Reconstruction of a severe open distal humerus fracture and intercondylar fracture with complete loss of 13 cm humeral bone by using a free vascularized fibular graft: A case report

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ABSTRACT

Background: Segmental bone defects resulting from traumatic injuries are complicated problems with significant long-term morbidity. Vascularized bone grafts, by definition, are placed with their vascularity intact, and thus are immediately viable.

Case: A 46 years old man referred to Sanglah Hospital after roadway accident and subsequently fell to the valley. Open wound Ø 5x2 cm (already stitched), bone loss 13 cm length, tenderness over the arm and elbow, radial artery and ulnar artery palpable, O saturation 98%, no paresthesia, no active ROM elbow flexion and extension, active ROM wrist 80/70, active ROM MCP-IP 90/45, and patient can do a thumb extension. Already done the free vascularized fibular graft, and stabilized with 3.5 mm reconstruction plate and screwing for intercondylar fracture. Then checked with angiography for vascular viability.

Discussion: Management of bone defects after severe open fractures of the distal humerus encompasses many technical difficulties. In these cases, appropriate osteosynthesis may not always feasible, and bone grafting should be considered for the restoration of normal elbow anatomy. Vascularized bone transfers are more efficient than conventional corticocancellous interposition grafting for the management of massive bone loss (>6 cm). The free osteocutaneous fibula flap is a composite tissue transfer suitable to address combined defects. Clinical monitoring and early detection of anastomoses failure can be done within hours after the surgery by evaluating the skin paddle viability.

Conclusion: The surgeon should decide elbow reconstruction in severe injuries that compromise several structures and create tissue defects by careful evaluation. The kind of lesion and mechanism of trauma are not necessarily the most important factors for planning treatment. The free osteocutaneous fibular graft should be further considered as a reconstructive option for the treatment of metaphyseal or juxta-articular complex defects of the elbow joint.

Keywords: humeral bone defect, bone loss, free vascularized fibular graft

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INTRODUCTION

Reconstruction of large skeletal deficiencies presents a challenging problem to the orthopedic surgeon; methods have evolved significantly during the past decades. Several studies have demonstrated the clinical usefulness of autogenous cortical bone and allograft reconstruction, but resorption of bone and fractures of the graft are possible complications.1

Vascularized bone grafts, by more rapid healing and hypertrophy, may tolerate mechanical loading better and reduced the incidence of resorption and stress fracture. Although several clinical studies have shown the usefulness of vascularized grafts concerning union and resistance to infection, we have found no studies of bone dynamics in vascularized grafts.1

The traditional solution for reconstruction of segmental bone defects has included autogenous cortical cancellous bone obtained from the ilium, tibia, or fibula transference of whole bone segments without vessel anastomoses, i.e., fibula; allograft bone transplants; and custom prostheses. Autogenous bone grafts are considered as the gold standard for bone replacement, mainly because they offer minimum immunological rejection, complete histocompatibility and provide the best osteoconductive, osteogenic, and osteoinductive properties.2,3,4 However, clinical benefit is not guaranteed and there is an associated 8-39% complication.5 Each of these techniques possesses problems which frequently compromise the desired objectives of long-term stability and viability required for functional reconstruction of an extremity.6

In autografts of cortical bone or whole bones, the majority of osteocytes die, requiring the eventual replacement of the dead bone by creeping substitution process in which dead bone is ultimately replaced by living bone. In massive allografts, the entire grafted segment is a nonviable scaffold.
which is replaced with viable bone from the recipient bed. Complications of segmental autografts and allografts include nonunion between the graft and the recipient bone, resorption, collapse of particular segments, and fracture of the graft. Also, prolonged immobilization of 6 to 18 months is required depending upon the length of the defect.6

The use of vascularized autograft in reconstruction may provide rapid biologic incorporation, growth potential in skeletally immature patients, and the ability to thrive in compromised soft tissue environments. Although several options exist for vascularized bone transfer (such as iliac crest, rib, or clavicle), the fibula is the most commonly transferred free autograft. The use of free fibula transfer to the humerus is well established for posttraumatic bone loss and nonunions.7

Segmental bone defects resulting from traumatic injuries are complicated problems with significant long-term morbidity.8 Open intra-articular fractures of the distal humerus are frequently the result of high-energy trauma.6 These injuries can be associated with severe bone and articular cartilage fragmentation, extensive soft tissue damage, and concomitant injuries, which may jeopardize limb integrity and patient survival. Because of the complexity of injury, treatment is difficult, and the subsequent clinical outcome is often inadequate.9

Vascularized bone grafts, by definition, are placed with their vascularity intact, and thus are immediately viable. As a result, vascularized bone grafts obviate the need for incorporation by creeping substitution and may instead incorporate into the adjacent host bone via primary (or secondary) bone healing.8,9

The high functional requirements of the elbow depend not only on the complexity of the joint but also on the maintained function of vessels and nerves and the soft tissue coverage. The high density of good structures that may be involved in lesions at this level may cause severe functional impairment of the upper limb. Accurate reconstruction of the articular surfaces and early mobilization of the elbow joint are critical for restoring proper joint function.10

The principles that should guide the reconstructive surgeon in the process are the following:10

1. Extensive debridement of damaged tissues (immediately it may be difficult to identify which tissues are devitalized, particularly following high-energy traumas);
2. Restore a good blood supply;
3. Stabilize bone components with rigid fixation;
4. Ensure stable and well-vascularized skin coverage;
5. Mobilize of the joint early.

**CASE REPORT**

A 46 years old man referred from Waingapu hospital to the emergency department of Sanglah Hospital after roadway accident and subsequently fell down to the valley 11 days before admission. Debridement and primary heisting of the wound have been done in Waingapu Hospital. The patient was alert and orientated, hemodynamically stable. The clinical and radiologic examination showed swelling over the right arm and elbow, angulation deformity to the anterior side, open wound Ø 5x2 cm (already stitched), 13 cm length bone loss, no pus, crustae, tenderness over the arm and elbow, radial artery and ulnar artery palpable, CRT less than 2 second, O₂ Saturation 98%, no paresthesia, no active ROM elbow flexion and extension, active ROM Wrist 80/70, active ROM MCP-IP 90/45, and patient can do a thumb extension, diagnose with OF Right Humerus segmental grade III B with Bone Loss AO/OTA types C2.3, according to the relevant classification systems for the open and distal humeral fractures, respectively.

The patient was promptly taken to the operation room for stabilization of the right elbow fracture and pelvic ring injury. The elbow wound was debrided and irrigated with 6 liters of normal saline solution and removal of all contaminated or dead tissues. And make ORIF Screwing in the intercondylar humerus. After checked marker of infection, and make sure no infection found, then take the second operation with free vascularized fibular graft.

![Figure 1](image.png) Fibular graft taking during operation
The flap was harvested using the standard technique, the fibula is osteotomized proximally and distally, with preservation of the peroneal vessels. Once the recipient site is prepared, the vascular pedicle may be divided and the fibula transferred to the desired location. If an osteomyocutaneous flap is required, dissection starts with a linear lateral incision over the fibula parallel to its border. Following ulnar nerve anterior submuscular transposition, a 17 cm fibular graft was inserted into the medial column defect and subsequently stabilized with a new 3.5-mm reconstruction plate for superior fragment and inferior fragment with half threaded cancellous screw for intercondylar fracture.5,7 Microvascular anastomoses of the donor peroneal artery and its accompanying veins were carried out on the corresponding radial artery and venae comitantes after the passage of the pedicle through brachialis muscle.

**Durante Operation**

After the stabilization of the fibula to the recipient site, typically done with rigid internal screw fixation, microvascular anastomoses are performed, reconstituting both arterial inflow and venous outflow to the fibular graft. Postoperatively, a posterior elbow splint was applied and antibiotic medication. Two weeks after the operation, we already have done angiography.
Management of bone defects after severe open fractures of the distal humerus encompasses many technical difficulties. In these cases, appropriate osteosynthesis may not always be feasible, and bone grafting should be considered for the restoration of normal elbow anatomy. Autografts usually contain viable osteogenic cells, bone matrix proteins and support bone growth which are obtained from vascularized and non-vascularized cortical and autologous bone marrow grafts. Vascularized cortical grafts heal rapidly at the host-graft-interface, and their remodeling is similar to that of normal bone. On the contrary, non-vascularized grafts do not undergo resorption and revascularization and, therefore, they provide superior strength during the first six weeks. Vascularized bone transfers are more efficient than conventional corticocancellous inter-position grafting for the management of massive bone loss (>6 cm). Site of grafting is another important factor influencing osteogenesis. Resorption and replacement of a bone graft in a skeletal bed occurs more rapidly at the end of a long bone (cancellous) than at the center of shaft (cortical bone).

The free osteocutaneous fibula flap is a composite tissue transfer suitable to address combined defects in the 1-stage procedure. The fibula is a long and straight tubular bone, which is not difficult to harvest, while donor site morbidity is minimal up to a graft length of 20 cm.

Clinical monitoring and early detection of anastomoses failure can be done within hours after the surgery by evaluating the skin paddle viability. In the herein case, the interposed vascularized graft completed the triangle formed by the lateral and medial bony columns and the trochlea, and also promoted fracture healing and patient recovery.

In conclusion, the free osteocutaneous fibular graft should be further considered as a reconstructive option for the treatment of metaphyseal or juxta-articular complex defects of the elbow joint.

CONCLUSION

The surgeon should decide elbow reconstruction in severe injuries that compromise several structures and create tissue defects by careful evaluation. The kind of lesion and mechanism of trauma are not necessarily the most important factors for planning treatment. The profile of the patient and general clinical conditions, surgical team experience and the level of multidisciplinary assistance have to be considered as well. The ideal procedure is an “all-in-one” reconstruction; however, this cannot always be achieved immediately. In these cases, the surgeon should choose reconstruction methods while taking into consideration the future steps for optimal treatment.

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