

# Free Muscle Flaps for Reconstruction of Upper Limb Defects

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## KEYWORDS

- Complex upper extremity injury • Timing of reconstruction • Free muscle flaps
- Functional muscle transfer • Reanimation • Indications

## KEY POINTS

- Restoration of structure, function, and sensation after trauma or resection of tumor are critical in the hand.
- Early complete debridement, immediate repair/reconstruction of underlying structures and synchronous flap coverage enable early hand therapy, earlier return to function, and improved outcomes.
- In the upper limb, free tissue transfer is indicated for significant wounds around the elbow, forearm, and hand, where local options are inadequate, compromised by trauma, or would cause additional functional deficit or result in sacrifice of major axial vessels to the hand. Muscle flaps may also deliver functional reanimation.
- Muscle flaps contour well into complex three-dimensional defects, filling deep dead space. They may be indicated where the wound has been significantly contaminated or exposes a fracture (particularly with periosteal stripping/open joint).
- Commonly used free muscle flaps include the latissimus dorsi, rectus abdominis, gracilis, and serratus anterior flaps. The first 2 are commonly used as musculocutaneous flaps, and all may be split skin grafted.
- Postoperative rehabilitation is individualized for the structures injured. Active mobilization within 2 to 5 days of early debridement and reconstruction is desirable.

## INTRODUCTION

Soft tissue defects are usually reconstructed by consideration of the reconstructive ladder, although the reconstructive elevator may be more appropriate for the upper limb to maintain dextrous, sensate interaction with surroundings.

Superficial wounds can be managed by skin grafting, but in the hand, axilla, and antecubital fossa, there is a risk of secondary graft contracture, leading to restriction of movement and function, and aesthetic results may be unsatisfactory. Where underlying vital structures (eg, tendon, bone, nerve) are exposed, normal function requires

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reconstruction with vascularized tissues. Flap cover enables early mobilization, which is critical to optimizing long-term function, and when local options are compromised (or would themselves compromise the outcome), early free tissue transfer from outside the zone of injury is required.<sup>1-3</sup> Thus complete debridement, repair, or reconstruction of vital structures, and primary free flap cover within approximately 24 hours of the injury is the ideal management for complex isolated upper extremity injury.<sup>4</sup>

Although primary amputation is frequently appropriate for severe lower limb trauma,<sup>4,5</sup> function with an upper limb prosthesis is generally poorer than after reconstruction, and upper limb amputation is associated with poorer health and psychosocial outcomes than limb salvage. Amputation may still be indicated after unrestorable devascularization injury, multicompartament muscle loss, if limb salvage would be life threatening,<sup>6</sup> or for the unreconstructable hand. A synchronous free flap may effectively preserve length on the amputation stump.<sup>7</sup> The optimal reconstruction is dependent on the mechanism and timing of injury, location and extent of wound contamination or infection, soft tissue and bone loss, the degree of nerve or tendon injury, the quality of vascular supply, and the suitability of the local tissues. When selecting a free flap, one must consider the flap dimensions, pedicle length/caliber, thickness, texture, color, durability, and sensory requirements. Donor site morbidity, facilitation of secondary reconstructive procedures, and surgeon's preference are also important.<sup>1</sup>

### **Early Complete Debridement**

Tumor resection often requires composite tissue excision to obtain clear margins. A similar approach aids complex upper limb trauma management. For 12 to 24 hours after injury, wounds are typically necrotic and contaminated, rather than suppurative or subject to invasive infection. En bloc excision of this wound pseudotumor by sharp dissection through noncontaminated tissues and unbreached tissue planes is a critical part of flap reconstruction, by converting the contaminated wound into a fresh surgical wound, and is favored over serial debridement.<sup>8-20</sup> With the exception of critical, viable, longitudinal structures (nerves, vessels, tendons, viable bone), all dead, contaminated, or marginally viable tissue is removed, rendering the wound ready for immediate coverage (Figs. 1-6). Bacterial load is decreased, and a wound bed of healthy tissue facilitates flap survival, uncomplicated wound



**Fig. 1.** Case 1: upper limb debridement series for a 38-year-old man involved in an industrial accident resulting in a crush/abrasion injury to the volar right wrist, radial and ulnar borders of the hand, and dorsum of the little finger. The patient presented 4 days after injury after exploration at a district general hospital. Debridement and reconstruction were undertaken with nerve graft reconstruction of the median nerve, and use of the palmaris longus tendon for reinsertion of abductor pollicis longus and extensor pollicis brevis tendons, as well as reconstruction of flexor carpi radialis tendon and the transverse carpal ligament. Synchronous free flap cover was used, using the radial artery and cephalic vein as recipient vessels. Palmar view of the preoperative wound, inadequately debrided, and with reactive extension of the zone of trauma and plaster of Paris contamination from inadequately applied dressings.

healing, and minimizes fibrosis. Furthermore, injured or missing structures can be clearly visualized and evaluated for primary repair or reconstruction.<sup>18-20</sup>

Reconstruction should be attempted as early as possible once adequate debridement is achieved. When adequate radical debridement is not possible, then, serial debridement is performed instead.<sup>15</sup>



**Fig. 2.** Case 1: dorsal view of the preoperative wound, inadequately debrided, and with reactive extension of the zone of trauma.

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