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Non-vascularized fibular graft in management of segmental bone defects: Study of twelve cases

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Abstract

Segmental skeletal defects due to bone loss in comminuted open fractures and defects due to excision of sequestered bone fragment in cases of osteomyelitis can be managed with staged treatment. Use of PMMA spacer beads or blocks mixed with appropriate heat resistant broad spectrum antibiotics to fill the bone defects has been practiced since decades. In the initial stage of bone defect management, these spacers along with external fixator to stabilize the injured lower extremity are of paramount importance. In second stage, fracture fixation with plates and using autologous cancellous bone grafts from the iliac crest to fill the skeletal defect is a standard practice all around the world. In large defects, addition of osteogenic autologous non-vascularized fibular graft and bone graft substitutes give superior results. In this study we evaluated the results in twelve cases of distal femur segmental bone defects due to trauma and osteomyelitis. We treated all cases with non-vascularized fibular strut grafts and cancellous bone grafts at the time of definitive fracture fixation. We obtained good results according to Functional Outcome Scoring System (FOSS) used to grade outcomes in open fractures of distal femur, in all the cases treated with this method.

We conclude that use of non-vascularized fibular graft with cancellous bone graft in cases with segmental bone loss in distal femur, along with sturdy fixation is an excellent method for reconstruction of bone defects and leads to good results.

Keywords: open fractures of distal femur, PMMA, external fixator, osteoconduction, osteoinduction

1. Introduction

Fractures resulting in segmental skeletal loss are challenging to treat for all the orthopaedic surgeons across the globe. Bony defects may result from resection of avascular/sequestered segment of bone during debridement in open comminuted fractures or in cases of osteomyelitis (OM). Autologous vascularised or non-vascularised fibula strut grafts (with cancellous bone grafts and/or bone graft substitutes) provide a reliable means of treating such conditions in developing countries where bone banks are scarce or not available for allograft procurement [1, 2]. Masquelet technique is an interim procedure, which is widely acceptable worldwide for treatment of long bone OM & open fractures with bone loss. It induces a periosteal membrane and also promotes release of growth factors which prepares the fracture bed against graft resorption & towards eradication of infection with an antibiotic impregnated PMMA spacer that preserves dead space volume and length of the limb for delayed reconstruction [3, 4, 5]. Staged treatment for open fractures with debridement, primary stabilization of fracture with an external fixator and PMMA spacers (beads/blocks) followed by definitive fixation and use of ample amount of Bone grafts has been labelled as standard protocol for open fractures of distal femur [6]. In this retrospective study, we evaluated results of 12 cases of distal femur segmental skeletal loss.

2. Materials and Methods

We studied retrospectively ten cases with segmental bone loss and two cases with osteomyelitis in distal femur, treated with non-vascularised fibular grafting with cancellous bone grafts (CBG) at GMERS, Gotri Medical College, Vadodara treated between October 2014 and October 2018. Six patients had lower femur fractures with segmental bone loss,

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four patients had distal end of femur fractures with severe comminution and two patients had chronic osteomyelitis. There were 8 male and 4 female patients in our study (Male: Female ratio= 2:1). Minimum age of the patient was 28 years and maximum age of the patient was 60 years (mean age 44 years). All patients with segmental bone loss at the time of presentation had open fractures. Two patients had Gustilo-Anderson Open Grade II fractures & eight patients had Gustilo Anderson Open Grade III fractures. All open fractures were caused due to road traffic accidents, two patients with osteomyelitis had trauma due to domestic fall.

2.1 Treatment of patients with osteomyelitis of distal femur with fracture

In our study, two patients with osteomyelitis of distal femur had pathological fracture due to domestic fall. One patient presented after three days of trauma & other patient presented after four days of trauma. Until the time of presentation to the hospital, these patients underwent some sort of treatment in form of massage or gel application at home. On exploration in operation room, copious amount of pus was drained from patients' thighs. On operating table, the necrotic, avascular bone fragments (sequestrum) were excised in both patients and thus an iatrogenic segmental skeletal deficiency was created. One of the cases had huge defect (post debridement) of about 11cm. The defect was filled with 40gm PMMA spacer (cylindrical in shape) mixed with 2 gm Vancomycin & 160 mg gentamicin in both the cases and then an external fixator was applied to stabilize the limb (Fig. 1).

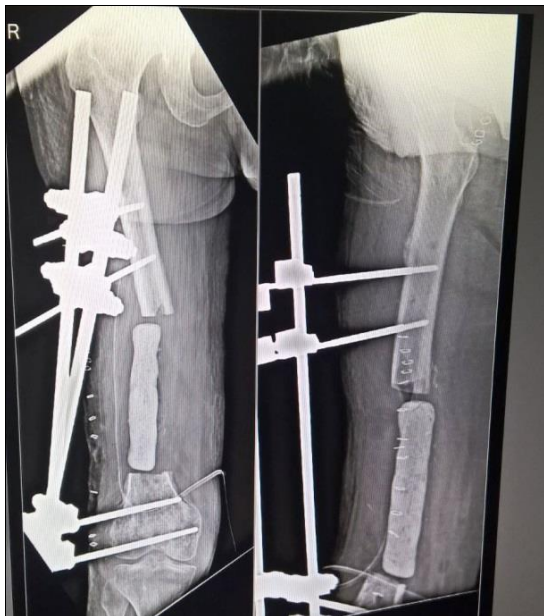


Fig 1: Shows Cylindrical PMMA cement spacer and an external fixator after excision of avascular sequestrum from osteomyelitis of femur

2.2 Treatment of open distal femur fracture

Author CVT's preferred method of management was followed in all 10 patients of open distal femoral fractures. In case of Gustilo-Anderson open type II fractures, minimum 6 litres of irrigation with normal saline & in case of Gustilo-Anderson open type III fractures minimum 9 litres of irrigation with normal saline was given. Medium to low pressure pulse lavage was used during irrigation. 3 gm of Cefoperazone+ Sulbactam (3rd generation cephalosporin) along with 500 gm Amikacin were given intravenously in each case.

2.2.1 Gustilo-Anderson OG II fracture treatment

In casualty, to all patients with Gustilo- Anderson OG II fracture, a soap water wash was given to the limb. Painting was done with chlorhexidine/povidone iodine liquid. Wound irrigation was done with copious amount of normal saline, hydrogen peroxide and povidone iodine. Well- padded sterile dressing was applied & posterior slab was given to each injured extremity. In the next sitting, these patients were shifted to Operation Room. In all cases of Gustilo-Anderson OG-II fractures minimum 6 litres of irrigation with normal saline with a medium to low pressure pulse lavage equipment was a protocol. Thorough debridement of the wound was done in all the cases & all bony fragments devoid of soft tissue attachments were excised. The gap thus created was managed with large amounts of autogenous CBG & non-vascularised fibular strut cortical grafts from ipsilateral limb (Fig. 2). The fracture was fixed with dual or singular plates depending on fracture anatomy, osteoporosis and requirement of stability.



Fig 2: Shows dual plate fixation of the distal femur fracture with CBG and Fibular graft buried in the defect.

2.2.2 Gustilo-Anderson OG III fracture

Casualty treatment was same as Gustilo- Anderson OG II fracture. After shifting the patient to Operation room, the fractures were thoroughly classified & injuries were clearly looked upon. Severely comminuted, loose fragments were excised. Four out of eight cases had segmental bone loss at the time of injury due to big fragments getting lost from wound. This gap was filled with 40 gm PMMA cement spacer mixed with 2 gm vancomycin & 160 mg gentamicin. Fracture fragments were stabilized with external fixator (Fig. 3).



Fig 3: Shows stabilization of the right lower extremity with an external fixator following debridement of wound, and primary closure. The PMMA spacer loaded with antibiotics was kept in the defect created by bone loss

For all patients with osteomyelitis & Gustilio-Anderson OG III fractures with segmental bone loss, limb was stabilised primarily with external fixator and PMMA cement spacer loaded with antibiotics was placed in the defect. In all these cases, we went for definitive fixation after 3-4 weeks. Soft tissue closure in few cases required secondary suturing, and in a few cases a VAD (vacuum assisted dressing) was applied followed by coverage with skin grafting or flap surgery. Fixation was fortified with custom-made implants (anatomical distal femoral plates) in some cases with large segmental skeletal defects. In that we asked the manufacturer to give a solid segment without screw holes in the plate. That segment corresponded to the location of the bony defect, the size of which was determined on actual size radiograph of both the extremities as a part of pre-operative planning. We believe this adds to the strength of the plate and prevents implant breakage when the patient starts bearing weight on the injured extremity. It allows us for early ambulation of the patient (Fig. 4).



Fig 4: Shows a solid segment without screws in the plate. This segment of the plate lies parallel to the defect and acts as a supporting pillar on lateral side of the bone defect.

3. Results

All patients were followed up for an average period of 1.5 years, minimum being six months and maximum being 3.5 years. Patients were assessed clinically and radiologically at each visit and their progress was filed.

3.1 Fibular graft incorporation and fracture healing: In cases of fractures with comminution or bone loss, healing was defined as incorporation of fibular strut grafts with the cortex of host bone and union of fracture as well.

In cases of Osteomyelitis with bone defects, inability to differentiate cortices of host bone and fibular grafts without any discharging sinus was considered as successful final outcome.

In the two cases of Osteomyelitis in our series, one patient showed fibular incorporation at three months of initial surgery and another one showed similar union at 5 months.

Four of the fracture cases showed healed fractures and healed grafts within six months of initial surgery. Six cases had healing of grafts between 8 and 11 months of index surgery.

3.2 Knee flexion: Out of twelve, eight patients had Knee flexion of 120° and remaining four had flexion of 100°.

3.3 Functional outcome: Function at final follow up was evaluated on basis of Knee flexion, Pain, Comfort during activities of daily living (ADL) and limb length discrepancy.

The author used following scoring system devised by Thakkar *et al.* [6] to assess functional outcome of all 12 cases, which were reconstructed using non vascularized fibular grafts.

All the patients in our series had a good score using this system. So we had 100% good results with the method used by us for reconstruction of large bone defects.

Table 1: Functional outcome scoring system (foss) for open fractures of distal femur

Result	Score	Rating
KROM (range through flexion)		
Stiff knee (Can't walk)	0	Poor
70°- 100°	1	Fair
100°- 130°	2	Good
>130°	3	Excellent
Pain		
At rest	0	Poor
During ADL	1	Fair
During Stressful activities only	2	Good
No pain	3	Excellent
Comfort observed during ADLs		
Unable to rise from chair/Walk	0	Poor
Able to walk and climb with support/cane	1	Fair
Able to walk and climb without support/cane	2	Good
Able to walk>1km, swim, cycle	3	Excellent
Limb Length Discrepancy (Shortening)		
>6cm	0	Poor
3-6cm	1	Fair
1-3cm	2	Good
<1cm	3	Excellent

Interpretation of Scoring system Foss (Functional Outcomes): 0-3 points= Poor, 4-7= Fair, 8-11= Good, 12= Excellent.

4. Discussion

Vascularized fibular graft and cancellous bone grafts (CBG) with/without other bone graft (BG) substitutes have been a standard treatment regime for treatment of fractures with severe bone loss and segmental bone defects in patients with Osteomyelitis [7, 8, 9]. However, in an institute like ours, the expertise of a plastic surgeon is not handy and we do not have facilities which can avail us such a provision. Autologous Non Vascularized Fibular Graft (NVFG) with CBG is another proven method for reconstruction of large bone defects and maintaining length of the limb [2, 10, 11].

In our series, patients treated with autologous NVFG combined with CBG with or without BG substitutes had graft incorporation successfully. The drawback of this method is donor site morbidity when compared with Allografts. Also, the process of harvesting autologous bone grafts is lengthy, when one needs to procure large amounts of grafts. Compared to this, the advantages of this method supersede the difficulties. These grafts are not allografts and so not allergic. They are not immunogenic and are accepted well by the host body.

4.1 Osteoconduction: It is the process by which implanted scaffold passively allows ingrowth of host vascular cells and tissues.

4.2 Osteoinduction: It is the process by which exogenous growth factors promote differentiation of host mesenchymal cells to form chondroblasts and osteoblasts that form new bone.

4.3 Osteogenesis: It is synthesis of new bone by donor cells derived from either the host or graft donor.

CBG has all the above mentioned properties with a good potential to facilitate fracture union. But CBG does not provide a strong structural support. Although autologous NVGF has a weak osteoconductive and osteoinductive properties, it still has good osteogenic property and provides a good sturdy structural support when combined with a strong fixation method ^[12]. Having said this, it is also well known that these non-vascularized fibular grafts (NVFG) can be used for massive skeletal defects measuring up to 10 or 15 cm ^[2].

5. Conclusion

Non vascularized fibular graft with cancellous bone grafts with or without added bone graft substitutes like Tricalcium phosphate, Calcium sulfate, Hydroxyapatite, etc. is a good method for reconstruction of bone defects caused during open fractures or after debridement in Osteomyelitis and fractures. The method can be fortified with custom made implants which are predicted to have a higher strength as compared to routine implants.

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