Journal of Prestieesci in Surgery
open access to scientific & medical research

PrestieeSci
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Volume 01, Issue 01

Outcomes of Using Dorsal Reverse Adipofascial Flap for Fingertip Reconstruction

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Abstract

The fingertip is essential to normal hand function, it is the most distal part of the upper extremity with which we probe our environment. [1,2] Fingertip injury is the most common soft tissue injury of the hand accounting for 45% of all hand injuries. [3] Many surgical techniques are used for reconstruction. In this study, we adopted using dorsal reverse Adipofascial Flap to treat fingertip injuries with exposed bones and evaluate the aesthetic and functional outcomes. Ten patients with fingertip injuries were reconstructed by dorsal reverse Adipofascial Flap without using skin graft but with preservation of the germinal matrix. All the patients were satisfied regarding the functional and aesthetic outcomes of the involved fingers. Apart from two patients who developed hyperesthesia during follow-up periods. The dorsal reversed Adipofascial Flap with preserving germinal matrix and without skin, grafting is reliable and durable over time with acceptable appearance.

Keywords: Fingertip • Flap • Trauma, Reconstruction • Reverse Flap

Introduction

The hand is the most frequently injured part of the body, the majority of hand wounds are punctures or lacerations which can be closed primarily in the acute setting. More severe injuries; however, require the recruitment of additional tissue in order to obtain adequate coverage [1]. The fingertip is essential to normal hand function, it is the most distal part of the upper extremity with which we probe our environment, and provides tactile reception that guides all actions of the hand. In addition, it is a very visible and socially important structure. For these reasons, any injury can result in significant functional and aesthetic defects. The use of proper evaluation and techniques in repairing these injuries is essential in minimizing the subsequent problem [2]. Fingertip injury is the most common soft tissue injury of the hand accounting for 45% of all hand injuries. The middle finger is most frequently involved followed by the ring finger while the thumb is the least once. [3].

Anatomy

Fingertip is defined as every tissue distal to the insertion of the extensor and flexor tendons at the distal interphalangeal joint (DIPJ). It is composed of the bony distal phalanx, the nail plate, the nail bed complex, and a covering of skin and subcutaneous tissue that contains a high concentration of nerve fiber endings [4]. The pulp is a closed space containing Vertical fibrous setae anchoring it to the underlying phalanx's periosteum. The pulp contains the distal arborization of cutaneous lymph vessels and the terminal branches of the digital neurovascular system [5]. The nail apparatus which develops from the primitive epidermis is composed of the nail plate that firmly rests on the nail bed which is in turn composed of the germinal matrix (which produces most of the nail plate volume), sterile matrix, and the roof of the nail fold which is responsible for the smooth and shiny surface of the nail plate. The sterile matrix is closely associated with the periosteum of the distal phalanx while the germinal matrix is immediately adjacent to the extensor tendon insertion shown in (Figure. 1) [6,7].

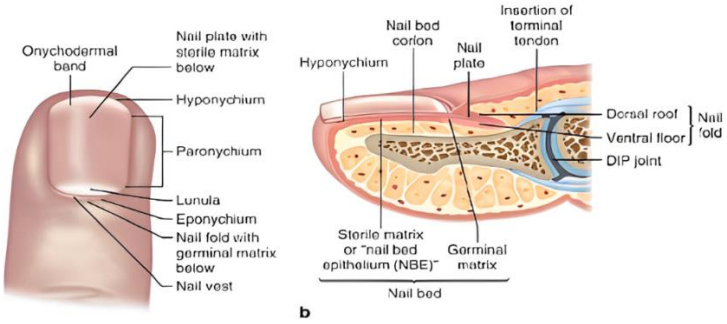

Figure 1. Perionychial of the fingertip.

The arterial supply to the digit is provided through the radial and ulnar proper digital arteries volar to the mid-lateral axis of the digit. As the proper digital arteries approach the DIPJ, a set of dorsal branches is given off just proximal to the DIP joint, and then a second set of dorsal branches are given off just distal to the DIPJ as shown in (Figure.2). Both sets contribute to the superficial arcade at the base of the Distal Phalanx. The superficial arcade perfused the dorsal skin of the fingertip and the nail complex [7]. The venous blood flows through deep and superficial venous systems that are connected by small perforating veins. the larger superficial venous system is composed of dorsal, lateral, and palmar components in the fingertip that form an anastomotic network that forms two veins running adjacent nail root. These two veins combine to form a single mid-axial dorsal vein called the distal venous arch that proceeds proximally and divides back into two dorsal veins at the DIP joint level. The smaller deep system runs as vena comitans to the digital arteries making up the minimally of venous return [8]. The exquisite sensitivity of the fingertip is mediated by numerous sensory organelles and relayed by the distal branches of the digital nerve. These organelles consist of varying arrangements of myelin in concentric patterns and include Pacinian and Meissner's corpuscles and Ruffini end organs. Each digital nerve trifurcates at the level of the DIPJ, sending branches to the nail complex, distal fingertip, and volar pulp [9] (Figure. 2).

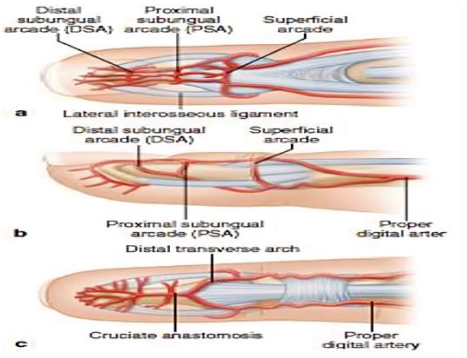

Figure 2. The Blood supply of the fingertip.

Classification

There are various classifications of fingertip amputations; these include those of Allen, Foucher, Tamai, Ishikawa, Hirase, and others as shown in [8] (Figure. 3).

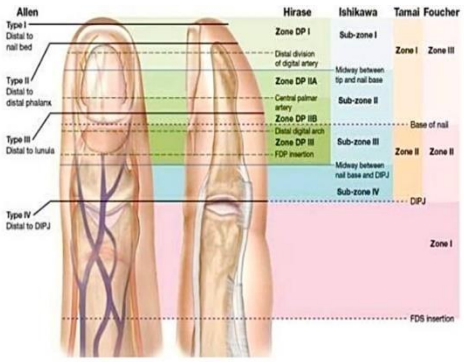

Figure 3. Classification of distal digital amputations DIPJ, distal interphalangeal joint; FDS Flexor Digitorum Superficialis; FDP, Flexor Digitorum Profundis.

Treatment

In general, the principles in the reconstruction of the fingertip include preservation of length, providing sensation, well-padded glabrous skin without neuroma, preserving the nail complex, and using local tissue transfers from the same digit where possible [11]. In the fingertip injuries, the wound is assessed properly so as to choose the best closure option. If the wounds cannot be closed primarily, they can be left to heel by secondary intention supposing no bone or tendon exposure. Wounds up to 2-3 cm can heel by this option within 4-6 weeks. However, secondary intention offers many advantages over flap closure, including improved contour, sensation, and lack of donor site morbidity [12]. When bone is exposed, the question then becomes whether length should be preserved (necessitating coverage of the site) or if sacrifice of length is justifiable in the given situation. Because the primary aim is to restore function to the injured individual, many of the wounds with exposed bone may be converted to wounds with no bone exposed by rongeuring followed by closure. In this study, we adopted using dorsal reverse adipofascial flap to treat fingertip injuries with exposed bone. Skin grafts and/or flap procedures have been described as another option when soft tissue loss does not allow for primary and secondary methods of closure. [13, 14].

Patients and Methods

A prospective study involving ten patients with fingertip injury between 2021 to 2022 conducted at our surgical facility. Their ages were ranging from six to forty-five years (mean age was 23.7). Fingertip injuries were selected in those cases where amputation at the level of lunula with exposed bone. Type3 amputations in Allen classification correspond with our surgical indications for this technique. So, we exclude those cases with amputations proximal to the nail fold.

Full history regarding the trauma and the past medical and surgical status was taken. Routine investigations were done in addition to x-ray films to assess the status of involved phalangeal bones. Informed consent obtained from the patients and /or their parents, and preoperative photograph were taken.

Operative Technique

Apart from one patient who was operated under general anesthesia, all of other patients were operated upon under local anesthesia using plain lidocaine 2% as a digital block under small rubber tourniquet control.

After debriding all the devitalized tissues and trimming of the sharp spikes of exposed phalangeal bones, the nail plate is removed when required. the defect size is measured carefully using surgical ruler, then the flap is designed and marked over the dorsal skin of middle phalanx of the involved finger and extend distally as far as 5mm proximal to the nail fold in a z-shape design as in figure (2.1).

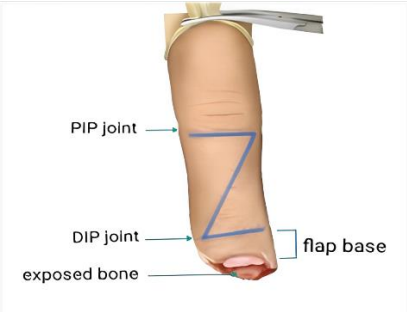

Figure 4. Skin marking.

The length of the flap represents the length of the defect, the length of the remaining part of the nail bed, and the 5mm proximal to the nail fold, this will represent the base of the flap which is based on distal dorsal branches that arise from digital arteries just distal to the DIPJ. In other words, the length of the flap is measured from the nail fold to the most volar edge of the defect plus 5mm as shown in (Figure.5). The width of the flap is the same width of the involved finger.

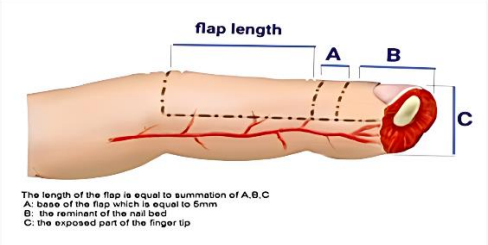

Figure 5. Flap length

The skin flaps are incised and carefully elevated preserving the subdermal plexus and exposing the underlying adipofacial tissues, the adipofasial flap is designed in a distally based manner starting 5mm proximal to the nail fold which represents the base of the flap as in (Figure. 6A). After incising the adipofasial flap, it is elevated off the underlying extensor tendons leaving intact paratenon in a retrograde manner till reaches the DIPJ (dissection of the flap does not pass distal to the DIPJ in order to preserve the vascularity of the flap). then turned down to cover the defect and fixed in place using 4\0 polyglycolic acid suture in a simple interrupted manner, then the two skin flaps returned and sutured to their normal place using 4\0polyproline suture as in (Figure. 6B).

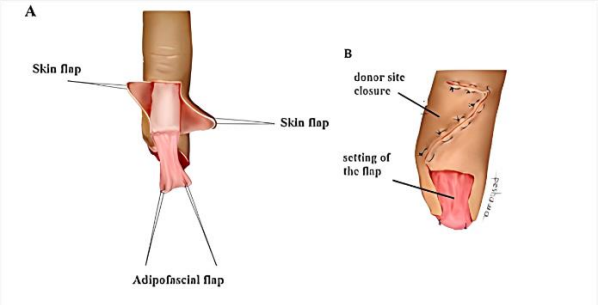

Figure 6a. Steps of operation: A skin flap incision with elevation of adipofascial flap, 6b. The setting of the flap and donor site closure.

Results

Table 1. Patient's data

Patient	Age	Sex	Finger	Defect type	Mechanism of injury
1	6	Female	RT little	Transverse	Door injury
2	45	Male	RT index	Dorsal oblique	Explosive injury
3	20	Male	LT middle	Transverse	Crush injury
4	19	Male	LT middle	Transverse	Knife injury
5	29	Male	LT middle	Volar oblique	Sow injury
6	20	Male	LT middle	Transverse	Knife injury
7	21	Male	LT middle	Radially oblique	Bullet injury
8	35	Male	LT index	Transverse	Shell injury
9	25	Male	RT ring	Transverse	Crush injury
10	17	Male	RT middle	Transverse	Knife injury

Figure 7. 17years old man knife injury of right middle finger Transverse injury with exposed bone.

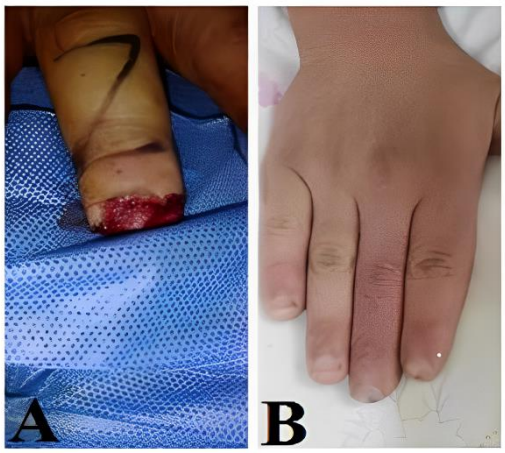

Figure 8a. 6-year-old child with door injury of right little finger Transverse injury with exposed bone. 8b. post-operative view 6-months later shows in complete nail plate growth.

Discussion

Fingers are our most exposed appendages and the most susceptible to injury. In today's society, industrial, construction, firearm, and motor vehicle accidents are the most common causes of severe mangling injuries of the digits [9]. The objective in the management of soft tissue injuries of the hand is to achieve primary wound healing, in order to minimize the inflammatory reaction, scar formation, and joint stiffness. The choice of treatment is based on the mechanism of injury, the size of the defect, location and status of the wound, and injuries to another part of the hand, as well as, the patient's age, sex, general health, and occupation [15]. Ideally, we should attempt to close a wound with skin that has the same properties and qualities as the tissue that was lost Unfortunately, it is not always possible to use "like with like "tissue because of the extent of the defect or the location and mechanism of the injury [16]. The treatment of fingertip amputations has undergone substantial change in the last 40 years. Early innovators such as Kutler and Atasoy proposed local advancement flaps, the thenar and the cross-finger flaps, and Hom digital and Hetero digital Island flaps are axial pattern flaps that maintain blood flow through a specific vascular pedicle [8].

Adipofascial flap was first described by Lai et al. They used it first as a random flap in two cases to cover defects over the DIPJ [17]. Since then, many surgeons adopted this flap to cover different defects on the fingers. Sabah H. N. Used this flap for reconstructing composite tissue defects at the dorsal surface of the fingers with exposed bone, tendons, or joints. He gained good functional results [21]. Dimitrios H. Laoulakos et al. used the dorsal reverse adipofascial flap for reconstructing nine fingertip injuries [18]. They used skin grafting over the flap with removal of the germinal matrix to avoid ungual residues. Hence there was no growing nail in the involved fingers but the overall functional results were satisfactory. Mubin Hosnuter et al.used the same flap and skin grafting in nine fingers but with the preservation of germinal matrix[19]. They claimed that if excision of the germinal matrix is adopted, remnants may still be present, resulting in the growth of nail spicules that may be uncomfortable, inconvenient, and cosmetically unpleasing. Similar to Mubin, Antonio Rampazzo et al. used this flap to reconstruct finger injury with preservation of germinal matrix but without using a skin graft depending on the secondary intention.

They achieved promising aesthetic and functional results [20]. In this study, we adopted Antonio's approach to treat ten finger injuries. Regarding the aesthetic appearance, all the patients and the third eye observer were satisfied with the final appearance and had no concerns about the minimal scarring that was present in the injured area. The appearance of the nail plate also was accepted by all of the patients. Hence, we are in agreement with the results of Mubin and Antonio who preserved the germinal matrix. Functionally, our results go with those of Dimitrios, Mobin, and Antonio in that the flap has proved to be a reliable cover.

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Apart from two patients who suffered from hyperesthesia, all of the other patients experienced nearly normal sensations at the tip of their involved fingers after 2-3 months of dysesthesia. Hence, we can state that using a dorsal reverse adipofascial flap without matrixectomy and without skin graft can preserve the length of the finger, restore gripping function, and restore an acceptable degree of aesthetic appearance. So, we recommend this technique in selected cases. However, a larger series of patients and a longer follow-up period are required to prove these results.

Conclusion

The dorsal reversed adipofascial flap with preserving germinal matrix and without skin grafting is a simple two stages operation for reconstruction of fingertip injury that provides a reliable coverage with acceptable appearance. Without donor site morbidity, it is not a must to put a skin graft over the flap.

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