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Non-vascularised fibular bone graft after vascular crisis: compensation for the failure of vascularised fibular free flaps

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Abstract

After reconstruction of a segmental mandibular defect with a fibular free flap, a vascular crisis can be detected clinically and a "no-flow" phenomenon found during re-exploration. Traditional methods used to solve this include removal of the failed flap and delayed mandibular reconstruction, or restoration of the defect with a functional reconstruction plate or contralateral fibular free flap. Our aim therefore was to investigate under what circumstances it is feasible to use a non-vascularised fibular bone graft (NVFB) as a free bone graft after the failure of a vascularised fibular free flap. From 1 January 2010–31 December 2014, 10 patients who had NVFB after failure of a fibular free flap were included in the study. All patients were treated at the Peking University School and Hospital of Stomatology. NVFB were preserved successfully without infection in all 10 cases, and follow-up imaging showed that it had incorporated well with the residual mandible, the basic function and facial aesthetics of which were maintained. In conclusion we have identified that by precise selection of patients, detailed preoperative planning, and meticulous postoperative care, NVFB can be used as a "rescue" technique after failure of a fibular free flap, and can successfully restore the segmental mandibular defect and facial contour.

Keywords: Fibular free flap; Vascular crisis; Non-vascularised bone graft

Introduction

There are various indications for mandibular reconstruction, the most common being malignant tumours, but they include conditions such as benign tumours, injuries, developmental deformities, and osteomyelitis.[1,2] Reconstruction of the mandible is a complex procedure, and continues to be a challenge in reconstructive craniomaxillofacial plastic surgery because the mandible has several important functions including appearance, mastication, deglutition, speech, and oral competence.[3,4] In 1989 Hidalgo first described the use of vascularised fibular free flaps (VFFF) for mandibular repair.[5] Since then this approach has gained widespread acceptance, and is used worldwide.[4,6] The flap is currently regarded as the gold standard for reconstruction of large segmental defects of the mandible, because the operation is relatively straightforward, and it gives good functional outcomes and improved cosmesis. However, its success is not assured if there are adverse events such as a vascular crisis.[7] A failed flap normally has serious implications for the physical and psychological health of the patient.

The purpose of this study was to find out under what circumstances it is feasible to use a non-vascularised fibular bone graft (NVFB) as a free bone graft after the failure of a VFFF.

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Table 1
Comparison of the 10 cases (all 10 were successful).

Case No.	Age, (years)	Sex (M/F)	Diagnosis	Length of bony defect (cm)	HCL classification[8]	Duration of follow up (months)
1	25	M	Recurrent ameloblastoma	11	H	18
2	48	M	Osteomyelitis	8	CL	9
3	22	F	Osteoma	17	CH	12
4	56	M	Recurrent ameloblastoma	7.5	CL	18
5	34	F	Odontogenic keratocyst	11.1	H	9
6	38	F	Ossifying fibroma	6	L	6
7	27	M	Traumatic segmental defect	9.5	CL	12
8	52	F	Ameloblastoma	10.5	H	18
9	41	M	Odontogenic keratocyst	9	L	6
10	46	M	Ameloblastoma	8.5	CL	9

H Hemimandibulectomy = defect of the lateral segment of any length, including the condyle.
C Central defects = the entire anterior segment, including two canines and four incisors.
L = Lateral defects excluding the condyle.

Methods

Patients

Between 1 January 2010 and 31 December 2014, 890 patients had vascularised fibular bone grafts at the Department of Oral and Maxillofacial Surgery, Peking University School and Hospital of Stomatology, of which 21 flaps failed. In 10 of these 21 patients the bone was not discarded but used as a free bone graft to restore the defect, and we have made a retrospective analysis of these 10 patients. General information was collected, including age, sex, and the pathogenesis and length of the mandibular defect. To categorise the defects in the mandible and adjacent soft tissue as a result of treatment, we used the standard international HCL classification.[8] Defect H encompasses the mandible from the symphysis up to and including the condyle; defect C covers the central mandibular segment between teeth 33 and 43; and defect L extends from the canine tooth to the base of the articular process, leaving out the condyle.

Surgical technique

Immediately a vascular crisis was recognised the surgical site was explored. When a "no-reflow" phenomenon was identified, then discussions were held by experienced senior surgeons, case by case, about reconstruction with the NVFB segment. Once a case was considered suitable for free bony reconstruction, the soft tissue that was adherent to the bone (including muscle, fascia, and marrow) was removed as thoroughly as possible and rigid fixation applied. The intraoral and extraoral incisions were then closed in several layers to achieve a water-tight seal. A drainage tube was inserted to eliminate dead space.

Postoperative treatment and follow-up

Postoperatively, all patients' wounds were irrigated twice a day with hydrogen peroxide and 0.2% chlorhexidine diluted in saline, and prophylactic antibiotics were continued intravenously for seven days. If necessary, intermaxillary fixation was applied to reduce the movement between the graft and the native residual mandible.

The mean (range) duration of follow-up was 12 (6–18) months, and clinical and radiological examinations were made. The reconstruction was considered successful if the continuity and consolidation of bone were obvious clinically and radiologically, with no evidence of infection. Facial aesthetics were assessed subjectively. If the bone graft was infected or resorbed either completely or to such an extent that no prosthesis was possible, the operation was considered a failure.

Results

Among the total of 890 patients who underwent VFBF in our hospital from 1 January 2010–31 December 2014, a total of 21 flaps were considered to be failures. Of these 21 patients, 10 were selected to have NVFB (Table 1). There were six men and four women, mean (range) age 39 (22–56) years. The length of the defect ranged from 6–17 cm. The patients were followed-up for a mean (range) of 12 months (range 6–18 months) after the reconstructive procedure. In all 10 cases the reconstruction was judged to be a success with no bony infection and good opening of the jaw. Most of the patients were satisfied with their facial appearance during follow-up. Imaging studies showed that the non-vascularised free bone graft had incorporated well with the residual mandible (Fig. 1).

Criteria used to select suitable cases were investigated retrospectively by comparing the results of the10 patients accepted for free bone graft compared with those of the 11 who were not. The factors used to select the 10 successful cases were: early recognition of failure of perfusion (7–67 hours), good physical condition preoperatively, minimal soft tissue loss during the primary operation (non-malignant cases), a well-vascularised bed of soft tissue, and the fact that we could get reliable primary closure and an oral seal.

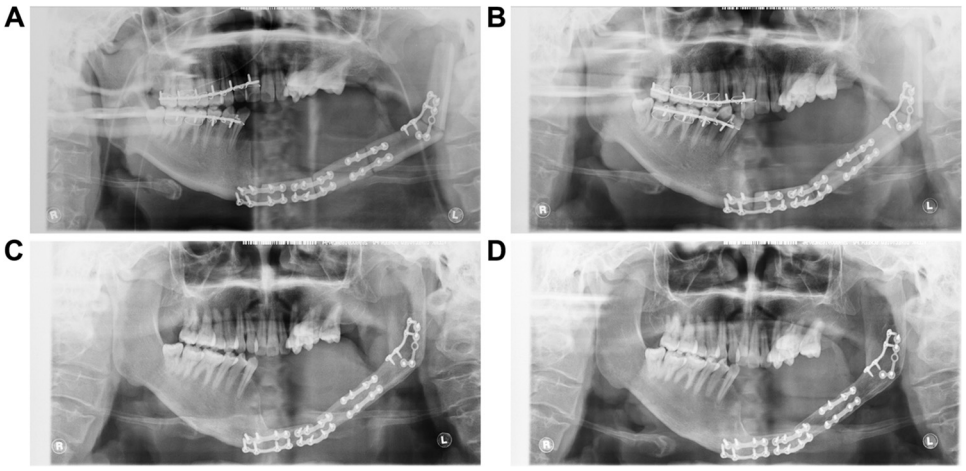

Fig. 1. Panoramic radiographs (A) immediately after operation, and (B) at one month, (C) 10 months, and (D) 18 months postoperatively. The bone callus appears during the first month, and then bony remodeling takes place.

Discussion

The reconstruction of the mandible is complex, because it plays an important part in chewing, swallowing, and articulation of speech. Solutions that have been proposed include functional reconstruction plates, and non-vascularised and vascularised bone grafts.[9,10] Vascularised fibular flaps have become the universally preferred method of reconstruction for major mandibular defects, as they produce both good functional outcomes and pleasing cosmesis, with a predictable high success rate.[6] Nevertheless, in a small percentage of cases there is still a risk of a vascular crisis. If this cannot be remedied at exploration of the graft there is the prospect of a large bony defect with considerable adverse effects on facial contour, aesthetics, oral function, and patients' psychological wellbeing.[1,4,11]

There are a number of options when a fibular graft fails, including traditional methods such as bridging the defect with a reconstruction plate with or without the intent to reconstruct the defect at a later date. Soft tissue flaps can be used in selected cases. These days a common approach is to attempt a second fibular flap immediately. However, the general complication rate in patients who have a subsequent free flap is higher than that after primary free flap reconstruction,[12,13] and the morbidity includes further microvascular failure.

Under such unfavourable circumstances we used NVBF as salvage after the failure of VFFF in selected cases. In all 10 patients the result was successful, with integration of free bone into the jaw and soft tissue architecture. Consequently the reconstructive failure rate was halved from 21 to just 11/890 (1.2%) patients treated. The factors used to select these 10 patients were: early recognition of failure of perfusion; good physical condition preoperatively; minimal loss of intraoral soft tissue at the time of the first operation; availability of a well-perfused, vascularised bed of soft tissue in which to wrap the free graft; and the ability to achieve a reliable, water-tight closure both intraorally and extraorally.[14]

Local infection, a history of radiotherapy, or the prospect of postoperative adjuvant treatment were considered contraindications to reconstruction with a free graft, as patients treated with radiotherapy have an appreciably lower success rate than those who are not irradiated.[15,16]

Apart from stripping the free bone graft of all soft tissue, Akbay and Aydogan sought to improve integration by drilling several bores in the non-vascularised fibular bone graft to increase the amount of surface in contact with both the bone and surrounding tissue.[17] We used titanium plates in all our cases to provide stability. Many studies have reported the superiority of internal fixation, and confirmed the beneficial influence of the biomechanical conditions provided by holding the graft stable.[18,19] It is also possible to use postoperative inter-maxillary fixation for two weeks to minimise movement at the interface between the bone and the graft, and allow early microvascularisation of the free graft.[3]

Previous studies have shown that the most common complication at the recipient site is intraoral wound dehiscence, which almost always heralds infection and failure of the graft. Consequently a water-tight closure is an essential prerequisite of success.[3,20,21] An additional supportive factor is to place a suction drainage tube into the cavity to eliminate dead space and prevent accumulation of saliva and formation of a haematoma.[3,22] Postoperative antibiotic treatment and good oral hygiene are important additional factors to prevent infection. At follow-up visits, the patients reported satisfaction with their oral function and facial aesthetics.[11,22] Similar functional and aesthetic improvements with NVBF have been reported in other studies.[23,24]

Conclusion

Non-vascularised fibular bone grafts can be preserved successfully to restore segmental bone defects of the mandible after the failure of vascularised fibular free flaps. Key points

that should be considered to achieve good results include precise selection of patients, detailed preoperative planning, and meticulous postoperative care.

Conflict of interest

We have no conflicts of interest.

Ethics statement/confirmation of patients' permission

This study adhered to the principles of the Declaration of Helsinki in terms of medical protocols and ethics and was approved by the institutional ethics committee (PKUSSIRB – 201412028). Patients' permission not required.

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