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Reconstruction of isolated mandibular bone defects with non-vascularized corticocancellous bone autograft and graft viability☆

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ABSTRACT

Objective: The aim of this study is to discuss the use of non-vascularized bone grafts in mandibular reconstruction and their viability.
Methods: In this study, 11 patients with mandibular defect treated by surgery using non-vascularized bone grafts between 2011 and 2012 were reviewed. All patients underwent preoperative and postoperative 3-dimensional computerized tomography scan for surgical planning and evaluation of success after surgery. Grafts were used for defects caused by mandible tumors in 2 patients and firearm injuries in 9 patients. Reconstruction was achieved by using various non-vascularized bones, including iliac crest, fibula and scapula. To improve graft supply, periosteum of the grafts was spared and multiple bores were created on the graft during surgery by drilling. At the postoperative period, Dextran 70 and Bencyclane Hydrogen Fumarate was given in order to enhance micro-circulation. On the postoperative day 5, 15 and 30, Tc-99 m methylenediphosphonate scintigraph, blood-pool single photon emission computed tomography and it's bone phase were performed in order to assess viability of bone grafts greater than 3 cm.
Results: Mean age was 32. 27 ± 13.33 (min = 10–max = 56). Of the 11 patients, 10 (90. 9%) were men and 1 (9. 1%) was woman. Mandibular defects were at right corpus in 3 patients; at right ramus and angulus in 1 patient; at left corpus in 1 patient; at left ramus and angulus in 1 patient; at left ramus, angulus and corpus in 1 patient; left parasymphysis in 1 patient; at bilateral corpus in 1 patient; at symphysis in 1 patient and at whole segment from right corpus to left one in 1 patient. The following grafts were used: iliac crest grafts in 9 cases, scapula graft in 1 case and fibula graft in 1 case. The smallest graft used was 1 × 2 cm in size, while the greatest, single piece graft was 7 cm in size. The greatest multi-piece graft was a fibula graft of 14 cm in length. All grafts with a size of 3 and 7 cm had been supplied at the end of first month. No bone resorption or donor site morbidity was observed in any patient.
Conclusion: Non-vascular bone grafts can be successfully used in isolated bone defects of mandible in case of appropriate graft selection for fitting anatomical region. A single piece iliac crest grafts up to 7 cm can be revascularized in long-term.

1. Introduction

Bone grafts are the bone fragments which are removed from a part of skeletal system and used to heal and strengthen the diseased area. The materials used for this purpose may not only be taken from patient himself/herself but also they may also be cadaver-originated or synthetic. These grafts are used to bridge a gap developed in spine disorders such as infection, trauma, tumor, degeneration and deformity or to achieve fusion. Grafts taken from patients' skeletal system itself to achieve fusion are termed as autograft. Hip and extremities are the most frequently used sites as the source of autograft.

Reconstruction in the oral and mandibular region is a difficult task. Anatomical, functional and esthetic aspects have to be taken into account while performing reconstructive surgery [1]. While a lot of alloplastic materials are available for reconstruction of mandible defects, the role of free non-vascularized bone grafts remains to be important [2,3].

There are some points in mandibular reconstructions those have to be emphasized. This important points are the facial skin envelope, neuromuscular dynamic functions, the bony supportive framework and soft tissue volume [4]. In this context, it will fail to

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repair isolated bone defects by using plate alone without bone and soft tissue reconstruction in terms of esthetic and function.

Bone autografts removed from fibula, iliac crest and ribs are widely used at maxillary, mandibular and nasal regions with varying success rate. However, micro-vascular surgery using soft tissue and bone (composite graft) with vessel anastomosis may be a better method but it requires special skills and expensive equipment. While scapula and iliac crest grafts could be selected among alternative grafts, fibula grafts with many advantages seems to be choice of the graft in mandible reconstructions at the present [5]. In the literature, it was demonstrated that fibula has been successfully used as non-vascularized graft since it is a strong, long and tubular bone [2,6]. Moreover, it is also an option to use fibula non-vascularly in structures as mandible without load-bearing.

It has been reported that non-vascularized iliac bone grafts with fixation screws are successfully used in extremity reconstructions [7]. It has been reported that these grafts ware revascularized 2 weeks after cancellous bone operations and up to 8 weeks in cortical bones [8]. Bone scintigraphy is a practical, non-invasive and effective method in the assessment of viability. Single photon emission computed tomography (SPECT) scans have some advantages over planar imaging such as enabling 3 dimensional evaluations, allowing discrimination of superimposed activities and increasing image activity by increasing signal: background rate. Scintigraphic imaging was used in the assessment of graft viability in our patients underwent graft surgery.

In the present study, we aimed to discuss feasibility of non-vascular corticocancellous autogenic bone grafts, graft viability and surgical outcomes in mandibular reconstructions.

2. Materials and methods

Eleven patients underwent mandibular surgery at our clinic between October, 2011 and July, 2012, were retrospectively evaluated. Informed consent was obtained from all patients. Two patients were treated for mandible tumors. The remaining 9 patients were admitted because of firearm injury. Reconstruction was achieved in all patients by using various non-vascularized bones, including iliac crest, fibula and scapula.

All patients underwent surgery under general anesthesia. All patients received 7.5 cc/kg/day Dextran 70 infusion and 2 mg/kg/day Bencyclane Hydrogen Fumarate for 1 week after surgery in order to improve micro-circulation. For prophylaxis, adult patients received Cefazoline sodium (1 g, twice daily for 5 days), whereas a 10-years old patient received 0.5 g twice daily for 5 days. At the postoperative period, food ingestion was abolished for 7–30 (mean = 11.48 ± 7.23) days in cases underwent oral and gingival interventions during surgery. Nutrition was achieved through a nasogastric feeding tube during this period.

Surgery planning and surgical success was evaluated by pre- and postoperative 3-dimensional computerized tomography (3-D CT) scans in all patients.

Radiology, histology, bone scintigraphy, bone densitometry, laser Doppler flow measurements and biomechanical tests have been used in order to assess viability of bone grafts. In our cases, we performed scintigraphic bone studies on the day 5, 15 and 30 after surgery to assess bone viability in bone grafts greater than 3 cm in size. The most widely used evaluation is three phase bone scintigraphy with Tc-99 methylenediphosphonate (MDP) and blood pool and bone phase SPECT in the assessment of blood flow and viability of maxillofacial bone grafts. In the present study, dynamic perfusion and blood pool images from cranium were obtained to assess viability after intravenous injection of 740 MBq (20 mCi) Tc-99 m MDP. Subsequently, blood-pool SPECT scan was performed. After 4 h, delayed static and SPECT images of whole body was obtained. For the publication of this study, consent of all patients and approval of local Ethics Committee were obtained.

3. Results

Mean age of the patients was 32. 27 ± 13.33 (min = 10–max = 56); there was 10 men (90. 9%) and 1 woman (9. 1%). Mandibular defects were detected at right corpus in 3 patients; at right ramus and angulus in 1 patient; at left corpus in 1 patient; at left ramus and angulus in 1 patient; at left ramus, angulus and corpus in 1 patient; left parasymphysis in 1 patient; at bilateral corpus in 1 patient; at symphysis in 1 patient and at whole segment from right to left corpus in 1 patient (Table 1).

For reconstruction, iliac crest grafts were used in 9 cases (Fig. 1), whereas scapula graft in 1 case (Fig. 2) and fibula graft in 1 case. The smallest graft used was 1 × 2 cm in size, while the greatest single piece graft was 7 cm in size. The greatest multi-piece graft was a fibula graft of 14 cm in length (Fig. 3). All grafts with a size of 3 and 7 cm had been supplied at the end of first month. Scintigraphy was not performed in grafts smaller than 3 cm in size, given the observation that even grafts larger than 3 cm in size had been supplied. No bone resorption or donor site morbidity was observed in any patient.

Gargle with polyvidone iodine and to take care for oral hygiene were recommended. No donor site morbidity was observed in any of the patients. An oral-cutaneous fistula was developed in one patient; however, fistula was closed after secondary suture and stopping oral intake. No infection related to bone was detected, while an abscess was found at submandibular region in 1 patient regardless of graft; however, it was recovered by drainage and antibiotic therapy. At the postoperative period, the most common problems were pain and nutritional difficulties. There was no significant bleeding requiring perioperative blood replacement.

4. Discussion

Microvascular osteocutaeneous free flaps provide a powerful tool in the reconstruction of composite defects in mandible. However, this flap technique includes some complications in both donor and recipient sites [9,10]. Sensorial changes, femoral neuropathy and incisional hernia can be observed in iliac crest free vascularized flaps [11], while edema, cold intolerance, sensorial loss and weakness can be observed at the distal to donor site in free fibular flaps [9]. The peroneal artery and vein are divided and ligated in the free fibular flaps. The weakness at lower extremity can occur as a result of failure in arterial blood flow, whereas edema can resulted from failure of venous drainage.

Another problem is the need for external incision at the recipient site to perform micro-anastomosis. These incisions can result in scar tissue as well as facial paralysis risk during surgery [12]. However, a non-vascular graft can be used via transoral route without an external incision if the bullet did not cause a defect other than a small bullet hole.

Non-vascular grafts may be preferred in patients who have circulatory problems or predisposition such as those with varicose veins or in those who refuse external incision at mandibular region. In our study, there was a case, in which a mandibular graft up to 7 cm in size was supplied and we recommend reconstruction with standard vascularized free flaps above this size.

Bone tissue is supplied by 3 different sources including blood flow of periosteum, endosteum and surrounding soft tissue [8]. In the present study, as non-vascular grafting was used, it was attempted to provide blood supply to grafts from all 3 ways by sparing periosteum. Periosteum was spared in all non-vascular grafts other than perpendicular plate and they were sutured to adjacent soft tissue.