

## Substantial reconstruction of segment of index by osteo-tendo-cutaneous pedicled radial forearm flap: Case report

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### Abstract

**Introduction and importance:** The hand is one of the most vital organ that the surgeon aims to preserve its function and natural appearance. Although the index finger was used to reconstruct the thumb, the function of the index finger is important as function of the thumb, making its reconstruction necessary. Gunshot injuries are common, especially in a war zone, and unfortunately, they create complex wounds that are hard to reconstruct and infection is very common. In this article, we report rebuilding segment of index finger with a pedicled osteo-myo-tendo-cutaneous radial forearm flap.

**Case presentation:** A 50-year-old black man with no past medical comorbidities, sustained trauma to his left index finger by high-velocity injury that led to composite tissue loss including metacarpal and proximal phalanx. After applying the initial irrigation and dressing to the wound, his hand was supported by a volar cast then he was referred to the hospital. The hand was examined at the operation room and the index finger was found to be hanged with a medial skin pedicle with necrotic and exposed bone and tendon. He underwent a session of debridement followed by reconstruction using a pedicled osteo-myo-cutaneous radial forearm flap accompanied with metacarpophalangeal joint arthrodesis.

**Clinical discussion:** In this scenario, Ray amputation is simple and functional result is acceptable if the patient agreed. Abdominal and regional flap are alternatives to free flap but they will not provided same results. Radial flap is used to reshape second ray of hand and made reasonable outcome.

**Conclusion:** The radial forearm flap was used to reconstruct segment of index finger and fulfill our requirements, which include bone, tendon, and skin cover. Additionally, this is a simple and single stage procedure and micro-surgical equipment is not necessary.

**Keywords:** Hand injury; Hand reconstruction; Index finger reconstruction; Radial forearm flap; Osteo-cutaneous radial flap.

## Introduction

The hand is a precious functional organ with complex neural, vascular, and mechanical properties. It is vulnerable for trauma due to its marginal location and mobile auto-defense mechanism. Hand surgery aims to restore former functions either fully or partially using a reconstructive ladder concerning aesthetic aspects. The index finger plays a major role in the hand, and any impairment will decrease the strength of the grip and lateral pinch. A composited effect can be created by high-energy trauma, putting the digit at risk of ischemia if it hasn't already been amputated [1,2].

Local and distant tissues were being recruited to reconstruct the hand, and recently, free flaps became a popular option. All these methods are acceptable to restore hand parts but complications, surgical difficulties, and the patient's condition influence the choice of flap. The early cover is mandatory to protect the skeleton of the hand and resume joint mobility as soon as possible [3,4].

The radial forearm flap with various modifications is considered a powerful tool for reconstruction since it was introduced by Yang et al. although it is gaining popularity as a free flap and has utility in head and neck reconstruction but is still an effective option for hand reconstruction [5].

Osteocutaneous flaps have been reported as a workhorse for thumb reconstruction, and few reports have mentioned using them for complex hand defects, offering a well-matched tissue with favorable outcomes and satisfaction. An additional advantage is that it is a single-stage procedure without the need for microsurgical skills [6,7].

This article describes using an osteomyo-tendo-cutaneous radial forearm flap for the reconstruction of composite index defect.

## Case Presentation

A 50-year-old black man with a dominant right hand with no significant medical background. He presented to the ER department complaining of a left-hand wound that was caused by a Fireworks blast that crossed through the palm to the dorsum at the level of the second finger. He was referred from the primary healthcare unit two days after the initial trauma, where washing and dressing were applied to the wound and a volar cast was used to support the hanging index finger. At the hospital, reassessment of the patient was done, and fortunately, only his left hand has been affected. X-ray for the left hand was requested and revealed loss of the head of the second metacarpal, proximal segment of the proximal phalanx and the Metacarpophalangeal Joint (MCPJ).

The patient was told about result of x-ray and he was counseled about reconstruction and amputation, but he preferred to keep his finger even if it is not functioning. He was taken to the operation room for examination under anesthesia and debridement. The wound was exposed and found to be extended from the mid of second metacarpal bone to mid of proximal phalanx of the index and composite tissue was missed includes; extensor tendon and a radial branch of digital artery and nerve, but finger still well perfused by ulnar branch of digital artery. After excision of the necrotic tissue, trimming of bone edges and ligation of

a radial branch of the artery to index; the wound became wide about 10×8 cm, and dressing applied and the hand was supported by a volar cast and another session of debridement was planned. The patient was returned to the ward where he received intravenous 1<sup>st</sup> generation cephalosporin. Three days later, the patient was brought back to the operation room, the wound exposed again, and found to be clean apart from bone edges which were trimmed again. The Osteocutaneous radial forearm flap was previously chosen to cover the defect.

Allen's test was performed and was negative. Then marking of the flap was done and about 7cm +/- 2 cm of bone loss was estimated from the initial debridement. After application of a tourniquet, the skin was incised then dissection of subcutaneous tissue from radial to ulnar side done down to the sub-fascial plane above brachioradialis muscle to the level of intermuscular septum then tracking radial artery down to the septum. The flap was elevated from the other side to pedicle then a portion of brachioradialis was taken with 7 cm unicortical radial bone segment. Also, palmaris longus was incorporated into the flap to reconstruct an extensor tendon of index finger. The lazy S incision was made distally to the donor side then the flap was raised from the donor site and applied to the defect. The bone fixed first using interosseous nylon sutures 2/0 which provide stable fixation, followed by tendon repair then subcutaneous tissue was approximated and finally the skin. Again, the hand was supported by a volar cast, and the patient returned to the ward.

A week later, the patient was discharged from hospital to be followed at an outpatient clinic. Edema was the only complication while perfusion of the flap was ensured. Later, wound infection and partial wound breakdown occurred at the second web space, which was resolved by wound dressing, while the donor site healed uneventfully.

Three weeks later, physiotherapy was started to mobilize the interphalangeal joints, and the first x-ray showed a callus at the edges of the bones and healing if the bone occurred within two months. Movement of the forearm and wrist was restricted initially due to pain but returned to normal as soon as the pain subsided. The hand was kept off-loading for 4 months to avoid a radius bone fracture. Sensation of the hand was preserved, and index finger numbness was observed post-surgery, but a week later sensation returned to the distal finger apart from the lateral edge of the flap, while two-point discrimination increased compared to the adjacent finger. A month later, he was able to grip a bottle, but the strength of the grip was still not as powerful as that of the contralateral limb. Range of motion is restricted to the extension and flexion of intraphalangeal joints, and hand movement was not affected.

## Discussion

The vitality of the hand as a receptor and effector to communicate with the environment puts surgeons at a challenge to respect each component of the hand while considering reconstruction methods. Composite defects require restoration of all missed parts and a prefabricated flap is the best example of three-dimensional flaps, but it is similar to distant flaps in a multiplicity of procedures. Lack of setup for micro-surgery and long operating time eliminate free flap to be chosen as the report from a developing country where this sophisticated surgery is not applicable, but radial forearm flap meets criteria for limb

reconstruction, especially the hand [8].

Combat injuries are classified as dirty wounds that require generous irrigation, excision of devitalized tissue, and delayed cover. Although local antibiotic usage protocols exist, there are no data available for weapon injury management, even though international rules may be inapplicable worldwide due to regular changes in antibiotic protocols. In our case formal precaution of dirty wound were delivered to the patient such as: Irrigation, debridement and another late session of evaluation of wound in conjunction of IV antibiotic (1<sup>st</sup> generation cephalosporin) and adhere to the ICRC protocol for weapon wound [9,10].

Every patient went through a counseling session before surgery, and expectations were considered before formulating management plans. Although this report from the conflict zone and amputations are common, to some populations, amputations are considered stigmatizing and affect the individual psychologically. The index finger plays a significant role, especially in the dominant hand, but in the contralateral limb it will not play the same function. Even in the dominant limb, index function will swipe to the middle finger if a ray amputation is performed, and patients report functional and aesthetic satisfaction. In our case, the expectations of the patient are not achievable at our facility, but after counseling, his decision is to keep his index finger, even after explaining the complications of flap and finger dysfunction.

Reconstruction of the hand can be achieved by abdominal flaps and local flaps, such as a posterior interosseous flap and ulnar perforator flap, but they cannot build complex wounds. The current standard of reconstruction uses a microvascular flap but facilities for such surgery are not available in developing countries like Sudan and a pedicled flap was the only option. A reverse osteo-cutaneous radial forearm flap was the best option for the reconstruction of our case, as it provided a three-dimensional cover and build-up the missed segment of index finger. A reliable vascular supply and thin color-matching skin made this flap superior to other flap. Also harvesting flaps with a segment of radius bone and Palmaris tendon offer a single composite flap optimal for hand reconstruction [9]. In our case a segment of the radius bone perfectly replaced bone defect and a portion of the brachioradialis muscle protected bone perforators and gave bulk to full wounds. Also, the radial bone segment was taken with less than 50% thickness and 7 cm long to avoid reported pathological fracture and functional disability. Palmaris tendon was used to repair an extensor tendon and balance the action of flexors.

Also, in our case, the metacarpophalangeal joint has been assaulted, and joint replacement prosthesis was not available, therefore arthrodesis of the joint is the only wise solution. Joint fusion is recommended to restore hand function when arthroplasty is not achievable, hence this will strengthen the pinch grip of the index. Mini plate is the optimal way to fix hand fracture, and K. wire and screws do similar job, but all these osteosynthesis are not available at time of surgery and we used conventional method by using non-absorbable nylon 2/0 to fix bone segments [10,11]. Early mobility of the interphalangeal joint reduces the stiffness of the finger; physiotherapy was commenced on day 10 in our patient.

As mentioned previously, wound infection was predicted in all dirty wounds but in spite precaution; superficial infection occurred and was managed by regular dressing. Also, edema was presented early and simply relieved by elevation.

Although osteocutaneous radial forearm flap is a versatile reconstructive option for the hand and other regions mainly the head and neck, it-inherited donor site morbidities that drawback the use of the flap. Literature mentioned multiple donor site complications related to components of the flap; skin, muscle, bone and neurovascular elements [12-14].

Hand de-vascularization by harvesting one of the main hand vessels was an obstacle but bridging of the vascular system eliminated this complication, despite this, Allen's test routinely was performed twice; pre-operative and intraoperative to confirm the hand viability. Also, modifications were described using perforators rather than the main radial trunk and the flap was vascularized successfully. Additionally, flap congestion was reported as a side effect of the flap, I Matev et al. advocate anastomosis of an additional vein including into the flap to the superficial venous system of the hand [15,16].

Also, several methods were introduced for donor site closure therefore decreasing morbidity. Tissue expansion, negative pressure wound therapy, and advancement and narrow flaps were used to close the donor site primarily instead of resurfacing of defect by skin graft. Disadvantages of split-thickness skin grafts such as; graft loss, exposed tendons, long-term unpleasant appearance and hypertrophic scar can occur, but the skin graft is still commonly used for donor site closure [17]. In our patient, the skin graft healed uneventfully same as the skin graft donor site, while the appearance was accepted by the patient with mild hyperpigmentation compared to the adjacent local skin.

Pathological fracture of the radius is considered the most major complication and prophylactic plating of the radius is recommended in several researches, while Hiroshi Yajima et al. refill radius bone defect by iliac bone graft and report no fracture occurred [18,6]. In our case, we neither fixed the radius by plate nor used an iliac graft to rebuild the defect because the plate was not available beside the affected hand is not the dominant therefore we advised to keep the limb off-loading to avoid stressing on radius and no fracture was observed clinically and radiologically. Also we took less than 50% of radial bone cortical thickness.

Another withdrawal problem is a reduction in movement and strength of the hand and different scales are used to measure resultant disability. Literature illustrated an excellent range of movement in RFF patients with prophylactic radius plating although this decrease in motion will not significantly affect daily activities [18-20]. In our case, the movement was delayed till the skin graft healed then forearm movements were started, followed by the wrist and no obvious limitations were noticed compared to the contralateral limb.

As with all surgical procedures, radial forearm flap has limitations and complications according to how the surgeon will tailor the flap to fit the defect, although these donor site morbidities are recorded but remain low [21,22].

## Conclusion

The radial forearm flap is a workhorse for hand reconstruction and modification of the flap rebuild defect of various missed components. The reliability of the pedicle, ease of harvest, and long rotational arc made it a versatile flap. Index reconstruction with three-dimensional defects can be achieved by this flap at a single procedure.

**Consent:** Written consent was obtained by patient to be part of this job and provide permission for publication includes photography. A copy of consent available but written in Arabic to allow patient to understand purpose of study.

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