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Reamer Irrigator Aspirator bone graft harvesting: Complications and outcomes in an Asian population

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ABSTRACT

Introduction: Autologous bone grafting has been accepted as the gold standard in the treatment of non-unions and in definitive filling of segmental bone defects. However, there have been well-recognised complications associated with their harvest. The Reamer Irrigator Aspirator (RIA) system is an alternative technique of autologous bone graft harvesting. Studies have been published in the Western population showing the efficacy and outcome of this technique. No prior studies were done in the Asian population, who has smaller average canals, different femoral geometry as compared to Caucasians and weaker bone density in both genders.

We aim to present the findings and discuss its suitability in the Asian population when dealing with segmental bone loss and non-unions requiring reconstruction.

Methods: We conducted a retrospective analysis of all trauma patients with segmental bone loss and non-unions treated with RIA bone grafting over a 4.5 year period.

A total of 57 cases of RIA bone grafting were conducted on 53 patients. The amount of bone graft harvested, blood loss and post-operative pain were measured. Patients were followed up for union rate as well as complications of the procedure.

Results: Union was achieved in 86.8% of patients. The mean time to union was 17.64 weeks. Seven patients did not achieve union after the first RIA surgery, in which six of seven were open fractures initially and six were smokers.

One major intra-operative complication was recorded, that being a fractured femoral shaft due to thinning of the cortex by the RIA harvester. There were two patients who developed donor site superficial soft tissue infection that resolved after a course of antibiotics. There were no long-term complications seen in all patients.

Conclusions: The safety and efficacy of RIA bone graft harvesting for the management of non-union in the Asian population is promising, with adequate graft quantities, high success and low complication rates that are comparable to the Caucasian population. The diameter of the medullary canal in our population is suitable for this procedure. We believe that RIA bone graft harvesting provides a reliable and safe alternative source of autologous bone grafts for bone grafting of non-union sites.

Introduction

Non-union is a common problem in the management of patients with segmental bone loss following trauma. Bone grafting is a frequently used treatment method for this complication that can be further subdivided by the use of autogenic bone grafts, allogeneic bone grafts or bone graft substitutes such as bone morphogenic proteins (BMP), demineralised bone matrix (DBM) and ceramics [1].

The use of bone graft substitutes is becoming increasingly popular. This is likely because the use of such substitutes avoids potential issues associated with autologous bone graft use, such as limited quantity of graft and donor site morbidity. However, autologous bone graft remains the gold standard bone graft

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material in view of its inherent osteoinductive, osteoconductive and osteogenic properties with viable precursor cells [1]. The most popular source of autologous bone graft is iliac crest though complication rates with iliac crest bone graft harvesting have been reported to be as high as 10% [2,3].

The bone reamings from the intramedullary canal of long bones such as femur and tibia can provide an alternative source of autologous bone graft [4]. The Reamer Irrigator Aspirator (RIA) system (Synthes, USA) has recently come into use for the harvesting of bone grafts. Indications for use of this system include clearing the medullary canal of bone marrow and debris, sizing the medullary canal for the acceptance of an intramedullary implant, removing infected or necrotic bone from the medullary canal and harvesting finely morselized autogenous bone and bone marrow for bone graft. Reaming debris has been shown to be a rich source of growth factors with content comparable to that from iliac crest [4].

The use of the RIA system for bone graft harvesting is associated with lower donor site morbidity and pain compared to iliac crest bone harvesting [5]. Furthermore, patients treated with RIA bone grafts have been shown to have similar rates of union, time to union and infection rates when compared to patients treated with iliac crest bone graft [6].

A review of the literature revealed that the majority of RIA studies were conducted on Caucasian populations. The aim of this study is to investigate the complications and outcomes in the use of the RIA system for bone graft harvesting for the management of non-union in an Asian population.

Patients and methods

Patients and demographics

A retrospective study was performed looking at all trauma patients managed with RIA bone graft harvesting from September 2008 to March 2013 at our institution. Institutional ethics review board approval was obtained.

Our study group consisted of 53 patients who underwent a total of 57 RIA bone graft harvesting procedures. 7 cases of RIA bone graft harvesting were performed for recalcitrant non-union, after failure of the initial bone grafting procedure. Excluding procedures done for recalcitrant non-union, RIA bone graft harvesting for the remaining 50 cases was performed at a median of 12 (range: 8–52) weeks post-injury.

Patient demographics are summarised in Table 1.

The RIA bone graft harvesting procedure was performed by three orthopaedic trauma surgeons trained in the use of the RIA system.

There were 4 different indications for the initial RIA procedure in our study group. 44 were due to segmental bone loss with non-union of fracture, 5 were due to malunion with bone loss and 4 were due to infected non-union.

Revision fixation was performed for 31 of the 57 cases during the bone graft procedure.

Measurement of bone defects

We classified bone defects using the definition described by Stafford [23]. The method of measurements is as shown in Fig. 1a–d. Bone defects were defined as either cylindrical or conical depending on whether there was no bone contact or point bone contact respectively. We measured the defect volume on pre-operative radiograph by using a set of derived geometric formulas.

There were 37 conical defects and 20 cylindrical defects. The mean bone defect volume was 31.6 cm^3 (range: 3.14–141.4 cm^3).

Table 1
Demographic and fracture characteristics of the patients.

Division by gender	Number of patients (total $n = 53$)
Male	50
Female	3
Division by race	
Chinese	26
Indian	11
Malay	8
Other Asians	8
Division by smoking	
Smokers	20
Non-smokers	33
Division by mechanism of injury	
Road traffic accidents	39
Falls	6
Industrial accidents	6
Gunshot	1
Re-fracture	1
Division by fracture characteristics	
Open–Gustilo grading	
Grade I	1
Grade II	4
Grade IIIa	7
Grade IIIb	23
Grade IIIc	2
Closed	16
Division by fracture sites	
Tibia	32
Femur	18
Humerus	2
Radius	1
Division by source of graft	
Ipsilateral femur	29
Contralateral femur	14
Ipsilateral tibia	11
Contralateral tibia	3

RIA graft harvest technique

The donor bone was chosen on the ipsilateral side to the recipient site unless there were concomitant injuries. Image intensifier guidance and radiolucent ruler were used intraoperatively to choose the size of the reamer head. (The chosen reamer head size was not to exceed the narrowest diameter of the medullary canal by more than 2 mm). The entry site for the reamer at the tip of the greater trochanter was then identified with fluoroscopy. The entry site for the tibia was the anterior edge of the tibial plateau centred over the medullary canal via the medial parapatellar approach. A 13 mm cannulated drill bit was used to open the entry site, allowing insertion of a ball-tip guide wire into the canal. The guide wire was inserted concentrically in the canal. The RIA system was then assembled (Fig. 2) and inserted over the guide wire. The guide wires and subsequently the reamers maintained as central a position as possible in the distal femur during harvest.

There is a potential for eccentric reaming if excessive force is used to "push" the reamer down the medullary canal. This can lead to over reaming of the cortex and perforation. Gentle sequential, gradual in and out movements of the reamer along the canal were performed until the desired amount of bone graft was obtained. If insufficient bone graft was obtained, the reaming was repeated with a larger reamer head ensuring there was a minimum of 3 mm of cortical bone left circumferentially. For larger defects, following harvesting from the shaft of femur, the tip of the guide wire was bent to guide it into the lateral and medial femoral condyles for