ORIGINAL RESEARCH PAPER

Plastic & Reconstructive Surgery

REVISITING REVERSE HOMODIGITAL ISLAND FLAP FOR THE RECONSTRUCTION OF FINGERTIP DEFECTS

KEY WORDS: Fingertip, Flap cover, single stage

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ABSTRACT

Introduction: Fingertip injuries are one of the most common entities encountered by hand surgeons. Depending on the size, type (transverse, dorsal oblique and volar oblique), and nature of tissue defect various reconstructive techniques are in use ranging from conservative management with secondary healing to microvascular surgeries. Reverse Homodigital Island Flap (RHIF) is a local flap based on the peculiar vascular anatomy of fingers. In our series, we have used this flap for reconstruction of large defects of fingertips and the outcomes were analysed. **Materials and methods:** A single centre prospective study was conducted in our institute among 10 patients (7 males and 3 females) from June 2023 to November 2024 with large fingertip defects (>1.5cm). Only patients with good flow in both radial and ulnar digital vessels and positive digital Allen test were selected for reconstruction with RHIF and the patients were followed up for a period of 6 months. **Results:** The average duration of surgery was 60 minutes, all flaps settled well. One patient had a business end congestion (n = 1; 10%) on POD 1, which was treated conservatively and subsequently settled well. One patient developed pain due to neuroma formation later in the follow up period which was treated with analgesics. Hypersensitivity of the flap was reported by one patient 2 months after the surgery. All patients are having good finger mobility without any stiffness. **Conclusion:** Reverse Homodigital Island flap is an excellent option for reconstruction of large fingertip defects which precludes the need for immobilisation of fingers and hence promoting speedy rehabilitation. Preoperative evaluation of the vascularity of the digit with handheld Doppler has helped in improving final outcome of the flap..

INTRODUCTION

Fingertip injuries are one of the most common entities encountered by hand surgeons. Depending on the size, type (transverse, dorsal oblique and volar oblique), and nature of tissue defect various reconstructive techniques are in use ranging from conservative management with secondary healing to microvascular surgeries. Reverse Homodigital Island Flap (RHIF) is a local flap based on the peculiar vascular anatomy of fingers. In this series, RHIF flap has been used for reconstruction of large defects of fingertips and the outcomes were analysed.

Each finger has a radial and ulnar digital arteries inter-connected by transverse palmar arches at the level of neck of proximal, middle and distal phalanx (Figure 1). In Reverse Homodigital island flap, we raise the flap based on one of the digital arteries and ligating the other one. The flap will receive its blood supply in a retrograde fashion through the opposite digital artery, through the transverse palmar arch at the level of neck of middle phalanx, shifting the pivot point to neck of middle phalanx (Figure 2).

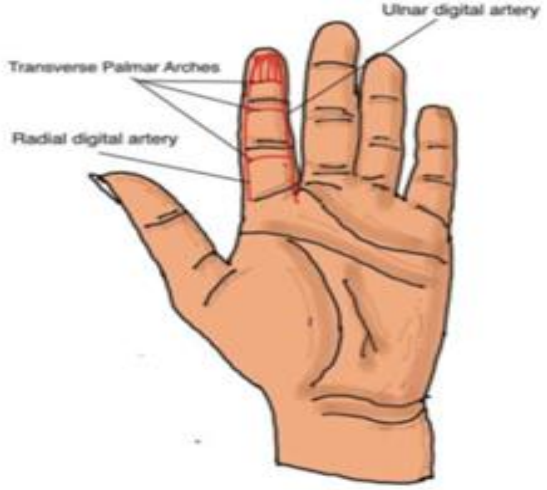

Figure 1- Finger Blood supply

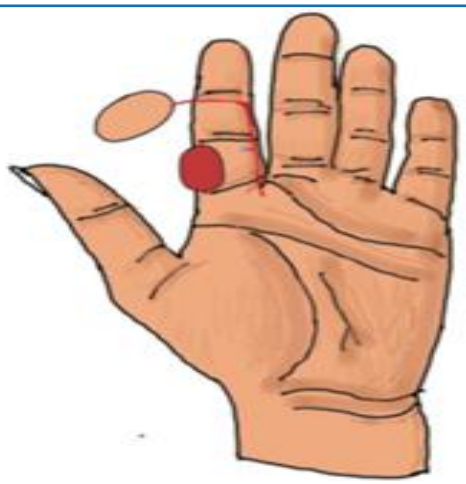

Figure 2-Vascular basis of flap

MATERIALS AND METHODS

A Prospective study was conducted from June 2023 to November 2024 among 10 patients (7 males and 3 females) who has undergone Reverse homodigital island flap for large fingertip defects. Patients were followed up for a period of 6 months and outcomes were analysed.

Eligibility Criteria

Only patients with good flow in both radial and ulnar digital vessels with Positive Digital Allen's test were included in the study. All cellulitic hands with edema and induration were excluded.

Operative Technique

All patients were operated by the same surgeon under regional block (supraclavicular block). Digital block was not preferred to avoid inadvertent injury to digital neurovascular structures. Pneumatic tourniquet and 4x loupe magnification were used uniformly for all patients. After thorough wound debridement of defect, the flap was planned over the proximal phalanx region of the same finger either ulnarly or radially (Figure 3). Ulnar side was preferred for index finger and radial side was

preferred for ring and little finger to hide scar. No side preference was set for middle finger. A neutral line incision was marked between the flap and the defect. Incision made at the proximal end of the flap after inflating the tourniquet and flap raising started from proximal to distal in a plane superficial to the paratenon. Digital NVB identified (Figure 4). and clamped at the proximal end of the flap to confirm the flap and finger vascularity. The clamped vessel and digital nerves were ligated and cut once confirming the vascularity and included in the flap. Isolating the nerve from the vessel was avoided to obviate injury to the periarterial venous plexus. Flap islanding done. Tourniquet deflated for the easy identification of the Proximal Transverse Arch identified at the level of neck of proximal phalanx which was ligated and cut (Figure 5) and hence shifting the pivot point to neck of middle phalanx where middle transverse palmar arch is located. Skin flap raised in subdermal plane in the bridge segment. Inset given to the defect with 5-0 Prolene (Figure 1.6, Figure 1.7,). Skin flaps closed primarily with 5-0 Prolene. Remaining secondary raw area resurfaced with SSG (Supplemental file 1).

Figure 3- Flap marking

Figure 4- Digital Nvb Identification

Figure 5- Ligation and Division of Transverse Palmar Arch

Supplemental File 1 – RHIF procedure photos

A – Defect, B – Flap marking, C – Neurovascular bundle at the tip of the instrument, D – Flap elevation and ligation of proximal volar transverse arch, E, F – Flap inset

RESULTS

The study population had an age range between 18 and 45 years with 7 males and 3 females (Table 1). 3 patients had smoking habit and 1 patient had HTN as comorbidity. Most common finger involved was MF (60%). Average fingertip defect was of size 2.37 cm2 (1.95 cm2 – 3.4 cm2). The mean operating time in our study was 60 minutes. All the cases were operated within the first 24 hours injury without any prior intervention. Complication in the form of business end congestion was seen in one patient on postoperative day – 1 and flap settled well on removal of tight sutures. During the follow up period of 6 months, one patient developed paresthesia due to cut nerve proximal end, which was treated with analgesics and patient responded well to it. Hypersensitivity of fingertips was reported by one patient which was found to improve over time as the sensation from periphery took over. Most of the patients regained sensation of fingertips to normal by 3-5 months. Although the flap looked bulky in initial stages due to adipose tissue, this ironed out over time with the use of finger crepe bandage (Supplemental file 2).

Excellent finger mobility without any joint stiffness was observed in all cases (Video 1).

DISCUSSION

The fingertip is the part of the terminal phalanx that is distal to the insertion of extensor and flexor tendons and comprises the complex and the glaberous pulp(1). Fingertip injuries, despite their seemingly small scale, carry significant weight due to the crucial cosmetic and functional roles these distal structures play in daily life(2). Their exposed location inherently places them at a high risk of traumatic insult, presenting a unique challenge for hand surgeons tasked with reconstruction. The paramount objectives during repair extend beyond simple wound closure, encompassing the meticulous preservation of digital length and intricate function, while diligently avoiding the debilitating complications of stiffness and neuroma formation(3). Fingertip injuries frequently involve not only soft tissue loss but also damage to the digital pulp, exposure of critical underlying structures, and often, concomitant injury to the nail bed complex(4,5).

Over the years, a diverse array of reconstructive techniques has been described to address distal finger defects (Chart 1), particularly those complicated by the exposure of underlying bone, tendon, or joint structures. This constellation of injuries necessitates a nuanced approach from hand surgeons, who must carefully balance the restoration of function, aesthetic outcome, and crucial sensibility in the reconstructed digit. The reconstructive armamentarium available to the surgeons

includes a spectrum of options, ranging from local flaps like V-Y advancements and antegrade homodigital neurovascular island flaps, to regional flaps such as cross-finger, thenar, and the RHIF itself, as well as more complex distant (pedicled groin) or free flap procedures(6). Among these, the reverse flow homodigital island flap (RHIF) has emerged as a valuable and increasingly utilized option.

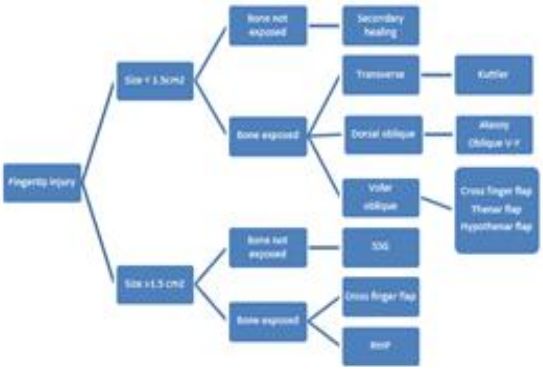

Chart 1 - Treatment Algorithm of Fingerprint Injury

While smaller, volar oblique defects may be effectively managed with local flaps, larger defects often necessitate the consideration of regional or distant flaps, or even replantation when feasible. However, replantation at this distal level is technically demanding and often not a viable option. Cross-finger flaps, a commonly employed technique for larger defects, are associated with prolonged immobilization and a higher risk of stiffness(7), with added burden of second procedure for flap division.

The reverse flow homodigital island flap, pioneered by Lai et al. in their initial study and subsequently validated by Kojima et al., offers a distinct advantage as a single-stage procedure for addressing these complex injuries. Its survival is predicated on the intricate network of three transverse commissural branches that interconnect the two proper palmar digital arteries. This unique vascular architecture allows for a reliable retrograde blood supply to the transferred tissue even after the proximal ligation of one of the main digital arteries(8).

These crucial anastomotic vessels are typically located proximally on the phalanx condyle and dorsal to the flexor tendons, providing a consistent source of perfusion. The versatility of the RHIF is further enhanced by the ability to harvest the flap from various locations along the non-dominant side of the proximal and middle phalanges. Moreover, the size of the flap can be tailored to the specific dimensions of the defect, allowing for adjustments in both the volar and dorsal directions to achieve optimal coverage. The RHIF is specifically raised from the proximal dorsoradial or dorsoulnar aspect of the injured digit, based on a distally based pedicle containing the digital artery, which is intentionally ligated proximally to facilitate retrograde flow. The abundant distal anastomoses between the digital arteries, including the superficial, proximal subungual, and distal subungual arcades, ensure a robust retrograde arterial supply, while venous drainage is effectively achieved through the perivascular cuff of tissue surrounding the pedicle. Furthermore, a significant advantage of the RHIF is the potential to maintain or even restore sensation by including a sensory nerve branch within the flap(9).

Other locoregional options have not gained widespread acceptance due to less favourable outcomes. Thus, the RHIF has become an increasingly favoured technique due to its single-stage nature, leading to shorter hospital stays, earlier return to work, and reduced overall costs. This single-stage approach also facilitates earlier active motion, which is particularly beneficial in the context of acute traumatic injuries(10).

The RHIF provides a reliable retrograde blood supply from the closest viable arteries, and its longer vascular pedicle allows for a wide arc of transposition, ensuring sufficient tissue coverage for distal reconstruction(11). The skin centring the neurovascular bundle of the proximal phalanx, being typically thick and hairless, serves as an ideal donor site for replacing volar pulp tissue(12). Additionally, the fact that both the donor and recipient sites are on the same digit allows for the procedure to be performed under regional anaesthesia if required, further streamlining the process and potentially reducing patient morbidity.

The advantages of the reverse homodigital island flap like reliable blood supply, thin skin flap and good texture(13) comes at the price of sacrificing one of the digital vessels and hence it is contraindicated in patients with negative Digital Allen test.

Clinical studies and experience continue to validate the utility and effectiveness of the reverse homodigital island flap in addressing the complex challenges of fingertip reconstruction. The growing adoption of RHIFs in the reconstruction of traumatic fingertip injuries underscores their perceived efficacy, although the existing body of high-level evidence is still evolving.

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