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Use of Proximal Phalanx of the Index Finger to Reconstruct Thumb Metacarpal: A Case Report.

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A 12 year old girl sustained injuries to her left hand and abdominal wall, from a mortar shelling incident. The index and thumb metacarpal were destroyed by the blast while the abdominal injury was non-penetrating. Five days after debridement, the distal thumb and index finger remained viable. The proximal phalanx of the index finger was mobilized on its vascular pedicle as a composite graft to reconstruct the metacarpal of her thumb. The remaining skin defect was covered later by a fasciocutaneous flap based on the dorsal interosseous artery and split thickness graft. We present this case as the first one reported in literature.

Introduction

The thumb is very important for the functioning of the hand, contributing about 40 per cent of the function of the hand, while the rest of the fingers contribute 60 per cent[1]. Many techniques of reconstructing the injured thumb have been reported, depending on the complexity of the injury and may range from simple soft tissue repairs to complex osteo-myo-cutaneous flaps, and toe transfers. Other methods include distraction osteosynthesis, pollicisation of the index finger, bone grafts, phalangization and prosthetics[2-6]. The optimal technique depends on the level of injury, the type of tissue lostdestroyed first and second metacarpals

Figure 1. The wound at presentation shows destroyed first and second metacarpals

Figure 2. Radiographs show severely comminuted Fracture

Figure 3. The wound day five, viable fingers.

Figure 4. Mobilization of proximal phalanx of index Finger. Volar digital vessels demonstrate

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Figure 5. Transection of middle and distal phalanx Skin and neurovascular bundle.

Figure 6. Transposition of the phalanx and attachment to the metacarpal bed.

Figure 7. Dorsal interosseous artery flap Rotated on its vascular pedicle And used to cover web space.

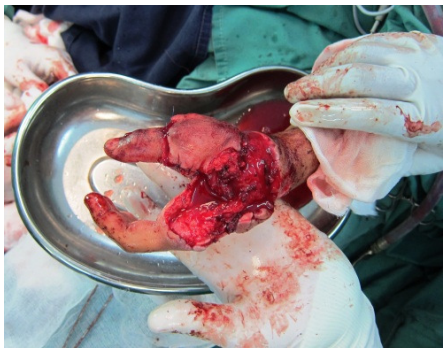

Figure 8; Completion of transposition.

Figure 9. Attempted abduction of thumb at 3 weeks

Figure 10. Attempted opposition at 3 weeks.

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Figure 11. Plain film shows good alignment of bone

At the first debridement, both index and thumb metacarpals were found to be either missing or comminuted to articular surfaces with contamination rendering them unsalvageable. The dorsal arterial branch from the dorsal carpal arch to the index was damaged; the dorsal branches of the radial artery to the thumb (radio-dorsal arteries) were also damaged as well as the terminal radial artery feed into the deep palmar arch. The damaged ends of these vessels were thus ligated. However, the volar soft tissues were intact and evidently provided adequate vascular supply to the hanging index finger and thumb making amputation not necessary (Figure 3). The wound was debrided, lavaged and dressed with bulky gauze and hand elevated in the ward. She was given Penicillin 4 mega units four times per day intravenously, and Metronidazole (Flagyl^{R}) 250 mg thrice daily for five days, as per our protocol. Pentazocin 15 mg intravenous and Paracetamol 500mg orally thrice daily were used to manage pain peri-operatively.

She was taken back to theatre after five days, for closure of her abdominal wound and change of dressing with evaluation of the hand. The thumb and index finger remained viable but loosely hanging on volar soft tissue bridges containing their vascular supply (Figure 4). A suggestion was made to reconstruct her metacarpals by fibula graft or iliac graft, or use the viable index finger proximal phalanx, on its vascular pedicle to reconstruct the thumb metacarpal. The option of fibular graft necessitated microvascular anastomosis, unavailable in our field hospital. The wound was cleaned and dressings changed, to await consultation with the parents.

Five days later, after considering options above, the option to sacrifice her index finger was preferred. The proximal phalanx of her index finger was mobilized on its volar digital arterial supply mobilizing it together with the first common digital artery, after ligating this artery's branch to the middle finger and preserving the radial volar index artery, a branch from the deep arterial arch on the radial side of the phalanx. The middle and distal phalanges were then excised, taking care to retain a longer skin flap on the preserved proximal phalanx. The volar glaborous skin was then divided along the flexor tendons and both flexor digitorum profundus and superficialis tendons were excised. The skin flaps were dissected open, taking care not to go beyond the digital vascular pedicle on the sides of the phalanx. The bulk of interossei muscles remaining in the first web space were dissected to come with the composite phalanx graft taking care to preserve the adductor policis. The mobilized proximal phalanx of the index finger was then implanted in the

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prepared former bed of the thumb metacarpal and the capsules of the trapezium-first metacarpal joint, and that of the first metacarpal-phalangeal joint were repaired with prolene 4-0.

The skin overlying this phalanx was then stitched to the native skin, the wound lavaged with saline, dressed with bulky gauze and hand elevated in ward (Figures 5-15). The same antibiotic therapy was extended for three more days. Three days later the remaining soft tissue defect in the first web space was covered with a reversed local fasciocutaneous flap based on the dorsal interosseous artery. The donor area was grafted. The flap remained viable and healed un-eventfully, with post-operative plain films revealing a well aligned new thumb metacarpal (Figures 16-25).

Discussion

Restoration of thumb structure and function dates back over 100 years since the days of Nicoladoni's attempt to transfer a toe without micro-vascular anastomosis[1,2]. These efforts have since been refined and perfected thanks to advances in plastic and reconstruction surgery. Due to the considerable importance of the thumb in hand function, many methods have evolved to restore its structure, when part or all of the cytoskeletal structure is destroyed by trauma or tumour surgery. These methods include phalangisation, osteoplastic reconstruction, and pollicisation of remaining fingers, free toe transfers and prosthetic appliances.

Evidently this surgical methods continue to evolve and improve, thereby enabling better cosmetic and functional outcomes. It is often the aim of the surgeon to preserve, as much as possible, all the fingers in the hand before resorting to any form of salvage procedures. In some instances however, it may become prudent to utilize other fingers to reconstruct the thumb structure and thereby restore hand function[5-7]. It is important that the opinion of the patient be considered in choosing the final option because some of these options may take long and tortuous surgery and rehabilitation.

This case represents one such instance, in which after consultation with the parents, it was decided to utilize the index finger that had lost its metacarpal, to reconstruct a metacarpal for the thumb. It must be noted that there are other options like use of vascularized fibular and harvesting graft from the radius. However these options present particular challenges in harvesting and may require microvascular surgical skills to anastomose the arteries, which was not available at the field hospital. The morbidity of harvesting bone from the iliac crest was not acceptable to our patient. The complete destruction of the first and second metacarpals including their articular surfaces, made basic bone grafting methods less preferred, besides excluding osteoplastic methods which were un-available at our field hospital. At best, such an attempt when successful would have given her a fused trapezium-first metacarpal joint, a fused first metacarpo-phalangeal joint, and the same picture in the index finger, rendering the first web space a fixed space, unable to open palm for big grasp function. This was compared to offering her a mobile thumb with a wider web space which could enable better open-grasp activity.

The choice of a local vascularized flap based on the dorsal interosseous artery was informed by the ease of mobilization of this flap. It provided adequate and reliable coverage of the soft tissue defect at the first web space leaving a minor defect that was grafted[8]. The thumb commonly receives its blood supply from the princeps pollicis artery which usually a terminal branch of the radial artery after giving off the deep arch and its branch to the index finger (arteria volaris indicis radialis). The thumb also receives dorsal branches from the radial artery before it enters the snuff box, namely dorsoradial and dorsoulnar branches which have great variability in numbers[9]. From Figure 1, it is clear that the terminal feed from the radial artery into the deep palmar arch was damaged including the dorsal branches named above. However, the princeps pollicis artery originates at the beginning of the deep palmar arch which was spared in this injury. This therefore means that because of the good anastomosis with the ulnar artery, the arterial supply was from the ulnar

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input. It should be noted that occasionally, the princeps pollicis artery arises from the superficial palmar arterial arch, thereby obtaining blood from the ulnar artery[9,10]. The free anastomosis between the anterior vessels and the dorsal vessels via the arches provided an adequate collateral supply to the thumb distal to the metacarpo-phalangeal joint, especially because the volar soft tissues were not damaged.

It was not deemed necessary to dissect and map out the arterial plexus of the thumb, as it was obvious ten days after injury that it was viable, and such dissection could have endangered that vital supply.

While there were many options including attempting to reconstruct the metacarpals by bone graft from the distal radius, iliac crest or vascularized fibula, there were many reasons that made it impossible to employ these techniques including patient preference, donor site morbidity, lack of microsurgical instruments and the risk of worse outcome after prolonged attempts at reconstruction. It was therefore decided to have a functional thumb instead of a non-functional thumb and index finger, an idea that was well received by the patient and parents. Being a child it is expected that she will have quick occupational rehabilitation and functional improvement to as good as a normal hand. Good flexor function of this thumb is expected, but the child will require another procedure to reconstruct the extensors to the thumb as they were destroyed, and the extensor digitorum indicis was also not salvageable. In the absence of other options, we advise use of this method to manage similar injuries because of its simplicity.

Conclusion

Thumb reconstruction especially after trauma, is technically demanding requiring patient cooperation, motivation and the surgeon's commitment to focus first on function and structure. With a good grasp of basics, various combinations of surgical manoeuvres can help a surgeon solve this challenge even in austere environments.

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