



OSTEOCUTANEOUS FIBULAR FREE FLAPS IN COMPLEX UPPER LIMB TRAUMA

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ABSTRACT From 2005 to 2011 a total of 115 fibula free flaps were done; in this group there were seven patients with composite defects in the upper limb following acute trauma. 2 of these reconstructions were for the humerus and 5 for loss of metacarpals in the hand. The length of the bony defect ranged from 4 cm to 10 cm. 2 patients had in addition replacement of segmental loss of radial nerve and partial loss of triceps muscle. 1 of the 7 patients had a loss of the skin paddle 2 weeks postoperatively and needed a pedicled groin flap to cover the exposed viable fibular graft. Follow up period ranged from 1 years to 5 years. In all cases bony union was achieved without the need for secondary bone grafting.

KEYWORDS : Fibula osteocutaneous flap/traumatic metacarpal loss/segmental humeral defect

Introduction

Combined osseous and soft tissue defects of the upper limb are difficult to treat and require complex micro vascular reconstruction for limb salvage. Such defects can result from trauma, infection or oncologic resection.

In select clinical situations where the bone gap is small or the defects are in the distal part of the upper limb reconstruction could be successfully carried out by combining a skin flap local or free with non-vascularized iliac crest bone graft.

The transfer of vascularized combined osteocutaneous graft is advantageous because of the ability of the graft to survive in a hypovascular, potentially infective environment. In addition vascularized bone graft react to biological and physiological reactions in a normal way. They are capable of physiological osseous healing and hypertrophy to withstand continuous physical stress.¹

The first micro vascular fibular transfers were performed by Ueba² and Fujikawa in 1973 and Taylor³ et al in 1974. Combined osteocutaneous fibula transplantation was carried out in 1983 by Chen and Yan⁴ as well as by Yoshimura et al.⁵ The lateral approach to fibula harvest was described by Gilbert⁶ and is the most commonly used approach.

Materials and Methods

Seven consecutive patients in whom trauma resulted in segmental loss of skin and bone and were treated by free fibular osteocutaneous flaps during the years from 2005 to 2011, are reported here. All cases underwent a primary reconstruction. Conventional radiographs were done in all patients to assess the degree of skeletal injury. Angiograms were not done. Intraoperative Doppler was used to facilitate the location of skin paddle of the fibula flap. All the fibula flaps were harvested in antegrade fashion through a lateral approach.



Image 1: Pre operative clinical photograph and radiographs of crush injury left hand

All the microanastomosis were done using 8 '0' or 9 '0' monofilament nylon sutures under the operating microscope or a 4X magnifying loupe.

The area over the recipient pedicle was not closed but covered with a split thickness skin graft to prevent compression of the pedicle.

The skin paddle of the fibula flap was sutured to the edges of the skin defect; where the skin defect was large, the non critical part of the defect was covered by a split thickness skin graft

2 patients who needed replacement of segment of humerus also needed sural nerve grafting of segmental loss of radial nerve (1 cable of superficial peroneal nerve, harvested along with the fibula flap was also used) and in both cases the lateral hemi soleus muscle, harvested as a part of the fibula flap to replace a block of lost triceps muscle (without neurotisation).

5 of the flaps were done for hand defects; 3 of these were for 2 contiguous metacarpals (double barrel fibula flap with intact periosteal bridge); 1 of the 3 double barrel fibula flap was for loss of 1st and 2nd metacarpal where a 1 inch osteotomy between the bone segments permitted achievement of an adequate first web space. The other 2 were double barrel fibula segments for replacement of third and fourth metacarpals. 2 flaps were for loss of thumb metacarpal only; loss of extensor tendons in the hand if present was not replaced.

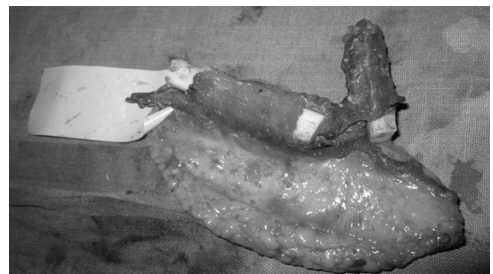


Image 2: Osteocutaneous free fibula flap with one inch osteotomy



Image 3: insert of fibular flap with two barrels

Postoperative assessment of flap vascularity was done clinically and based on color of the skin paddle, turgor and skin scratch for color of dermal bleeding.

Post operatively routine radiographs in 2 planes were done at 6 weeks (for the hand reconstructions) to permit removal of K wires and the application of an external splint. This was removed at 2 months and the patients subjected to a graded physiotherapy programme.



Image 4: post operative radiograph (on right) showing well incorporated bone and functional usage of hand by patient in a clinical photograph (on left)

X-rays were done at 1 month, 3 months and 6 months in patients who had the injuries in the arm (2 patients). External fixator was removed 3 months after the injury and an immobilizing brace was continued for a further month. Graded physiotherapy was started for all the joints and a resting static splint to prevent wrist flexion continued till recovery of the radial nerve function was noted.

All patients with a minimum follow up period of 12 months were assessed for a. skeletal stability and hence bony union and b. upper limb motor function and the results depicted as a percentage of the normal upper limb.

Results

Though the fibula flaps survived in all the patients, 1 patient had loss of the overlying skin paddle due to constricting dressings after the second week; this was debrided and since the vascularity of the fibula bone flap was preserved (as assessed by color and bleed of the periosteal bridge and soft tissues on the fibula bone surface), a pedicled groin flap was done for coverage to ensure healing.

All patients needed skin graft at the donor site; 6 of the 7 patients had uneventful healing; 1 of the 7 had partial exposure of the peroneus longus tendon less than 5 cms and this healed after debridement and regular wound dressings. All except 1 were weight bearing and walking 4 weeks after the surgery.

Discussion

The free fibular osteocutaneous flap⁷ has been the mainstay of lower jaw reconstruction in view of its advantages of predictable vascularity, long vascular pedicle, antegrade or retrograde design and the ability to fashion multiple bony segments attached to a periosteal bridge. Further refinements have permitted harvesting portions of muscle and overlying cutaneous nerves as vascularized segments to be used for complex composite tissue⁸ requirements at various recipient defects. Its use has been described also in lower and upper limb reconstructions following defects resulting from trauma⁹ or tumor¹⁰ excisions and unusually for similar defects in the trunk.

Though the Ilizarov¹¹ technique and Enneking¹² procedure has partially supplanted the free fibula technique in lower limb defects, such is not the case in upper limb defects.

Among the various free osteocutaneous flap choices available for bone defects greater than 4 cms the scapula¹³, the radius¹⁴, the iliac crest or the first metatarsal do not have any of the advantages of the fibula flap and further have quite a few disadvantages that do not permit them to be applied to a variety of clinical problems in the upper limb

The alternative to composite osteocutaneous flaps is skin flap cover (pedicled or free) with a non-vascularized bone graft, usually the iliac crest; the disadvantages of this are infection and resorption of bone graft and hence a need for prolonged immobilization with or without further secondary procedures.

The results can be judged from our tabular analysis of results. Single metacarpal reconstruction seems to give the best functional results especially the thumb. This is due to probably the localized nature of the injury coupled with the importance and strategic position of the thumb

in the hand. Reconstruction of the thumb and the index, fares slightly worse on account of the appearance of the thumb web in the reconstructive plan.

Multiple metacarpal replacements in a crush injury of the hand gives predictable skeletal stability but poor movement especially if the injury is close to or involves the MPJ; some form of partial arthroplasty of the injured MPJ coupled with early active mobilization should give better function. In this series none of the patients had mobilization of their hands till the third week after surgery.

Free fibular osteocutaneous flaps for humeral defects obviates purposive shortening of the limb and wound closure followed by distraction lengthening¹⁵; furthermore the composite tissue loss can be reconstructed using various combinations of skin muscle bone and nerve as partially if not totally vascularized grafts. Since a small amount of length discrepancy in the upper limb may not be noticeable, some shortening of the gap before the inset of the fibular flap may permit direct repair of the injury of the adjacent nerves in certain circumstances.

Conclusion:

The predictability of successful bony union and thus achievement of skeletal stability following fibular free flap makes it the procedure of choice in reconstruction of segmental defects of bone in the upper extremity. It also affords additional tissue for composite reconstructions involving loss of more tissue types though not to the same extent as flaps based on the subscapular system (which had the main drawback of preventing a 2 team approach during the surgery). Application of better fixation methods, combining fibula flaps with prosthetic materials for joint arthroplasty ensures better functional rehabilitation of these patients.

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