthesis failure.

Figure 5. Two-year follow up: Facial contour and dental occlusion of the patient were well restored.

age width of each fibula graft was 8.67 mm and the average height of each fibula graft was 13.16 mm, respectively. We further investigated the marginal bone loss of dental implants inserted in fibula before prosthetic rehabilitation and after observation, no significant difference was noted. Although the dental implant system we used were not specifically designed for fibula grafts, our results showed proper feasibility for implants-borne fixed prosthetic rehabilitation in large-scale reconstructed mandible with single barrel vascular free fibula flap.

The other main challenge for implants-borne fixed prosthetic rehabilitation in reconstructed mandible with single barrel vascular free fibula flap is the complicated conditions of peri-implant soft tissue. Excessive thickness and mobility of the overlying mucosa and skin flap lead to high susceptibility to chronic inflammation. Although a debulking procedure can be performed, the thickness of the soft tissue at the proposed implant site can still be more than 10 mm, especially for the molar region. According to the study by Blake et al [22], the overall incidence of peri-implant inflammation (including mucositis and peri-implantitis) in free fibula grafts can be up to 38%. This incidence may be higher for single barrel vascular free fibula flap, although no specific data has been

reported. Thus, a restrict patient selection and close observation was needed. In our case, the patient was fully aware of the complications and motivated to adhere to strict oral hygiene requirement. Also, our patient's proper physical health, no involvement of osteocutaneous flap or radiotherapy were positive factors for the success of the treatment [23]. Another soft tissue challenge in cases with vascular free fibula flap is the hyperplastic tissue overgrowth. Soft tissue hypertrophy often appears after the placement of the healing abutments and mucosa-resin contact, which led to coverage of implant abutments, recurrent mucositis and long-term implants failure [12]. To address this issue, we fabricated a CAD/CAM screw-retained tooth-like healing abutments, which efficiently helped the transepithelial tissue formation. Also the CAD/CAM titanium frame helped separate the resin prosthesis from mucosa and allowed daily oral hygiene control.

Although further investigation on this technique might be needed, the current report demonstrates the successful computer-aided reconstruction of a large-scale mandibular defect with single barrel vascular free fibula flap and implants-borne fixed prosthesis.

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Disclosure of conflict of interest

None.

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