A Case Series: Non-vascularized Autologous Fibular Graft in the Treatment of Major Segmental Bone Defect after Post-traumatic at Diaphyseal Femur

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Introduction

Fractures resulting in segmental bone loss are very challenging for the orthopedic surgeon. These are commonly seen as the result of increasing civil strife and motor vehicular accidents. Non-vascularized fibula graft and cancellous bone grafting provide a reliable means of treating such conditions in developing countries. Orthopedic surgeons in developing countries have the option of choosing vascularized bone transfers, bone transport, allogenic bone grafts, bone graft substitutes, and several other means to treat such conditions, however, in developing countries where such facilities or expertise may not be readily available, the surgeon has to rely on other techniques of treatment. The aim of this case series is to determine the efficacy of the use of non-vascularized fibular grafts to re-establish bone continuity for the purpose of weight-bearing in lower limbs. This old-age technique first reported in 1911 [1], [2]. Fractures with segmental bone loss are more likely to be open and often occur because of high-energy trauma.
vascularized osteo-cutaneous fibular graft has been recommended as a useful treatment modality for the reconstruction of extensive tibial defects combined with soft tissue injury, non-vascularized bone graft is effective only for short bone defects (<5–6 cm) [8], [9], [10]. The purpose of our study is to describe our experience treating major bone defect using non-vascularized fibular autogenous grafts that were used for the reconstruction of posttraumatic in large bone defect.

Case Report

Case 1

A 16-year-old female patient was admitted to our emergency department after got a Traffic Accident using motorcycle. The trauma had broken the posterolateral aspect of his right thigh and shattered the femoral diaphysis. Bone splinters had lacerated the surrounding muscles and the skin on the anteromedial aspect of the thigh. This open fracture is classified as a Gustilo III A and involved one-third of the femoral shaft length (Figure 1).

Skin traction and debridement were chosen as a first-line treatment, the wound was largely exposed and debrided and the wound was left open, for the treatment of open wounds, to prevent further infection. After 2 weeks the wound was re-debrided and primarily closed.

One month after the initial injury the tissue had healed sufficiently to consider a reconstruction, there was no evidence of infection. Non-vascularized autologous fibular graft with the Internal fixation with limited contact dynamic compression plate (LC-DCP) method were considered. Immediate reconstruction with a massive bone autograft was preferred because it would allow rapid weight-bearing.

A 9 cm non-vascularized fibular graft (Figure 2) was fixed by an internal fixation LC-DCP (Figure 3). The length of the reconstruction was based on the opposite femur.

Figure 1: Gap femoral shaft fracture 7 cm

Despite the effect of open wound that produced by a high-speed injury when it goes through tissues, there was no sign of vascular or neural injury, and peripheral pulses were palpable at inguinal artery, popliteal artery, dorsalis pedis artery, tibialis anterior artery, tibialis posterior artery, all fingers saturation are 98%. This patient with Transverse fracture with a combined bone, muscle, and skin defect about 15 × 8 cm with muscle-based.

Figure 2: 9 cm non-vascularized fibular graft
The different tissue layers were closed over a suction drain.

After a short stay in the hospital, the patient recovered gradually from surgery, and physiotherapy was immediately started. He was discharged non-weight-bearing for 2 weeks postoperatively.

The first signs of bone healing were evident on radiographs at 8 weeks, 8 weeks after operation the results of the control femur x-ray if comparable 2 months ago, are currently installed plates and screws in one-third of proximal to one-third of the distal femur, the position of the bone fragments is smoothly performed using a bone graft begins to show periosteal reactions minimal appearance (Figure 4).

Final follow-up found in 32 weeks radiographs (Figure 5) showed consolidation and the bridging achieved of the femoral diaphyseal shaft with definite Fibula in bridging the Femoral defect, the patient has a good range of movement of the hip and knee (Table 1) and there is no leg length discrepancy nor atrophy (Table 2) (Figure 6).

The patient begun partial weight bearing in 8 weeks, full weight bearing in 24 weeks, and finally the patient can walk without using crutches and has no problems in a squatting position.

### Case 2

A 37-year-old male patient was admitted to the emergency department due to a traffic accident while riding a motorcycle on may. A few days later the patient comes and complaint of pain in his right thigh, where implant failure of the femur was noted during X-ray, and reoperation was performed on occasions.

Another episode of pain was noted 4 days after the first reoperation of the femur, and then one year later his right femur (Figures 7 and 8).

On June 2019, perform removal of the implant and during the operation was discovered the fibrotic tissue and diaphyseal defect of femur 10 cm, majority
of defect arise from the lateral site and little part of the diaphysis in the medial site.

Figure 5: X-ray femoral AP/L and post open reduction internal fixation

Figure 6: Clinical examination in 32 weeks, there was no leg length discrepancy

Using non-vascularized autologous fibular graft, iliac graft, and synthetic bone graft for internal fixation with femoral locking plate method was considered. Immediate

Figure 7: X-ray femoral AP/L and post open reduction internal fixation

Figure 8: X-ray before operation with implant failure and nonunion

Figure 9: During operation show defect bone: (a) Remaining partial bone in posteromedial side by defect 3 cm (b) missing total bone in the shaft femur by defect 7 cm

Using non-vascularized autologous fibular graft, iliac graft, and synthetic bone graft for internal fixation with femoral locking plate method was considered. Immediate
reconstruction with a massive bone autograft was preferred because it would allow rapid weight-bearing. A 10 cm bone graft was fixed by an internal fixation femoral locking plate. The length of the reconstruction was based on the opposite femur (Figures 9 and 10).

Results

The patient has a good result with good functional outcome (Tables 3 and 4) after open reduction internal fixation and using a non-vascularized autologous fibular graft for treating the major bone defect after post-traumatic femoral shaft fracture (Figures 11-13).

Discussion

The prevalence of femoral shaft fractures is approximately 10 per 100,000 people with peak-age related incidence between the ages of 15–24 years [11]. The early reference stated that vascularized bone graft offer significant advantages over conventional treatment methods in selected patients with segmental bone defects greater than 6 cm [12]. For defects of >12 cm, vascularized grafts are superior to non-vascularized grafts as indicated by failure rates of 25% and 50%, respectively [13]. In our case, we are using cortical autologous bone graft because it would allow rapid weight-bearing and fasten the mobilization.

Another study also showed that vascularized cortical grafts healed more rapidly at the site of graft-host interface and their remodeling capability was similar to that of a normal bone. Unlike non-vascularized grafts, these grafts do not undergo resorption and revascularization and therefore they provide superior strength during the first 6 weeks but have potential non-union > 6 cm [14]. In our case, the bone defect >6 cm and we are using fibular graft and into the femoral medullary cavity and having a good outcome. Despite their initial strength, cortical grafts still must be supported by internal or external fixation to protect them from fracture while they hypertrophy in response to Wolff ‘s law and mechanical loading [15], so we
decided to using internal fixation to increase response to Wolff’s law, in the 24 months we found a bridging callus, it is same effective such as vascularized cortical grafts. Bone gaps could resulted from atrophic non-union. They are characterized by poor blood supply. Non-vascularized fibular bone graft might took longer time to achieve union, but if used in good vascular bed and soft tissue coverage, it could obtained a similar result to the vascularized fibular bone-graft [16].

Studies by Azam et al. [17] and El-Negery [18] concluded that non-vascularized fibular bone graft gave a satisfactory outcome and less demanding procedure in femoral fracture in both children and young adults. In our case series, the good result happened in a 16-year-old woman and a 37-year-old man with complete union of the non-vascularized fibular graft and almost complete range of motion at the hip and knee joint. Tall et al. [19] conducted a study about treating non-union in neglected long bone fractures by osteo- periosteal decortication which they reported 2 cases of leg length differences. Study by Zhang et al. [20] investigated monoliteral external fixation as an alternative method for treating femoral non-union with large bone defect. From 41 patients, there are three cases of axial deviations, five cases of docking site non-union, 23 pin-tract infection cases, 14 knee joint stiffness cases, two osteogenesis insufficiency cases, one refracture case, and two cases of loose external fixation pin, complete and comprehensive debridement surgery with autologous non-vascularized fibular graft, stabilized fracture with LC-DCP allow an early rehabilitation. Early mobilization combined with strengthening activities after surgical treatment of femoral shaft fracture in adults may result in early resolution of impairments and functional limitations and decreased disability [21]. Physiotherapy and early mobilization would result in better outcome for the patient, all of these are less expensive and widely reproducible options to manage bone defects in complex open shaft femoral fractures in order to achieve union, preserving length and motion with no donor site morbidity and giving patients good functional outcome.

### Table 3: Range of motion

<table>
<thead>
<tr>
<th>Joint</th>
<th>Flexion</th>
<th>Extension</th>
<th>Abduction</th>
<th>Adduction</th>
<th>Internal rotation</th>
<th>External rotation</th>
<th>Right knee</th>
<th>Flexion</th>
<th>Extension</th>
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<tbody>
<tr>
<td>Right hip</td>
<td>140°</td>
<td>0°</td>
<td>45°</td>
<td>30°</td>
<td>45°</td>
<td>45°</td>
<td>60°</td>
<td>0°</td>
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### Table 4: Leg length discrepancy measurement

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<th>Right (cm)</th>
<th>Left (cm)</th>
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<tr>
<td>True Length</td>
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<td>95</td>
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<tr>
<td>Apparent Length</td>
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<td>Anatomical Length</td>
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### References


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