Section: Plastic Surgery

Original Research Article

RECONSTRUCTION OF VOLAR THUMB INJURIES USING HETERODIGITAL PROXIMALLY BASED NEUROVASCULAR ISLAND FLAP

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Received : *23/11/2023*
Received in revised form : *17/01/2024*
Accepted : *02/02/2024*

Keywords:
Volar thumb injuries, Neurovascular Island flap, Soft tissue defects, Littler's heterodigital.

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DOI: 10.47009/jamp.2024.6.1.283

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2024; 6 (1); 1421-1425

Abstract

Background: The optimal choice for addressing the thumb's complex volar soft tissue defects involves using a heterodigital neurovascular island flap. **Objective:** This article focuses on the efficacious resurfacing of the thumb's diverse and intricate composite soft tissue defects by applying Littler's neurovascular island flap. **Material and Methods:** This retrospective observational study was conducted in a tertiary care hospital from August 2016 to August 2019, examining 40 patients with volar thumb injuries, with 14 cases reconstructed using Littler's neurovascular island flaps. The reconstruction procedures employed various techniques, including the V-Y advancement flap, Moberg's advancement flap, cross-finger flap from the index finger, and Littler's heterodigital neurovascular island flap technique, which relies on a single neurovascular pedicle. **Results:** The mean age of the participants in this study was 33.57 years, consisting of 13 male patients and one female patient. All flaps exhibited successful survival, and the donor site was addressed using a split-thickness skin graft, resulting in a 100% take rate. The average duration of the surgical procedures ranged from 2 to 3 hours, with a mean time of 2.30 hours. The follow-up period was extended from 10 to 15 months with an average duration of 12. The utilisation of the neurovascular island flap ensures a stable cover with robust padding, providing enhanced sensation and increased blood flow to replace damaged tissue with similar tissue. **Conclusion:** This study demonstrates that Littler's heterodigital neurovascular island flap is a technically feasible, ideal, single-stage, reliable, and sensate flap for reconstructing thumb volar soft tissue.

INTRODUCTION

Digital trauma involving a digit's pulp or volar aspect, accompanied by soft tissue and digital nerve defects, can lead to functional impairment in the absence of appropriate intervention. Effective management aims to preserve digit length while ensuring sensate coverage and aesthetically pleasing outcomes with minimal donor-site morbidity. The heterodigital neurovascular island flap, initially introduced by Littler, is a dependable option for addressing such defects. However, its clinical utility is hindered by a notable incidence of donor site complications, including numbness, cold intolerance, hyperesthesia, scar contracture, and double sensitivity of the flap.[1-3] To address these challenges, various modifications to the heterodigital neurovascular island flap have been proposed. In 1990, Adani et al. presented a modified version incorporating a disconnecting and reconnecting technique to repair thumb pulp defects.[4,5] This involved dividing and coapting the proximal end of the proper digital nerve (PDN) and innervating the flap with the PDN stump at the injury site. Although this approach achieved satisfactory restoration of sensibility without double sensibility, concerns were raised regarding issues at the donor site.[6,7]

In 2006, Lee et al. introduced a heterodigitally innervated lateral middle phalangeal finger flap to treat resurfacing pulp defects. They coapted nerve bundles from the branches of the PDN and the dorsal branch of the PDN (DBPDN) to the nerve stumps of the PDNs at the recipient's finger. While this modification reduced donor site problems by

ISSN (O): 2687-5365; ISSN (P): 2753-6556

preserving the digital nerve in the donor site, it was noted to be unsuitable for large pulp or volar defects with a unilateral PDN defect.[8] The study by Sumathi et al. presented comparable results, indicating that addressing complex volar soft tissue injuries in the thumb posed a challenging reconstructive dilemma. This investigation focused on reconstructing the thumb pulp using our institution's proximally based Littler's neurovascular island flaps. These flaps emerged as an outstanding option, delivering commendable aesthetic and functional outcomes.[9]

The thumb tip pulp, characterised by its abundant vasculature and a high concentration of nerve endings, is crucial in facilitating intricate daily activities requiring coordination between the brain and the upper extremity. The neurovascular integrity of the digital pulp is paramount for its contribution to essential functions such as key pinch and tip pinch. Additionally, support from the nail is essential for effectively executing tip pinch and key pinch manoeuvres.

Aim

This retrospective observational study aimed to assess the efficacy of managing the thumb's complex volar soft tissue defects using a heterodigital neurovascular island flap, specifically Littler's neurovascular island flap

MATERIALS AND METHODS

This retrospective observational study was conducted in a tertiary care hospital from August 2016 to August 2019, examining 40 patients with volar thumb injuries, with 14 cases reconstructed using Littler's neurovascular island flaps.

Inclusion criteria

Patients with complex volar soft tissue defects of the thumb, encompassing injuries leading to the loss of skin, soft tissue, nails, nail beds, and terminal phalanx tufts, were included.

Exclusion criteria

Cases in which alternative flap techniques were used for reconstruction were excluded from the study.

Under anaesthesia, the thumb defect was debrided, and a flap from the ulnar side of the ring finger was meticulously marked. After dissecting the vessels, the artery-based flap was harvested and tunnelled to the thumb. A skin graft from the arm was used to cover the donor site. Monitoring, dressing changes, and stitch removal were performed for the thumb flap and hand under anaesthesia. Physiotherapy facilitates optimal movement. All flaps survived, with restored sensation and no pain or cold sensitivity. Emphasising functional recovery as crucial for successful outcomes, this study revealed minimal donor site issues. Data are presented as frequencies and percentages.

RESULTS

The mean age of the participants in this study was 33.57 years, consisting of 13 male patients and one female patient. The primary diagnosis included crush amputation of both the right and left sides. Their left thumbs stem from diverse work-related incidents, such as grinding machines, pressing machines, folding machines, gas cylinders, cutting machines, and lamination machines. Domestic accidents (door crush) and road traffic accidents involving two-wheelers have also been reported. The sizes of the defects ranged from 2.1 x 2.0 cm to 3.5 x 3.2 cm, and the corresponding flap sizes varied from 2.3 x 2.2 cm to 3.7 x 3.5 cm. Pedicle lengths were documented within a range of 4.0 cm to 5.3 cm.

All flaps exhibited successful survival, and the donor site was addressed using a split-thickness skin graft, resulting in a 100% take rate. The average duration of the surgical procedures ranged from 2 to 3 hours, with a mean time of 2.30 hours. The follow-up period was extended from 10 to 15 months with an average duration of 12. Neurovascular island flap transfer is indicated in cases of thumb damage characterised by loss of volar skin and soft tissue and varying degrees of nail, nail bed, and terminal phalanx loss. The utilisation of the neurovascular island flap ensures a stable cover with robust padding, providing enhanced sensation and increased blood flow to replace damaged tissue with similar tissue.

A Littler's neurovascular island flap is typically harvested from the ulnar aspect of the middle finger. This choice is based on the flap's longer length and reduced contact during normal handling compared with the radial aspect of the ring finger. Hand blood flow assessment involves Doppler examination and clinical evaluation using the digital Allen test. This test confirms blood flow to the radial side of the ring finger and the radial side of the little finger when the neurovascular island flap is harvested from the ulnar aspect of the middle finger and the ulnar aspect of the ring finger, respectively. This precautionary measure was taken to prevent ischaemia in the donor finger.

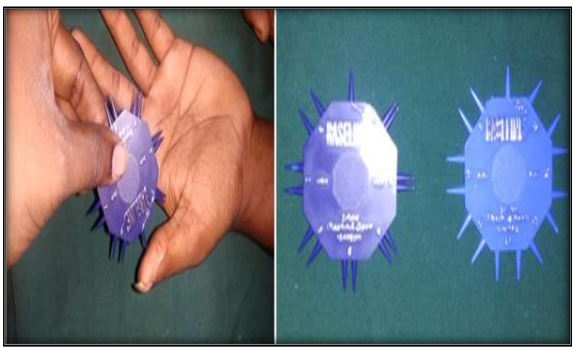

Figure 1: The instrument used in the 2-point discrimination test

ISSN (O): 2687-5365; ISSN (P): 2753-6556

This case report describes a crush injury to the right thumb that resulted in the composite loss of the distal part of the thumb. The damage included approximately 50% of the nail, nail bed complex, and tuft of the terminal phalanx. Additionally, it addresses the substantial loss of volar soft tissues. Figure 2A shows a visual representation of the defect. Figure 2B illustrates the meticulous marking of the neurovascular island flap, while Figure 2C shows the Classical Littler's neurovascular island flap. Successful integration of the flap is depicted in Figure 2D.

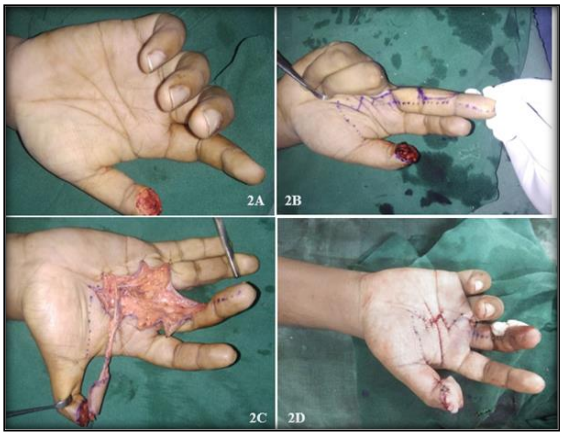

Figure 2: Complete loss of distal part of thumb

The case involved volar amputation of the distal thumb, accompanied by composite loss of volar soft tissue and the terminal part of the terminal phalanx. There was a complete loss of the nail and nail bed complexes. The reconstruction procedure employed for this scenario utilised Littler's neurovascular island flap. Figure 3A shows an image of the initial defect. Figure 3B shows the marking and harvesting of the neurovascular island flap. The Classical Littler neurovascular island flap is illustrated in Figure 3C, and the successful inset of the flap is shown in Figure 3D.

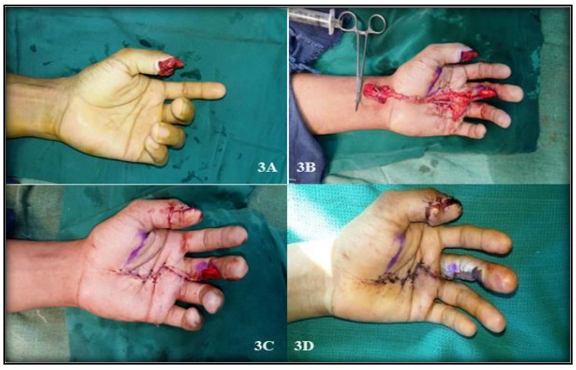

Figure 3: Volar amputation of distal thumb

This case involved diabetic cellulitis of the right thumb, resulting in amputation at the base level of the proximal phalanx. The infection extends into the synovial sheath of the flexor pollicis longus tendon and extrudes into the thenar muscles. The wound was debrided and resurfaced using a Littler's neurovascular island flap. Figure 4A presents an image illustrating the initial defect, whereas Figure 4B depicts the post-debridement status of the wound. In Figure 4C, the harvest and inset of the neurovascular island flap are showcased, and Figure 4D illustrates the well-settled neurovascular island flap.

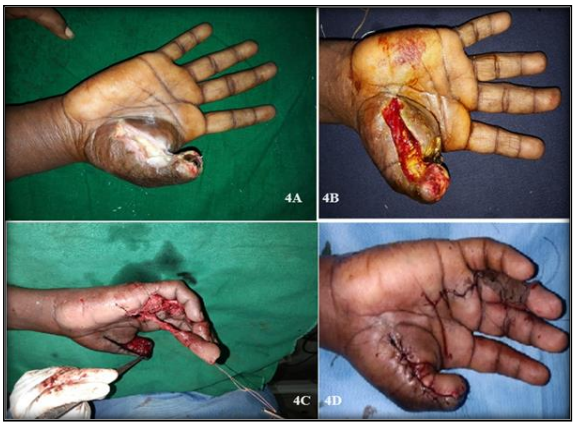

Figure 4: Diabetic cellulitis

In this case, there was a composite loss involving the radial volar part of the soft tissue and a portion of the IP Joint of the right thumb. Reconstruction was performed using Littler's neurovascular island flap. Figure 5A shows an image of the initial defects. The subsequent steps include stabilisation of the Thumb IP Joint using a K-wire, as shown in Figure 5B. Figure 5C depicts the harvest of the Classical Littler's neurovascular island flap, and a well-settled neurovascular island is shown in Figure 5D.

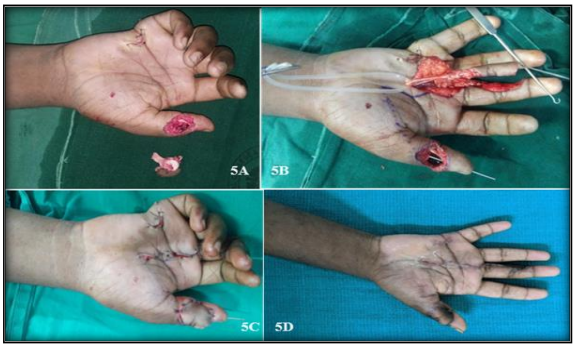

Figure 5: Reconstruction using Littler's Flap

ISSN (O): 2687-5365; ISSN (P): 2753-6556

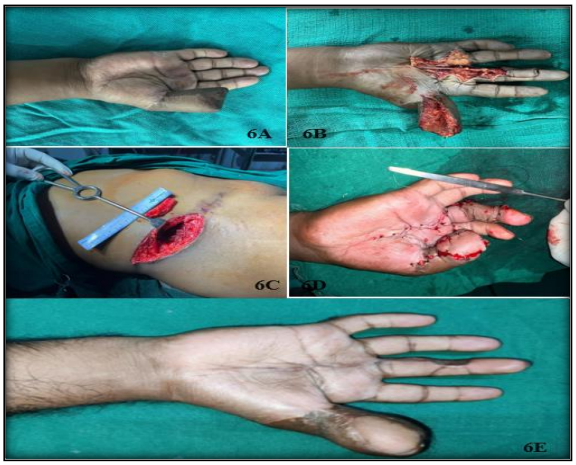

Figure 6: Osteoplastic Reconstruction of the Thumb

In this case, the thumb was reconstructed using a Littler's neurovascular island flap and bone length is augmented using bone graft harvested from iliac cret pegged into the base of the thumb proximal phalanx. Figure 6A shows an image of the Groin flap. The subsequent steps include harvest of the Neurovascular Iland Flap Figure 6B, Illiac bone harvestin Firgure 6 C, of the Classical Littler's neurovascular island flap, and a well-settled neurovascular island is shown in Figure 6E.

DISCUSSION

The tactile sense of the digit's digital pulp or volar aspect is functionally important. Loss of the pulp or volar aspect of a digit causes obvious morbidity when it includes soft tissue and PDN defects.[9] The ideal reconstructive method should cover a soft tissue defect, minimise donor site morbidity, and restore sensation.[10] Many surgical procedures have been reported for resurfacing pulp or volar defects. Reverse digital artery island flap, reverse dorsal homo-digital island flap, and reverse dorsal metacarpal artery flap are common pulp and volar reconstruction techniques associated with satisfactory aesthetic appearance. Still, sensory recovery of the recipient site is less reliable.[11-13] The modified cross-finger flap, innervated by the digital nerve's dorsal branch, is a reliable alternative for repairing pulp or volar defects with better sensory recovery.[14]

While free sensate flaps sourced from the toes or other areas, such as artery perforator flaps, can yield satisfactory aesthetic and sensory recovery with minimal donor site morbidity,[15,16] they necessitate prolonged operating times, advanced microsurgical techniques and entail a risk for anastomotic failure.[17,18]

The traditional heterodigital neurovascular island flap, initially introduced by Littler 4, offers well-vascularised skin coverage, a single-stage reconstruction, and an acceptable appearance for addressing digital pulp or volar defects. However, notable drawbacks include double sensitivity of the flap, cold intolerance, painful neuroma, donor pulp numbness, and scar contracture. In contrast to the traditional heterodigital neurovascular island flap, our modified flap involves the transaction of sensory nerves, which are then coapted to nerves at the recipient site, effectively avoiding the issue of double sensibility of the flap. Given that nerve transfer of the proper digital nerve (PDN) results in numbness of the pulp of the donor's finger, we addressed the PDN defect by employing a segment of the proximal dorsal branch of the PDN (DBPDN) as a free nerve autograft. This approach has demonstrated substantial recovery of pulp sensation.

CONCLUSION

This study demonstrates that Littler's heterodigital neurovascular island flap is a technically feasible, ideal, single-stage, reliable, and sensate flap for reconstructing thumb volar soft tissue.

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ISSN (O): 2687-5365; ISSN (P): 2753-6556