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Mandibular condylar-ramal reconstruction using vascularised costochondral graft based on the serratus anterior composite flap

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ABSTRACT

Background: Nonvascularised autogenous costochondral rib grafts are the gold standard for replacement of the mandibular ramus and condyle. However, condylar defects present a difficult condition to treat when soft tissue defects are involved. Thus, we used vascularised costochondral grafts (VCGs) with a cartilaginous cap based on the serratus anterior muscle flap to reconstruct these composite defects. The purpose of this study was to evaluate the advantages and effectiveness of VCGs based on long-term observation.

Methods: We evaluated 15 patients who underwent mandibular condyle and ramus reconstruction using VCG after a mean follow-up of 75.9 months (range 46–156 months). Our 15 case of mandibular reconstruction with a serratus anterior/rib composite free flap due to congenital or acquired defects involved a total of 18 condyles (bilateral reconstruction in 3 cases and unilateral reconstruction in 12 cases).

Results: Our success rate with the use of the serratus anterior/rib composite free flap was 100%, and there were no cases of resorption or malunion of the graft. The mean maximum mouth opening (MMO) at the last follow-up was 31.29 ± 7.56 mm (range 15–45 mm). Although two patients exhibited excessive growth of the graft, deficient growth of the graft was also found in our paediatric patients. Four patients who developed ankylosed TMJ during the follow-up period received additional gap arthroplasty.

Conclusion: VCG based on a serratus anterior flap was an excellent treatment modality for patients with uni-or bilateral composite defects of the ramus and condyle, in which soft tissue and hard tissue, including both bone and cartilage, were necessary.

1. Introduction

The temporomandibular joint (TMJ) has unique anatomical features, such as a meniscus and fibrocartilaginous tissue surrounding the joint, that are required for mandibular movement and stress distribution during mastication. Although nonvascularised costochondral grafts have been widely used for the reconstruction of condylar defects, microvascular free flaps are the preferred choice in cases involving a significant area of hard and soft tissue in a poor recipient bed resulting from multiple surgeries, infection, or irradiation. Therefore, vascularised tissues from the deep circumflex iliac artery (DCIA) or fibula osteocutaneous free flaps have been frequently used for reconstruction of the mandibular condyle and ramus. Several studies, however, have reported that these flaps are limited for reconstruction of composite defects for the following reasons: (1) they are too bulky for the TMJ area; (2) they cannot provide the fibrocartilaginous tissue that is a critical component of the TMJ; and (3) bilateral harvesting can lead to serious complications, particularly with DCIA flaps (Chen and Yan, 1983; Urken

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et al., 1991). Therefore, vascular transfer of the costochondral graft based on the serratus anterior composite flap has been introduced as a method for composite tissue reconstruction of complex defects of the ramus and condyle (Guyot et al., 2004).

A rib has previously been used as either a free or a pedicled composite flap for the reconstruction of defects around the mandible. Free vascularised rib transfers were harvested based anteriorly on the internal mammary vessels or posteriorly on the intercostal vessels. This type of approach has been described as difficult and time-consuming, and adaptation of the rib to the shape of the mandible using controlled fractures compromises the medullary blood supply (Ariyan, 1980). The ribs also receive a substantial part of their blood supply through the periosteum, which has been exploited in free flaps based anteriorly on the internal mammary vessels as well as the overlying muscles, including the latissimus dorsi and serratus anterior. (Harii et al., 1982; Maruyama et al., 1985; Richards et al., 1985; Takayanagi et al., 1988; Penfold et al., 1992; Netscher et al., 1998). As anatomic studies and clinical techniques have improved, however, many clinicians have selected the costochondral graft with the serratus anterior/rib composite flap as the best choice for reconstruction of mandibular defects due to several positive factors: a high graft survival rate, less resorption, and an adequate soft tissue volume for preserving facial contours through dead space filling (Kim and Blackwell, 2007).

Although Richards et al. (1985) and Netscher et al. (1998) both used the serratus anterior/rib composite flap with the cartilaginous cap to reconstruct hemifacial microsomia and hemimandibular defects in head and neck cancer patients, respectively, long-term follow-up of their patients has not been reported. Thus, we analysed the long-term results in 15 patients since 1996, and the results of our study demonstrate the advantages and effectiveness of vascularised costochondral grafts (VCGs) based on the serratus anterior muscle flap for composite defects of the ramus and condyle.

2. Material and methods

Among patients who underwent condylar reconstruction using vascularised costochondral serratus anterior composite flaps in the Department of Oral and Maxillofacial Surgery, Seoul National University Dental Hospital (SNUDH), from January 1996 to December 2009, 15 patients (male-to-female ratio 6:9) were eligible for this retrospective study, which was approved by the institutional review board of the SNUDH. The mean age of the patients was 27.3 years (range 4–48 years), and the mean follow-up period was 75.9 months (range 46–156 months). The patient characteristics (Table 1), intraoperative findings, and follow-up results were collected from the patients' medical records of admission, surgery, and biopsy. Patients with a maximal mouth opening (MMO) of less than 15 mm were examined using computed tomography to differentiate between bony and fibrous ankylosis. Overall, we evaluated the viability and morphologic changes of the flap, TMJ function based on the measurement of MMO (maximal interincisal distance), and donor site morbidity.

2.1. Surgical procedure

The vascularised costochondral serratus anterior flap was elevated in the supine position with the patient's arm abducted. The sixth or seventh rib was marked on the ipsilateral chest wall, and a curvilinear incision was made in the mid-axillary line (Fig. 1A). Skin and subcutaneous tissue were dissected until the anterior margin of the latissimus dorsi muscle was encountered. After further retraction, the anterior border of the latissimus and the vascular branches of the thoracodorsal artery, which supply the serratus anterior muscle, were traced. The serratus muscle belly supplying the sixth or seventh rib was then identified. The rib, together with the overlying serratus anterior muscle, was freed from the surrounding tissues until the costochondral junction was reached (Fig. 1B). The intercostal muscles attached to the rib were transected with an electric knife bipolarly until the pleural surface was encountered, indicated by the visible moving lung. Once both the inferior and superior borders of the rib were exposed, the inner surface of rib was dissected from the pleura using a curved mini-periosteal elevator by attaching a small part of the periosteum to the pleura to prevent its tearing, and finally, the anterior and posterior margins of the rib were dissected with a bone cutter. Rib elevation was started at the costochondral area with an elevator and a knife (Fig. 1C). The thoracic nerve above the selected rib was also transected, whereas the motor innervation of the serratus anterior muscle was left intact. When bilateral condyles were to be reconstructed, VCGs from the fifth rib, nourished by the lateral thoracic artery, and the seventh rib, nourished by the thoracodorsal system, were separately harvested at the same incision site. Alternatively, bilateral approaches were used to harvest two VCGs from both sides of the sixth or seventh rib.

After harvesting the flap, a “bubble test” was performed to exclude pleural damage. When pleural tearing was noticed, the area was repaired after evacuating the pneumothorax, using a Nelaton catheter placed under suction. After harvesting the rib, while maintaining its cartilaginous portion, a 4-hole miniplate and

Table 1
Demographic data of patients receiving vascularised costochondral grafts based on serratus anterior muscle for mandibular condylar and ramal reconstruction.

Patient	Sex	Age	Aetiology	Joint involved	Pre-op status	Interpositioning	Additional treatment	Post-op MMO[a]	Follow-up (mo)
1	F	45	Trauma	Bilateral	Ankylosis, bird face	No	Coronoidectomy	Ankylosis	156
2	M	26	Malignancy	Left		No	Parotidectomy	44	84
3	M	19	Malignancy	Right		No	Parotidectomy	Ankylosis	144
4	F	47	Trauma	Left	Condyle resorption	No	No	30	46
5	F	48	Malignancy	Left		Meniscus preserved	Parotidectomy	38	87
6	M	18	Trauma	Bilateral	Ankylosis, bird face	No	No	Ankylosis	71
7	M	40	Trauma	Bilateral	Ankylosis, bird face	No	No	31	64
8	F	11	Benign tumour	Right	Ankylosis, bird face	Temporalis fascia	Coronoidectomy	Ankylosis	55
9	F	32	Trauma	Left	Ankylosis	No	Coronoidectomy	29	54
10	M	47	Benign tumour	Left		Silastic sheet	No	28	77
11	F	6	Malignancy	Right		No	No	27	69
12	M	10	Malignancy	Left		No	No	33	70
13	F	13	Trauma	Right	Ankylosis	Silastic sheet	Orthognathic surgery	42	60
14	F	4	Hemifacial microsomia	Right		Meniscus preserved	No	21	54
15	F	43	Benign tumour	Right		Silastic sheet	Parotidectomy	21	48

[a] MMO shows the mean width of the maximal interincisal mouth opening in millimetres.