# *Orthoplastics Tips & Tricks:* Free Lateral Arm Flap for Reconstruction of the Hand Following Traumatic Injury: A Case Presentation

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## Introduction

Upper extremity injuries are extremely common, with an estimated incidence of over 1,000 per 100,000 persons per year.[1] While many of these injuries can be easily managed, large or complex injuries of the hand and upper extremity may require advanced reconstruction by a subspecialist. Defects following burns, infection, or tumor removal pose similar concerns. Critically important structures such as bone, tendon, blood vessels, and nerves are often exposed, and may benefit from free tissue transfer. While there are many options available for soft tissue coverage, each has unique advantages and disadvantages. When choosing an adequate flap or graft, the surgeon must take into account the size and location of the zone of injury, complexity of the injury, status of the surrounding tissue, exposure of the vital structures, and health status of the patient as well as smoking and nutrition status.[2] Other important factors include operative time, constant vessel anatomy, and donor site morbidity. The goal is to optimize reconstruction of form, function, and aesthetics for the patient.

Free tissue transfer provides the surgeon with vascularized soft tissue coverage as well as the option for bone, nerve, and tendon transfer. There are many free tissue options available for upper extremity defects including the groin flap, anterolateral flap, radial forearm flap, scapular flap, and lateral arm flap.[2,3] Because it tends to be thin and supple, the free lateral arm flap is an attractive choice for soft tissue covering around the hand and distal forearm.

The free lateral arm flap was first described by Song et al. in 1982 as a septocutaneous flap.[4] It was further popularized by Katsaros et al as a highly dependable free flap for small to moderate size tissue defects, known for its versatility with the option to raise the flap on its own, with underlying tendon, with bone, or with fascia only.[5,6] The lateral arm tissue can also be used as a sensate flap given its innervation by the posterior brachial cutaneous nerve.[7]

Here we discuss the case of an 18-year-old patient who required reconstruction and soft tissue augmentation of his first web space after a traumatic injury left him with a contracture that limited the function of his dominant hand. A fasciocutaneous lateral arm free flap was selected to provide a durable and supple surface to his first webspace after contracture release and thereby optimize the functional outcome of his hand reconstruction.

## Case Report

An 18-year-old right hand dominant male patient with no significant past medical history was referred to our clinic after sustaining a traumatic injury to the right hand in an ATV accident one year prior. At the time of injury, he suffered a Bennett's fracture of the right thumb, open transverse fractures of the index, long, ring, and small finger metacarpals and concomitant partial degloving of the hand (Figure 1). Prior to presentation to our clinic the patient had undergone multiple procedures on his right hand, including pinning of the metacarpal fractures with Kirscher wires (**Figure 2**), hand fasciotomies, and skin grafting to the volar hand.

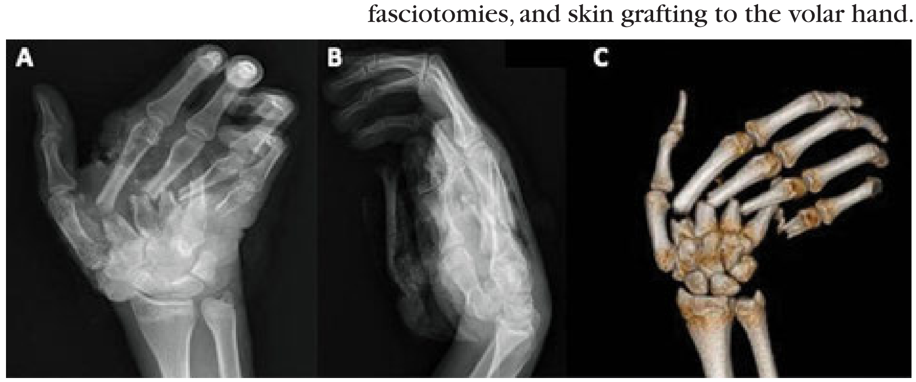


**Figure 1.** Imaging at time of injury. **(A)** AP and **(B)** lateral radiographs of the right hand at time of injury. **(C)** Three-dimensional reconstruction of a CT scan of the right hand.

One year after his initial injury, the patient had residual deformity of the right hand, with limited function, primarily due to loss of the fist web space due to scar contracture with associated fixed internal rotation of the thumb. He had swan neck deformities of the index through small fingers with ulnar deviation of all digits (Figure 3). His sensibility was intact throughout the hand except for hypoesthesia over the dorsal, radial aspect of the index finger. He had significant atrophy of the thenar musculature. A strong triphasic doppler signal was present over the dorsal branch of the radial artery. Imaging demonstrated malunion of the metacarpal shafts with a windswept appearance of the hand (Figure 4). The distal radius, ulna, and carpal bones appeared atraumatic and well aligned. The patient's chief complaint was impaired function of his dominant hand due to pain and position of his thumb. To address this complaint the patient and our team opted to pursue fusion of the thumb carpometacarpal (CMC) joint, first webspace contracture release and first webspace widening and deepening using lateral arm flap.

**Figure 2.** Initial post-operative AP radiograph of the right hand from surgical procedure prior to presentation.

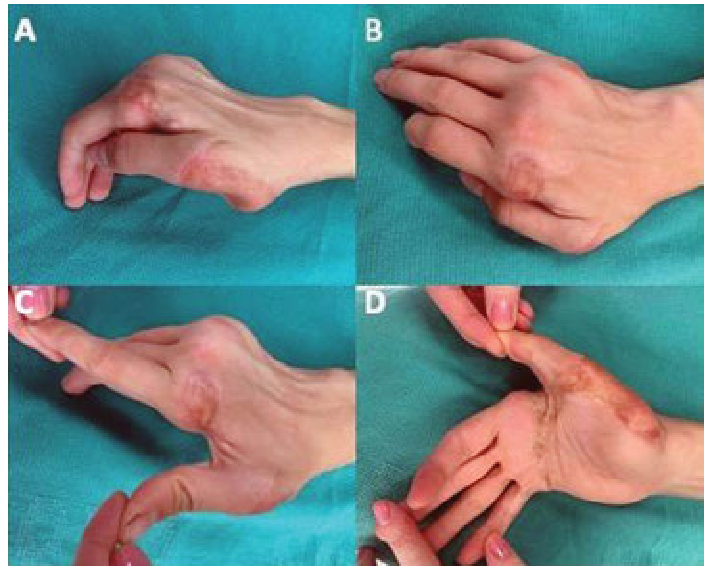


**Figure 3. (A-D)** Pre-operative images demonstration residual deformity of the hand with first web space contracture.

At the time of surgery, tourniquet was placed and inflated to 250mmHg. A zig-zag incision was made over the dorsal aspect of the first web space. An adductor tenotomy was the performed and the thumb was freed from the scar tissue in the first web space and palm. Next, dissection was carried down to the level of the thumb CMC joint. An arthrotomy was performed, and the base of the metacarpal was found to have collapsed and without healthy cartilage from previous trauma. An osteotomy of the metacarpal base was performed to optimize position the thumb for opposition and pronation. What little articular cartilage remained on the trapezium was removed and fusion with Kirschner wires and tension band was performed. The web space was further opened to the degree possible by taking down scar tissue and a template was created for the cutaneous portion of the free flap.

The template was placed and traced at the distal aspect of the ipsilateral upper arm. The anterior border was incised initially, and dissection was performed to the level of the biceps and brachioradialis muscles. A fasciocutaneous flap was raised from anterior to posterior visualizing and including the septocutaneous perforators arising from the posterior radial collateral pedicle. The posterior incision was made and


**Figure 4.** Imaging at time of presentation. **(A)** AP, **(B)** oblique, and **(C)** lateral radiographs of the right hand at time of presentation, demonstrating residual bony deformities of the metacarpals.

**Figure 5.** Right arm at time of surgery demonstrating template for lateral arm flap.

the fasciocutaneous flap was again raised to the pedicle. The pedicle was clipped distally and raised from distal to proximal taking a small amount of periosteum from the humerus at the distalmost aspect where the pedicle was so closely adhered to the bone. Tourniquet was deflated and removed. The posterior radial collateral artery was dissected and traced behind the lateral head of the triceps where it branches off the brachial artery. During the proximal dissection the radial nerve was visualized and protected. The posterior cutaneous branch of the forearm as it came into the flap was dissected and included. The pedicle was divided, and the flap was brought down to the hand (Figure 6). The donor site was closed in layers over 15Fr round blake drain.

At the hand, an end-to-end anastomosis was made between the pedicle and the dorsal branch of the radial artery over the thumb. Two concomitant veins were coapted using a 2mm sized venous couplers. A superficial branch of the radial nerve was coapted to the posterior cutaneous nerve branch on the flap. The flap was inset without tension and closed with nylon sutures (Figure 7). Radiographs were obtained post-operatively (Figure 8). The patient was placed in a soft dressing with a plan for a flap debulking procedure after eight weeks (Figure 9). He will continue occupational therapy for range of motion exercises to optimize his functional outcome.

## Anatomy

The blood supply to the lateral arm flap is reliable and consistent. The flap is supplied by the radial collateral artery which originates from the brachial artery and wraps

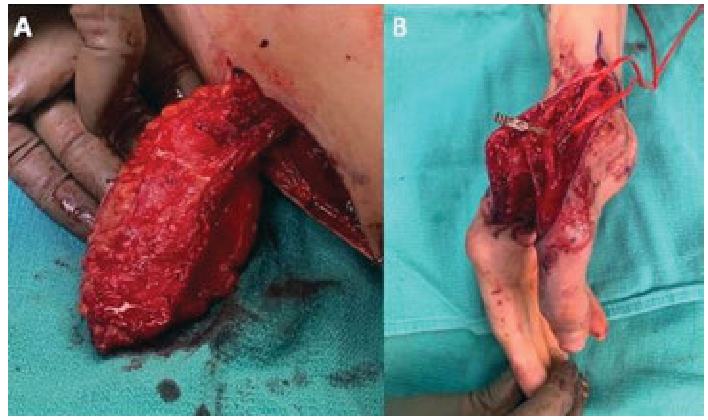


**Figure 6.** Intra-operative donor and recipient flap sites. **(A)** Dissected lateral arm flap with visible posterior radial collateral pedicle. **(B)** First web space after contracture release with exposed dorsal branch of the radial artery.

posteriorly around the humerus. As it descends, midway between the acromion and the lateral epicondyle, the artery enters the lateral intermuscular septum between the deltoid insertion anteriorly and the triceps posteriorly. Here it divides into the anterior and posterior radial collateral arteries. The posterior radial collateral artery runs between the triceps brachii and brachial muscles distally along the humerus. It is the posterior branch which supplies the lateral arm and lateral forearm flaps. Three to five septocutaneous perforator

**Figure 7.** Immediate post-operative images with well-perfused lateral arm flap within the first web space.

**Figure 8.** Immediate post operative radiographs of the right hand.

**Figure 9.** Pre and post operative clinical images at eight week post operative procedure for flap debulking demonstrating healthy flap with functional position of the thumb.

arteries in the lateral intermuscular septum of the upper arm provide the blood supply to the fasciocutaneous flap. It ultimately anastomoses with the interosseous recurrent artery around the level of the lateral epicondyle.[2,5,8,9] The posterior cutaneous nerve of the arm arises from the radial nerve in the spiral groove and accompanies the posterior radial collateral artery, innervating the skin of the lateral upper arm.[5]

The vascular pedicle not particularly long and runs underneath the flap itself. When traced back to the takeoff of the brachial artery a vascular pedicle of 7 – 8 cm can be possible with an arterial diameter of 1.5 – 2.0 mm.[5] There is generally a paired venae comitantes with a dominant vein typically a similar diameter to the artery. Fascia up to 12 x 9 cm may be used with good axial perfusion.[9] Other variations include taking a cutaneous portion of the flap extending distal to the elbow in a "hockey stick" shape. If needed a piece of vascularized bone on a cuff of periosteum from the humerus can be raised with the flap measuring 1.5cm wide.

## Discussion

The upper extremity and the hand specifically are regions that often require complex reconstruction in the setting of trauma or large soft tissue defects. Reconstruction of the hand is technically demanding given the close proximity and heterogeneity of very functional structures within the hand and forearm.[8] This is further made challenging due to the requirement of reconstructing surfaces with a low coefficient of friction which permit smooth gliding of structures—in particular tendons—with movement. The lateral arm can yield a variety of tissue for free transfer, including skin, fascia, muscle, tendon, and bone. The use of fascial tissue from this region allows for versatile soft tissue coverage. Creating a gliding surface for tendons clinically decreases the prevalence of adhesions and allows for maximal tendon excursion. The lateral arm flap has the added advantage of limiting preparation, draping, and surgical dissection to a single extremity as compared to free tissue transfer from the commonly used anterolateral thigh flap. While free fascia can also be harvested from additional sites the posterior calf, dorsal thoracic region, and temporoparietal region, the lateral arm is optimal for defects of the hand given the ease of access during surgery and the excellent tissue quality making three dimensional defect coverage easier.[9] The lateral arm flap can be harvested in the supine, lateral, or prone position.[9] Graft harvest from the lateral arm and donor site preparation in the ipsilateral extremity can be performed under the same tourniquet without the need for repositioning. Utilizing other common grafts often requires prepping and draping other areas of the body, which can lead to logistical difficulties in the operating room. This is also advantageous in that the flap can be harvested entirely under axillary block in ipsilateral upper extremity defects, eliminating the need for general anesthesia in patients who are higher risk utilizing a regional block.[6,10] The selection of a lateral arm flap with regional anesthesia coordination can also facilitate a decrease in post-operative pain if the surgical team requests use of an indwelling pain catheter.

## Conclusion

The lateral arm free flap is a versatile, reliable flap that allows for soft tissue coverage of complex wounds in the hand and upper extremity. It is particularly useful given its ability to create a gliding surface for tendons and other structures to reduce adhesion formation. We believe that our patient will regain meaningful use of his hand following the reconstruction of his first web space utilizing a free lateral arm flap. The choice of a lateral arm flap assisting with patient comfort and minimized morbidity to other extremities, facilitating increased functionality of his dominant arm.

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