Bone graft from iliac bone for maxillofacial reconstruction: An operative approach with decrease morbidity

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ABSTRACT

Background: In Maxillofacial surgeries, iliac bone graft has traditionally been harvested to provide osteoconductive, osteoinductive and osteogenic components to initiate bony formation. There are multiple types of procedures for harvesting iliac bone graft, either by surgical exposure procedure for procurement bone graft bicortical, unicortical, tricortical or by using Fritsch bone harvesting (trephine) system or by Spine-Tech grinding harvester technique. This study compares procedures for harvesting iliac bone graft by using sub-crestal window technique procedure and trap-door iliac crest bone graft procedure for different purposes like alveolar cleft, bone resection due to tumor, reconstruction of avulsed facial bone due to trauma by bullet injury or RTA, confirming that donor site morbidity of the sub-crestal window technique is more significant than trap-door technique.

Patients and methods: In this study (40 patients / 22♂:18♀) underwent harvesting of iliac bone graft with age range (3.5-65 years) in Al-Kadhmyea Teaching Hospital (2009-2012) for different purposes like alveolar cleft, reconstruction of mandible after tumor resection and reconstruction of maxillofacial defects due to massive blast or bullet injury.

Results and Conclusions: The results indicate that major complications from ICBG harvest are uncommon, but minor complications are common. The findings suggest that donor site morbidity of the sub-crestal window technique is significantly less than trapdoor technique. Making the sub-crestal window technique is the method of choice for harvesting large amounts of bone graft.

Key words: Bone graft, iliac bone, maxillofacial reconstruction. (J Bagh Coll Dentistry 2012; 24(4):77-82).

INTRODUCTION

Historically, autogenous bone graft has been commonly used by orthopedic and maxillofacial surgeons to help promote bone healing to provide structural support for reconstruction surgery. The iliac bone is the most common donor site because of easy access and procurement of relatively large and safe supply of both cortical and cancellous bone [(1,2)].

Bone grafts are now commonly used in restorative surgery in the following area of the facial skeleton [(3)]:

1. Reconstruction of mandible.
2. Reconstruction and build up of the nasal skeleton.
3. Onlay grafts to the supra-orbital regions and zygomatic molar eminence.
4. After surgical treatment of TMJ ankylosis to replace the condyle (rib graft is commonly used in this site).
5. Repair of oro-nasal and oro-antral fistula and alveolar cleft.

Despite the great progress in bone graft substitutes and micro-surgically anastomosis reconstructive graft surgery, these reconstructions often have extensive financial costs due to time and technical support and their limitations as a result of restricted medical capacity or through a lack of compliance [(4)].

Conventional autogenous iliac crest bone grafts remain the “gold standard” because of their osteo-inductive (non-collagenous bone matrix proteins, including growth factors), osteogenic (inducible osteogenic precursor cells), osteo-conductive (bone mineral and collagen) and non-immunogenic properties [(1,4-6)].

Three methods of harvesting autogenous bone graft from anterior iliac crest are commonly used that require only limited amount of bone. The first is trephine curettage [(7)] which is method of harvesting bone graft from either the anterior or the posterior Ilium; this method is mainly used for getting cancellous bone. The second method is trapdoor method of harvesting bone graft allows more extensive access to bone graft and is best suited for anterior ilium. The third method is the sub-crestal window technique of harvesting bone graft is performed for getting a bone block in any size or shape [(8)].

Complication from iliac bone grafting including donor site pain, arterial injury, nerve injury, hematoma, infection, gait disturbance and cosmetic deformity, hernia, urethral injury, peritoneal perforation, iliac crest fracture and sacroiliac joint injury [(2)].

As hematoma and infection, need additional intervention and come to the attention of the surgeon, other complications, however such as persistent pain, neuroma, skin irritability and numbness caused by injury to the nerves may be overlooked [(9,10)].

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There are some clinical recommendations regarding the avoidance of these complications, as when approaching the outer table of the anterior ilium, the incision should be stop 2 cm lateral to the anterior superior iliac spine to avoid injury to the lateral femoral cutaneous nerves and to the attachments of the inguinal ligament and to the Sartorius muscle and this will also help to avoid fracture of the ilium. A gluteal gait can be prevented by securely flap approximating the gluteal fascia to the iliac crest. Careful retraction of the iliacus and the abdominal wall muscles may prevent injury to the peritoneum and the nerves that overlie the iliacus muscle. When inner table of the anterior ilium is exposed, secure closure of the fascia of the abdominal wall muscles decrease the risk of hernia of abdominal contents through defects in the iliac crest. Strict attention to the sub-periosteal dissection of the ilium would minimize bleeding and risk of hematoma formation. Suction drainage has been shown to decrease the incidence of significant hematoma formation [8].

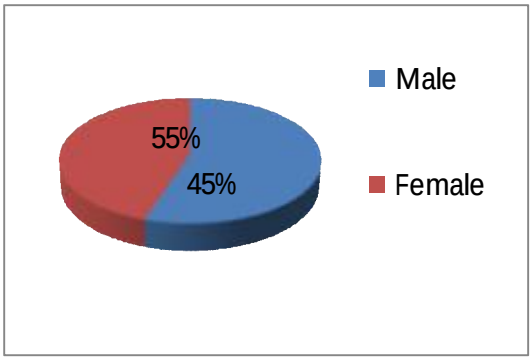

Figure 1: Male: Female

PATIENTS AND METHODS

In this study (40 patients / 22♂:18♀) underwent harvesting of iliac bone graft with age range (3.5-65 years) in Al-Kadhmyea Teaching Hospital (2009-2012) for different purposes like alveolar cleft, reconstruction of mandible after tumor resection and reconstruction of maxillofacial defects due to massive blast or bullet injury.

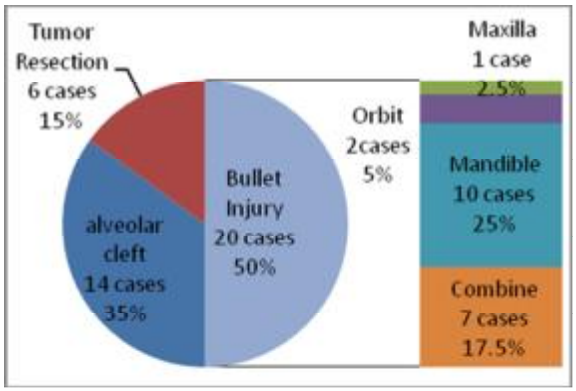

Figure 2: Causes of bone grafts

Pre-operative demographic and clinical data were collected including age, sex, employment status, primary and secondary diagnosis, associated medical comorbidities and medication.

The sub-crestal window technique of harvesting bone graft is performed by making skin incision over the anterior iliac crest, preferable near the iliac tubercle, the outer table muscle are stripped sub-periosteally from the ilium, a small straight osteotom is used to demarcation of the desired shape and size of the bone, then by the using of small curved osteotom is used to harvesting the bone piece either uni-cortical or bi-cortical. This bone block can be of any size or shape, depending on the ilium itself and the purpose of harvesting the bone graft for. Care must be taken with the osteotom not to penetrate the iliacus muscle medially.

When thicker piece of bone are needed for vertical bone augmentation, a bi-cortical may be harvested from the entire width of the crest. The gluteal muscle attachments are reflected from the lateral cortex along the crest of the ilium. Following the harvesting of the cortico-cancellous block(s), additional cancellous bone may be harvested with bone curette, the edge of the iliac cortex should be smoothed with a rasp or bone file. Following the removal of the bone graft, haemostatic materials such as bone wax, can be placed over the cancellous bone if need. A corrugated drain placed into the site followed by closure of the periosteal layer. The muscle layers and sub-cutaneous tissue are closed with vicryle mattress and interrupted sutures. The skin may be closed with proline simple interrupted suture. Operation was done in 20 minutes as finishing time for complete the taking bone graft and suturing of the donor site.

The patient given antibiotic cover for 7 days with ketorolac injection for the first day then changed to paracetamol IV injection for two days then change to orally non-steroidal anti-inflammatory drugs. The patient begins simple movements at the same night of operation, drain removed and discharging at the first day post-operation. The patient should avoid exercise and heavy lifting for 6 weeks following surgery.

Complication and morbidity of the donor site were evaluated on results by clinical evaluation in signs and symptoms. Post-operative data regarding pain, hematoma, scare, wound dehiscence, infection, itching at the area, gait disturbance and any other limitation of movement

occur were collected till 3 months post-operatively.

Figure 3: Iliac Crest Donor Site

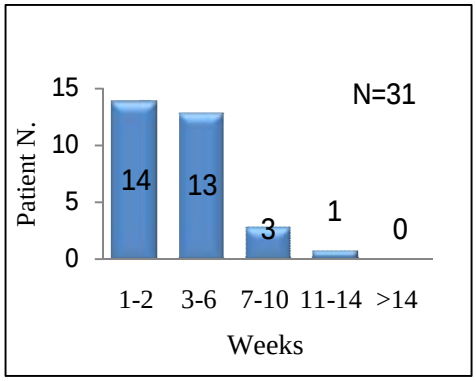

Figure 4: Duration of post-operative donor site pain

RESULTS

In this study (40 patients / 22♂:18♀) underwent sub-crestal window technique of harvesting bone graft with age range (3.5-65 years) in Al-Kadhmyea Teaching Hospital (2009-2012) for different purposes.

Bone graft volume harvested varies from 4 cm^3 to 15 cm^3 for different purposes can be summarized as (14 patients / 9♂:5♀) for closure of alveolar cleft with age range (7-18 years) with uni-cortical bone graft from the outer table of the ilium, while (6 patients / 2♂:4♀) underwent same surgery for reconstruction of mandible after tumor resection (ameloblastoma) by taking bi-cortical bone graft. Other (20 patients / 18♂:2♀) underwent surgery for reconstruction of maxillofacial boney defects due to massive avulsed injury by blast, gunshot and bullet injury taking bi-cortical either for reconstruction of mandible, floor of orbit, anterior maxillary region and zygomatic area. There was no intra-operative complication in all patients; Table 1 shows post-operative complications morbidity of the donor site in general.

Table 1: Post-operative donor site complications

Complication	N= 40	
	n	%
Residual oozing	4	10%
pain	31	77.5%
Difficulty walking	7	17.5%
Using of walking aids	0	0%
Itching of scar	5	12.5%
Altered sensation	2	5%
Other minor complication	1	2.5%
Over all major complication	0	0%

Of the 40 patients, 31 patients (77.5%) experienced pain at the donor site post-operatively; Fig 4 shows pain duration post-operatively for this group, reporting that 17 patient (54.8%) still record slight felling of pain after 3 weeks post-operatively. This ratio continued to decrease, only one case male Patient age 50 years old victim of bullet injury record pain till 12 weeks, and it is suggested that the pain was overstate.

Timing of patient walking was recorded as 32 patients of 40 (80%) started walking 12 hours post-operative, while the rest 8 patients (20%) started walking at the next morning.

Drain was removed after 24 hours post-operatively when changing the donor site dressing except for 2 patients delayed to 48 hours as the drain was positive.

The hospitalization time for 24 patients (60%) was 24 hours, while 12 patients (30%) discharged for home after 48 hours; only 4 patients (10%) stayed 7 days in the maxillofacial ward due to reasons other than the donor site. Table 2 shows the prognosis records.

Only 7 patients (17.5%) complained form walking difficulties, and majorly resolved spontaneously 2 weeks later, no use of walking aids was recorded.

Itching scare was reported in 5 patients (12.5%), treated by topical ointment. For the sense of parasthesia, 2 patients (5%) reported such condition. Only one patient represented wound dehiscence due to pre-mature suture removal of the donor site as a techniqual mistake.

In this study, in comparison between sub-crestal window approach and the other surgical approaches, significant value in operation time between these procedures as the sub-crestal procedure less manipulation and less time of operation as did in 20 minutes as finishing time for complete the taking bone graft and suturing of the donor site, while in the other procedure needs

more manipulation after re-approximation of iliac crest suturing or fixation by stainless steel wire which mean introduce a source of infection and needs more manipulation and may interfere with MRI taking by the patient later on in need [8].

Table 2: Post-operative Prognosis Records

Prognosis	Time				Mean Time
	12 h	24 h	48 h	1week	
Start walking	32 (80%)	8 (20%)	-	-	14.4 h
Drain removal	-	38 (95%)	2 (5%)	-	25.2 h
Hospital stay	-	24 (60%)	12 (30%)	4 (10%)	45.6 h

DISCUSSION

Bone for use a graft can be obtained from the patient or from a donor (allograft). The transmissions of the diseases through allograft bone continue to be possible despite standardized bone taking and tissue testing protocols [11,10], so allograft alone has been proven inferior to autograft in inducing fusions [12].

There are various alternative donor sites for harvesting bone graft in the body like ilium, rib, calvarium, tibia, maxilla and mandible. All these autografts remain the gold standard maxilla-mandibular reconstruction. Autogenous bone graft has osteo-inductive and osteo-conductive properties and is immunologically safe [1,4-6].

Cases with significant bone defect such as gun shots wounds with avulsed hard tissue or tumor resection associated with part of the bone especially in mandible, as presented in this study, require a large volume of bone graft, preferably from the ilium or rib due to their resistance to infection [4].

Cortical bone of the ilium is thickest at the intermediate line, but all the parts of the iliac crest are thick enough to accept dental implants after reconstruction of the basilar bone, while the rib graft is not thick enough for the same purpose, that is why the iliac bone is still one of the best sources for large bone graft [4,13].

Although the iliac crest can provide ample amounts of bone graft and the resulting scar can be easily concealed, surgeons have been concerned for long time about the possible complications and post-operative morbidity [9,14].This has led to attempts to describe a minimally invasive harvesting technique for iliac crest bone graft harvest.

Strict attention to sub-periosteal dissection of the ilium and less manipulation in the muscular attachment minimized the bleeding and hematoma collection. No significant effects of the depth, width and size of the graft in all these cases were results [8].

In this study hematoma collection at the donor site (post-operatively) was reduced due to less manipulation, less sub-periosteal dissection and less muscle reflection, and resolved by present of corrugate drain for mean time (25.2 hours). In comparison with Pollock et al. [15] study (used trapdoor technique for harvesting iliac bone graft) in which a large hematoma at the graft site with intermittent flare-ups of pain was experienced in (8.3%) of the patients for 14 months as a result of not using drain, this problem was resolved with steroid injection at the donor site [15]. While Constantinides et al. [16] study (also used trapdoor technique for harvesting ICBG) did not record any hematoma collection where he used iliac crest catheter for (0.25%) Marcaine infusion [16] and thought it may play a role in preventing hematoma collection.

On the subject of donor site pain and pain control, in this study (22.5%) of patients are relatively pain free and start walking early (12-24 h mean 14.4 hours), despite the analgesia used was ketorolac injection IV for 24 hours, replaced by paracetamol injection IV for 3 days. Pollock et al. [15] recoded (8.7%) of patients are pain free, while in Constantinides et al. [16] study (45%) of patients recorded as they can mobilized well or lots, and start walking (8-52 h mean 33 hours), this high percentage back to the regular direct infusion of (0.25%) Marcaine (2-5 ml each 8 h) by iliac crest catheter for mean time (48.2 hours), in addition to patient controlled analgesia PCA morphine pump [16]. Harold et al. [17] demonstrated that preemptive analgesia in the form of intra-operative bumpivacaine improved ambulation and reduced pain.

When comparing the results of this research with Pollock et al. [15] results in the duration of pain after the operation, we note that (54.8%) of this study patients record a slight feeling of pain, compared to (62.0%) of patients registered with Pollock et al. [15] after 2 weeks post-operatively, with one case of chronic pain lasted for 14 months because of collection hematoma resolved by steroid injection at the donor site [15] as shown in the Figure 5.

Difficulty walking in this study was noticed in (17.5%) of patients, majorly resolved spontaneously 2 weeks later except one case

delayed 12 weeks, and it was suggested that his problem was overstated, with no records of walking aids used. While Pollock et al. [15] study, (54.6%) of patients showed problems with ambulation, and (19.1%) of patients were using walking aids for 6 weeks.

Parasthesia at the donor site was experienced by (5%) of patients in this study against 34.8% in Pollock et al. [15] study.

Other minor complication was experienced only by one case of wound dehiscence due to premature suture removal as technical mistake.

The mean length of hospital stay in our study was (45.6 hours), while Constantinides et al. [16] records were (75.5 hours), as the corrugate drain removed at mean time (25.2 hours) while Constantinides et al. [16] used iliac crest catheter for Marcaine infusion (5 ml each 8 hours) for mean (48.2 hours) that increasing the hospitalization time [16].

The true morbidity of iliac crest bone graft harvesting is difficult to ascertain from current study, because many different techniques and details for harvesting are used and morbidity is often not reported in inadequately measured.

As a conclusion:

1. The results indicate that major complications from ICBG harvest are uncommon, but minor complications are common.
2. The findings suggest that donor site morbidity of the sub-crestal window technique is significantly less than trapdoor technique.
3. Making the sub-crestal window technique is the method of choice for harvesting large amounts of bone graft.

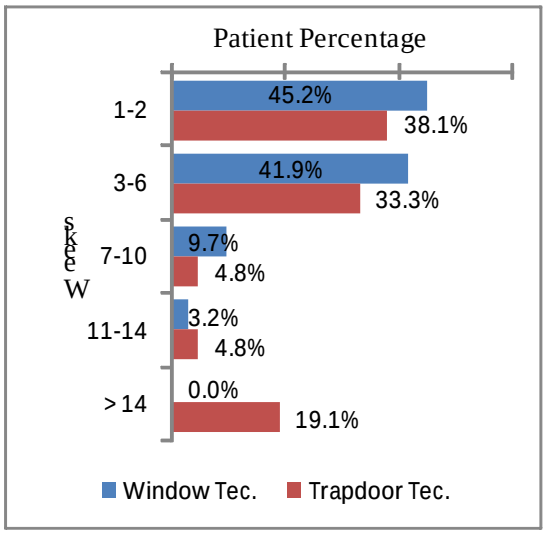

Figure 5: Comparison of post-operative donor site pain

Table 3: Comparison of bone graft donor site morbidity in our study with those of other authors

	Present study	Pollock (2008)	Constantinides (2008)
Approach	Window	Trapdoor	Trapdoor
Population	40 pts	24 pts	64 pts
Pain control	Simple requirements	N/A	High requirements
Pain free	9 pts 22.5%	3 pts 8.7%	29 pts 45%
Walking	12-24 h Mean 14.4 h	N/A	8-52 h Mean 33 h
Difficulty walking	7 pts 17.5%	13 pts 54.6%	N/A
	1 patient till 12 weeks	3 pts in >14 weeks	N/A
Walking aids	0%	4 pts 19.1%	N/A
Drain	Corrugate drain	No drain	Iliac crest catheter
Drain removal	Mean time 25.2 h	-	Mean time 48.2 h
Hematoma	0%	8.3%	0%
LHS	Mean time 45.6 h	N/A	Mean time 75.5 h
Parasthesia	2 pts 5%	8 pts 34.8%	N/A

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