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Iliac Crest Bone Graft in Maxillofacial Bony Defects

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Abstract

Background The reconstruction of facial deformity has been of paramount clinical concern for many years and one of the most difficult and challenging tasks facing the maxillofacial surgeon. The ultimate goal in the treatment is the relief of suffering, restoration of function of jaw, restoration of speech, regain of the normal looking contour and improvement in the quality of life.

Objective To obtain more knowledge on autogenous on lay bone graft behavior in different facial defects and to evaluate the lateral and medial surgical approaches to the iliac crest.

Methods A prospective study was conducted during the period from January 2009 to January 2012 on 20 patients with facial defects, in the orbit, zygoma, maxilla and mandible. The causes of defects were trauma, odontogenic tumors and alveolar cleft. Types of bone graft used were either block cortico-cancellous or chips cancellous bone, the block was either monocortical or bicortical bone graft.

Results Complications associated with donor site harvesting procedure included pain 5% and gait disturbance 5%. Failure of bone graft was observed in 3 patients (15%) while the rest, 17 patients, (85%) ended with functional and esthetic successful graft. Causes of failure were due to sequestration (5%), inflammation due to osteomesh (5%) and soft tissue breakdown (5%).

Conclusion Iliac crest graft has evolved as a safe, well accepted procedure, with relatively low morbidity that can be used for a wide variety of maxillofacial procedures.

Keywords Iliac crest, bone graft, facial defects

Introduction

The reconstruction of facial deformity has been of paramount clinical concern for many years and one of the most difficult and challenging tasks facing the maxillofacial surgeon. Bone graft represents one of the earliest devised reconstruction approaches to the musculoskeletal system. In addition, autogenous bone is available in many forms and unlimited quantity [1,2].

The ultimate goal in the treatment is the relief of suffering, restoration of function of jaw, restoration of speech, reprintof the most normal looking contour, and improvement in the quality of life [3-5].

In osseous restoration of full bone thickness for the face, many factors render the usual bone grafting procedures difficult and their prognosis uncertain including contour, morphology, nature of the muscular attachments and the effects of continuing trauma associated with mastication, phonation, swallowing and other mandibular movements [6,7].

The use of cortical and cancellous bone graft is common in many craniofacial deformities, because of its accessibility and the quantity of bone available. The ilium has become a

favorable donor site for cortico-cancellous and marrow grafting material [8-10]. Cortical bone, also known as compact bone, is one of two main types of osseous tissue. Cortical bone is dense, and forms the surface of bones. It is solid in appearance, and constitutes 80% of total bone mass. Compact bone is composed of many cylinder shaped units called osteons, or Haversian Systems, and transverse channels between them called Volkmann's Canal.

Cancellous bone, synonymous with trabecular bone or spongy bone, is one of two types of osseous tissue that forms bones. Compared to compact bone, which is the other type of osseous tissue, it has a higher surface area but is less dense, softer, weaker, and less stiff. It typically occurs at the ends of long bones, proximal to joints and within the interior of vertebrae. Cancellous bone is highly vascular and frequently contains red bone marrow where hematopoiesis, the production of blood cells, occurs. The primary anatomical and functional unit of cancellous bone is the trabecula. The bone usually forms initially as cancellous bone and then forms the compact bone [11].

The objectives of this study was to obtain more knowledge on autogenous on lay bone graft behavior in different facial defects and to evaluate the lateral and medial surgical approaches to the iliac crest.

Methods

Data were obtained in this study by reviewing prospectively the results of 20 patients with facial bone defects, 13 patients were males, and 7 were females with an age ranged from 12 to 59 years. All of the patients were subjected to autogenous bone graft taken from the anterior iliac crest to reconstitute facial defects. Those patients were admitted to the Department of Maxillofacial Surgery in Al-Imamain Al-Kadhymain Medical City during the period from January 2009 to January 2012.

The causes of defects were trauma, odontogenic tumors and alveolar clefts. The bone graft was used either immediately or after a while. The types of bone grafts used were either block corticocancellous or chips cancellous bone. The blocks were either monocortical or bicortical bone graft. The bone grafts were fixed by wires, bone plates, and screw by the use of osteomesh in case of chips bone graft; and for the mandible, intermaxillary fixation was used for immobilization for six weeks duration. Follow up period ranged from 3 months to 2 years after operation.

The indications for the orbital defects were cosmetic, and elimination of diplopia due to blow-out fracture. For the zygoma, the indication was cosmetic. For the maxillary and mandibular defects, the indications were closure of alveolar clefts, preparing a good bone quality for the placement of dental implant, severe trauma with loss of major part from the mandible and correction of the contour of the mandible after excision of a tumor. Table (1) shows the location of the defects.

Table 1. The different locations of the bone defects

Location	No.	%
Orbit	4	20
Zygoma	4	15
Maxilla	3	15
Mandible	9	45
Total	20	100

In regard to the type of treatment, the patients were treated as follows: for orbital defects, 4 patients with defective floor, 3 on the right side and one on the left side, 2 due to missile injury and 2 due to Rather infra-orbital approach was used within skin creases; and all of the bone grafts used were corticocancellous monocortical bone graft. Size of the defect was about 3 cm. The extensions of defect for grafting are shown in (Table 2).

Four patients had zygomatic bone defects, 3 on the left side, one on the right side. The treatmentwas done by extra-oral approach, infra-orbital approach, and cortico-cancellous monocortical bone graft was used. Size of the defect ranged from 3-5 cm.

Table 2. The extension of the defects needs to be grafted

Area	Size of the defects
Orbit	3 cm
Zygoma	3cm-5cm
Maxilla	2cm-4cm
Mandible	4cm-10cm

For the maxilla, there were totally 3 cases, 2 cases with alveolar cleft and 1 case with trauma to the alveolar ridge due to shell injury.Intra-oral approach was used and we inserted a monocortical corticocancellous bone graft to form an alveolar ridge in order to make an implant for the upper jaw. Size of the defect ranged from 2-4 cm.

For the mandibular bone defects, there were a total number of 9 patients operated for reconstruction of mandible, caused by RTA, shell injuries and ameloblastoma. The types of bone graft used were either cortico-cancellous bone graft, monocortical or bicortical, or chips of cancellous bone graft inserted in osteomesh tray at the defect site. The approach was always conducted through submandibular incision, and immobilization of the mandible was done by arch bar and interaxillary fixation for at least 4 weeks (between 4-6 weeks). Size of the defects ranged from 4cm –10 cm.

The patients were operated for bone graft taken from anterior iliac crest by two approaches; in 13 patients, we used medial approach, and in 7patients, we used lateral approach. A trapdoor osteotomy technique was usedfor all of the patients by retracting the skin by the assistant and incision was extended through the skin and periosteum to the crest of the ilium so that the incision lies lateral to and below the crest. The periosteum was reflected and raised with periosteal elevator. By vertical sectioning of the portion of the crest between the vertical cuts, a section of cortical table with its underlying cancellousbone was done. When cancellous bone alone was needed, an osteotomy was made over the central portion of the iliac crest and a wedge of cancellous bone is resected. The outer and inner tables of the ilium were then fractured toward each other with heavy forceps in order to eliminate the resulting dead space between them. This technique did not disturb the continuity of the crest and left no visible deformity. The amount of bone volume was measured visually. The drain was inserted and removed later when the amount of blood was less than 20 cc, removed from the donor site.

Results

The age of the patients (Table 3) with bone graft for reconstruction of facial defects ranged between 12 and 59 years. The mean age of the patients was 33.6 years. The male percentage operated on were 65% (13 males), and the percentage of females were 35% (7 females).

Table 3. Age of the patients

Age range (yrs)	No.	%
10 – 20	2	10
20 – 30	3	15
30 – 40	12	60
40 – 50	2	10
50 – 60	1	5
Total	20	100

The anatomical region distribution for facial defects that required bone graft were as follows: for orbit defects,20%, zygomatic defects, as shown in Fig.8 and 9, 20%, maxillary defects (Fig.1,2 and 6) 15% and mandibular defects (Fig. 8)45%.

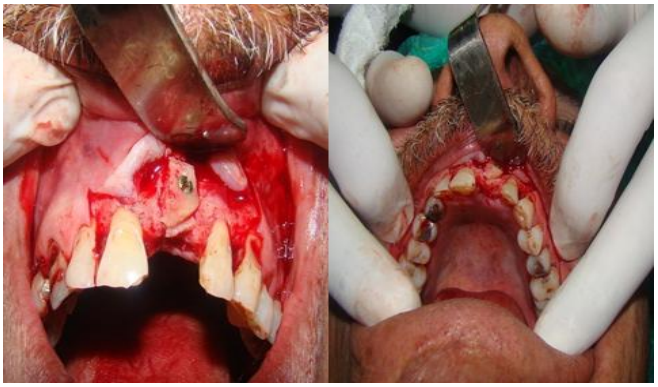

Fig. 1. Bone graft inserted to the alveolar bone and fixed by screw only to prepare a bed for dental implant. The cause of this defect was due to shell that caused avulsion of the left central incisor tooth and a part of the alveolar bone.

Fig. 2. Alveolar cleft.

The etiological factors of bone defects were 65% due to trauma, and from these 65% traumatic causes, 35% were due to RTA, 10% were bullet injuries and 20% were shell injuries. Alveolar clefts causes occur in 10% and odontogenic tumors of the mandible in 25% of cases (Table4). The immediate method of reconstruction was used in 5 patients (25%), mainly used in treatment of odontogenic tumor lesions. The delayed reconstruction due to trauma and other causes used in 15 patients (75%).

The method of immobilization of the mandible to the maxilla was done by intermaxillary fixation to the patients with mandibular defects in 9 patients (45%), while the zygomatic defects, orbital defects and maxillary defects did not need intermaxillary fixation.

Table 4. Causes of the bone defects

Causes of the defects	No.	%
Road Traffic Accidents	7	35
Bullet Injury	2	10
Shell Injury	4	20
Odontogenic Tumors	5	25
Alveolar cleft	2	10
Total	20	100

Complications associated with donor site harvesting procedure include pain in 1 patient (5%) persist for about 4 weeks and treated by analgesics and anti-inflammatory medications. Gait disturbance occur in 1 patient (5%) treated by physiotherapy, and improved. No complication occurs in 18 patients (90%).
Failure of bone graft observed in 3 patients (15%) while the rest 17 patients 85% ended with functional and esthetic successful graft (Table 5).

Table 5. Classification of Failure cases

Failure cases (Total no= 3) (15%)	Number of patients	%
causes	1 sequestration 1 inflammation from osteomesh 1 soft tissue breakdown	5 5 5
Types of bone graft	1 cancellous bone 2 corticocancellous	5 10
Defect involvement	2 bone and soft tissue 1 bone loss alone	10 5
Etiological factors	1 ameloblastoma 2 shell injury	5 10
Anatomical distribution of the defect	1 alveolar bone 1 mandible 1 zygoma	5 5 5

Discussion

The bone formation within the graft was more abundant when an iliac graft was used, probably because of better survival of osteogenic cells and more complete vascularization within the graft [11-13].

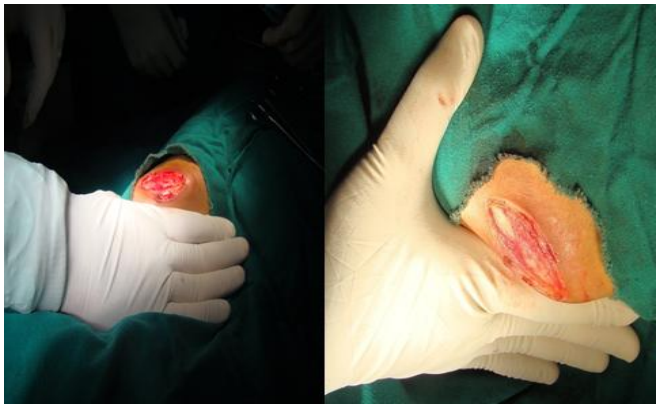

Fig. 3. Incision of the skin of the donor site

In reviewing the traumatic cases operated for bone graft, we found that the most etiological factors for the bony defects were high speed vehicles. This result is not similar to the study of Poirit (1953) which showed that 75% of maxillofacial injuries of the 2nd war were due to the fragmentation missiles, which in our study were the 2nd most common cause of facial defects [14]. Olsen and colleagues 1982 also reported that the most common cause of the defect was due to vehicle accidents [15].

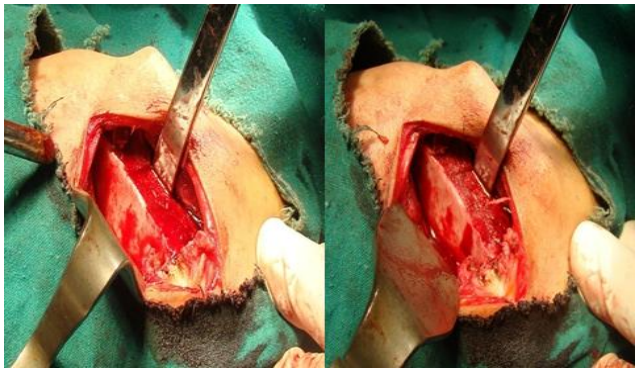

Fig. 4. Bone graft was taken as one block

Most surgeons who carried out bone grafting for mandible as immediate reconstitution to restore the defect caused by tumor surgery and not by a traumatic injuries. The chance for successful bone graft is higher if there is an adequate time elapsed between the time of injury and the time of surgical procedure in cases of traumatic injuries; this is due to risk of infection and sequestration of fragmented bone pieces as consequence to trauma [16]. So, the policy of our treatment in cases of traumatic injuries was to wait until all signs of infection disappeared, but certain steps of preparation were done to make the recipient site ready for grafting. While for odontogenic tumors we treated them immediately after removal of the tumor from the mandible.

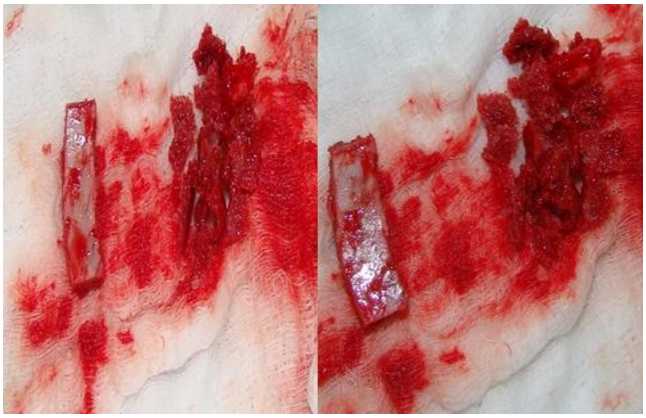

Fig. 5. Cortical and cancellous bone graft taken from the anterior iliac crest

Komisar (1985) concluded that delayed reconstruction was superior due to absence of infection and the immediate reconstruction of mandible has more chance to fail, while the delayed repair of traumatic injuries has better results [17]. Lundgren (1999), favor the use of a delayed approach by free autogenous bone graft [18].

Immediate mandibular reconstruction can be performed safely and expeditiously in nearly all healthy patients undergoing segmental mandibulectomy [19].

In our study, the cases were treated either by corticocancellous block bone graft or cancellous chips bone graft depending on the site and the length of the defect and the bed of recipient site (Fig.3-5). When the defect occurs in the mandible and extended to involve the body of

the mandible, Dacron-urethane mesh was used to carry the particular bone graft. In the case of defects in the floor of the orbit, zygoma, alveolar area, maxilla and the body of the mandible, a block of corticocancellous bone graft was used to repair the defect. There was no difference between the two types of bone graft with reference to their failure, but surgeons must adhere strictly to adequate preoperative preparation and skillful technique including generous graft contact and rigid stabilization.The graft bed must be vascular and free from infection. These should be observed in any procedure of bone grafting [20,21].

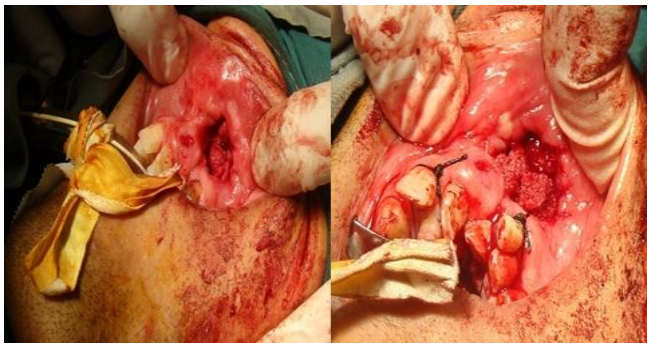

Fig. 6. Recipient site

Upon reviewing of our cases and being compared with those of other surgeons, we agree with Schwartz (1984) who stated that There is no all-purpose type of bone graft [22], and proper technical procedure with healthy non-scarred bed and rigid fixation will make the bone graft appear better than cancellous chip of bone because it is more rigid and helps in fixation. The mandibular osteomesh may stimulate a low-grade inflammation with seroma formation. The use of cancellous bone needs more care about fixation and stabilization which are not provided by its tray alone.

In all our cases treated by bone grafts, transosseous wires, screws and miniplates introduced to hold the corticocancellous bone graft to the bone of recipient site as well as the mandibular tray used to carry the spongy bone graft of the mandible. For immobilization mainly for mandibular bone graft, we used IMF. We think thatcases of rigid internal fixation are very good and donot need IMF for the mandibular reconstruction. The survival and success of the bone graft dependson the rapidity of the revascularization and the 1st phase of bone healing process can only take place if the capillary growth into the transplant finds absolute stable condition; therefore, secure internal fixation of the graft is mandatory [23].

Fig. 7. Zygomatic bone defects (contour deficient due to old trauma)

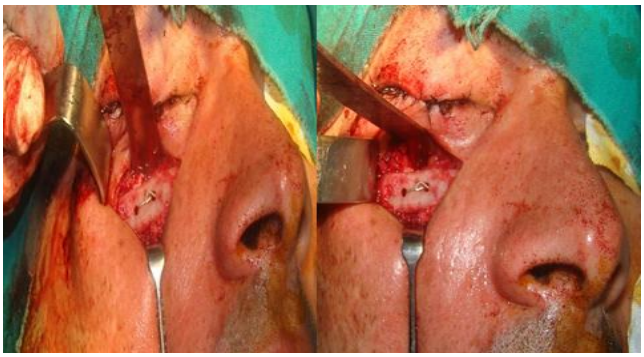

Fig.8. Preparation and fixation of the iliac crest bone graft to the zygomatic defect by stainless steel wire

Some surgeons were more conservative[24], in that they maintain their internal rigid fixation with reconstruction plates, lay screws, as well as miniplates for 3-4 months and then remove it to expose the bone transplant to functional load. Comparable with our cases where osteomesh tray was used, other surgeons showedlow modulus of elasticity lesser than that of cortical bone. Permitting the functional stress which may be an important factor in extensive graft resorption when titanium tray or bone plates are used, the extensive rigid fixation with high

modulus of elasticity was found to prevent the stress from transmitting to the bone graft [24].

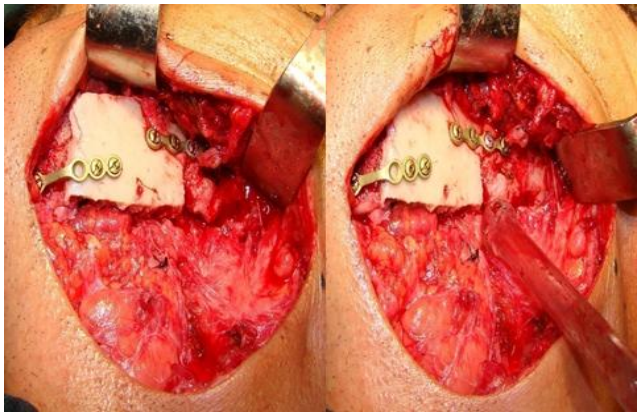

Fig. 9. Iliac crest bone graft inserted and fixed to the mandible immediately after segmental resection of the mandible due to ameloblastoma

The use of transosseous wire in compact bone graft gives a secure fixation when applied at each end by two holes for the recipient site and the bone graft. The wires passed through the holes and twisted tightly as conventional type and figure of eight wire but it was not regarded as a type of rigid fixation.

Ralf et al. suggests that miniplates fixation can be regarded as the method of choice for fixation of bone graft [25].

The recipient site needs not to put drain because the postoperative hematoma and seroma can be prohibited by arresting of all the bleeders, closure of the wound in layers and dressing with a pressure pack.

The most significant cause of early donor site morbidity was local pain, lasting up to 4 weeks postoperatively. In a study by Forrest (1992), seen in 27% and required an average of 5 days of parenteral narcotic analgesics [26]. In our study postoperative pain was seen in 5% of cases and required parenteral anti-inflammatory analgesics for 4 days then starting with oral analgesics after that.

Anatomically, bone harvest from anterior iliac crest via lateral approach would be expected to have more postoperative pain and gait disturbance [27-30].

However, the results of our study support Tagapongsa study in 1994 in that there is no difference in medial and lateral approaches [31]. Because the cancellous bone reservoir is located in the iliac crest area at the anterior 1/3 between the anterior iliac spine and tubercle, reflection of tensor fascia, gluteus medius, and gluteus minimus muscle in the lateral approach and iliacus muscle in the medial approach is inevitable. A large hematoma or excessive trauma can cause psoas muscle inflammation or dysfunction leading to postoperative pain and gait disturbance from anterior iliac bone harvest, injury to these muscles and bleeding from the cancellous marrow must be reduced to minimum [32].

When mucous membrane was intact or only slightly damaged, grafting was practical proposition, but quite contraindicated when the mucosal laceration were ragged or difficult to close. From reviewing the cases in our study, we had one case of failure due to penetration of mucous membrane by the bone graft in maxilla. We believe that watertight suture not under tension of the mucosal incision to prevent leakage of saliva with irrigation of the mouth by antiseptic wash will help to prevent infection from oral microorganisms [29,30].

Introduction of nasogastric feeding tube may be a protective appliance for a period of time until complete healing of the mucosa observed. Low grade inflammation due to allergic reaction may be associated with the use of Dacron-urethane osteomesh with collection of serous fluid. This induces low-grade infection, which is a potential predisposing factor for bone resorption ended with infection and failure. We observe it in one case [31,32].

We concluded from our study that the preparation of the recipient site prior to bone grafting procedure is important for successful results, delayed reconstruction of facial bones after trauma is indicated because most wounds are contaminated with loss of tissues, immediate reconstruction of the mandible after resection of benign tumors with low recurrent rates is important to prevent collapse of the segments,

cortico-cancellous bone graft obtained from the iliac crest provides a suitable amount of bone with osteogenic potential which can be fixated to the bones with a simple and rigid fixation, we also obtained approximately normal looking contour of the defect sites. Our success rate was 85 %. In our study if we analyze the causes of failure in the three cases (15 %) we can say that for the mandible the cause of failure is due to inflammation due to the osteomesh which is regarded as a foreign body (Fig. 4). For the alveolar cleft the cause probably was due to the use of only cancellous bone without any means of fixation and breakdown ofone of the sutures exposing the grafts and causing infection and therefore became a sequestra acting as a foreign body, therefore we suggest using a cortical bone graft and fixed with a micro-plates then we insert a cancellous bone and a water tight seal closure and instruction about good oral hygiene with chlorehexidine mouth wash. For zygomatic bone graft the cause might be due to infection by a maxillary sinus communication that might occur later.

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