

Cross finger flap for reconstruction of complex finger defects

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ABSTRACT

Traumatic hand injuries are commonly due to machinery accidents, road traffic accidents and are usually severe. Among the hand injuries, fingertips are most frequently injured. Injuries to the underlying structures of hand carry the potential for serious handicap and can lead to significant functional and cosmetic deficits. Phalangeal defects exposing bone and tendons always require flap coverage. Cross finger flap is a good option to cover such complex phalangeal defects. Over two year's period, twenty-two patients with complex phalangeal defects were operated. Traditional dorsal cross finger flap coverage was performed after detail explanation of the procedure. All flaps survived with good functional and aesthetic outcomes. The defects size ranged from 1.8×1.5 cm to 2.4×1.6 cm. Donor site defects covered with split thickness skin graft and well taken. Temporary joint stiffness was present following flap separation and resolved completely after physiotherapy.

Dorsal cross finger flap is a versatile flap for the palmar phalangeal region defects, lateral oblique, volar oblique and transverse finger amputation defects. The flap is simple to perform, reliable and allows preserving the length, contour, and retention of sensation and function of the digit.

Keywords: Cross finger flap, Flap

INTRODUCTION

Hand injuries are a major proportion of injuries seen in the emergency department of many hospitals worldwide.¹ Among traumatic injuries, one third affects the hand, with fingertips being the most frequently injured portion of the hand.² Lacerations and avulsion injuries are commonly seen in older children and young adults.¹ In regards to children, door crush injuries are the most common cause of injury. The pattern of injuries varies from simple laceration to soft tissue defects exposing vital structures. The fingers most commonly injured are middle finger followed by index, ring, little finger and thumb.³ For injuries with superficial soft-tissue loss, healing by secondary intention or skin grafting is the method of choice but complex defect with exposed bone or tendon and in different types of amputation, options include, bone shortening and primary closure, which is not always easily accepted by patients and patients' relatives. Such type of injuries carries the potential for serious handicap and may result in short term or long-term impairment of function. The dorsal cross finger flap is usually the best option for the phalangeal defects with exposed vital structures.⁴

Gurdin and Pangman described the cross finger flap originally termed as trans digital flap in 1950, since then it has been used successfully for reconstruction of finger.^{4,5} It has become the single best reconstructive method for fingers with significant soft tissue defect exposing vital structures and reconstruction of lateral

oblique, volar oblique and transverse finger tip amputations preserving the length of the digit.^{6,7}

Surgical Anatomy

The flap is elevated from the dorsum of adjacent finger of the injured finger and the hinge of the flap is on the side of the finger to be repaired. In contrast to the palmar skin of hand, dorsal skin of the hand is thin and free movable. The underlying layer of the loose structured subcutaneous tissue enables the skin to move freely and easy to harvest the flap.

The terminal branches of the radial and ulnar digital arteries cross the inter-phalangeal joint and supply the dorsal skin of distal phalanx. The middle and proximal phalanx dorsal skin consist of 2 constant symmetrical branches of arteries which are direct branches of radial and ulnar proper digital arteries that provides excellent retrograde flow.⁸ Areolar tissue over the extensor and paratendon provides a vascularized bed for skin grafting.⁹

MATERIALS AND METHODS

The work is based on 22 cases performed in Nepal Medical College Teaching Hospital and 2 tertiary center of Kathmandu, Nepal between 2010 and 2012. The soft tissue defects on the palmar aspect of distal, middle and proximal phalangeal regions of the finger and lateral oblique, volar oblique and transverse finger tip amputation with exposed bone were included for the procedure. All investigations were done according to the

protocols of the hospital for surgery. The cross finger flaps were raised from non-injured adjacent finger in all cases to cover the defect. A thorough radical debridement was performed in all cases prior to definite procedure. A written consent was obtained from all patients after detail explanation of the procedure and requirement of flap division after 3 weeks.

Surgical Technique

The surgery was performed under regional anesthesia (brachial block). Tourniquet was used in all cases and the procedure performed with surgical loupe magnification. The defect was measured and marked over the adjacent donor finger to elevate the flap with a sterile paper. The adjacent donor fingers were selected which would be most comfortable for the patient in an immobilization state following surgery. The flaps were raised along with dorsal veins, fat and fascia and opened like a page of the book with the base on the contralateral side of the recipient finger, without crossing the neuro-vascular line of the digits. (Fig. 1).



Fig. 1 : Flap rose from the middle phalanx index finger

The flap was inset to the defect with non-absorbable suture avoiding any undue tension (Fig.2) and Split thickness skin graft applied over the donor site. (Fig. 3) The Skin graft was harvested from the anterior lateral aspect of thigh in all our patients. The fingers were immobilized for 3 weeks. After 3 weeks, flap was divided



Fig. 2: Flap Inset over the proximal phalangeal defect index finger

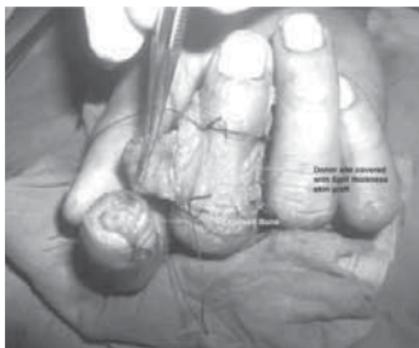


Fig. 3: Donor site covered with split thickness skin graft

RESULTS

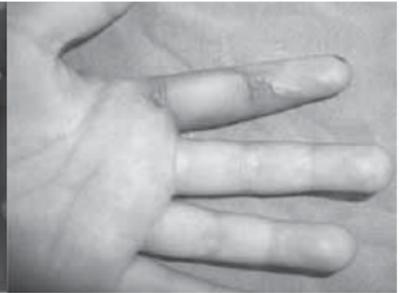
Between 2010 and 2012 period we have reconstructed 22 patients aged seven to 55 years with soft tissue defects of different size on distal, middle and proximal phalangeal region with exposed bone and tendon and lateral oblique, volar oblique, transverse finger amputation. The most common cause of defects in our study group was machinery injury which consisted of 12 and 5 door crush injury followed by 3 road traffic accident, 1 post electrical injury defect and 1 post infective raw area. The most commonly injured finger was index finger and middle finger. We used cross-finger flap from the adjacent non-injured finger in all 22 patients. The flaps survived completely and healed uneventfully in all of the cases and showed good result regardless of the width and length of the flap. The size of the flaps were 1.8×1.5 cm to 2.4×1.6 cm. (Table-1)

The split thickness skin grafts were used to cover the donor sites that were well taken and cosmetically satisfactory. The mean surgical duration was 80 minutes. All cross finger flaps were detached in three weeks interval. Considering forearm as an aesthetic area, we harvested skin graft from anterolateral aspect of the thigh after locally infiltrating with 2% xylocaine.

Initially dryness of the flap was observed and there were no sensations over the flaps. We observed recovery of sensation 3-6 months post surgery; joint stiffness as a result of immobilization for flap stabilization was noted temporarily that resolved completely following physiotherapy after separation. Long-term joint impairments were not seen. All the patients were satisfied with the cosmetic as well as functional outcomes.



Case no 7. 10 Years old child, Electrical Injury,



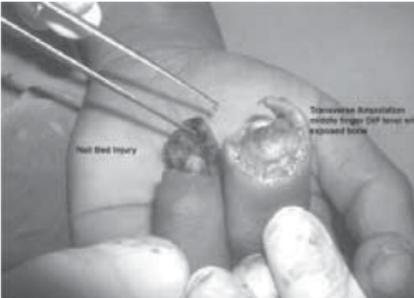
Post OP after 1 Month Soft tissue defect over the proximal phalangeal region with exposed bone and tendon



Case no.1. 21 Years male, Machinery crush injury index



Post OP after 1 Month finger with exposed bone



Case no 21. 45 Years old female, Machinery crush injury



Post OP after 1 Month Transverse amputations of middle finger DIP level and Nail Bed Injury (Avulsion of Nail Bed) ring finger

DISCUSSION

There are various treatment options to treat fingertip injuries and phalangeal defects with out exposed bone and tendons. The procedure should range from simple to more complex such as wound healing by secondary intention, split thickness skin graft and flap where as in complex phalangeal defects and different types of amputations, local advancement flap should be preferred in order to restore the length, function and sensibility

with good cosmetic outcome.

Simple procedures like wound healing by secondary intention is appropriate for pulp tissue loss and superficial smaller defects (size less than 1 cm²) however it takes 3 to 8 weeks to heal completely by wound contraction and epithelialization.^{10,11} Larger defects should be treated with split thickness skin (STSG) or full thickness skin graft (FTSG) as it provides durable skin, less tender. FTSG contract less and maintain better sensibility than STSG.

Table 1.: The site, size of the defect, donor site and the complications

Case no	Age/Sex	Defect	Donor finger	Size of the defect	Complications
1*	21 yrs./M	Distal Phalanx index finger	Middle	2.1 x 1.5 cm	Nil
2	25 yrs./M	Distal Phalanx index finger	Middle	2.1 x 1.6 cm	Nil
3	7 yrs./M	Proximal Phalanx index finger	Middle	1.8 x 1.5cm	Nil
4	18 yrs./M	Middle Phalanx index finger	Middle	2.1 X 1.4 cm	Nil
5	35 yrs./F	Middle phalanx middle finger	Index	2.3 x 1.5cm	Nil
6	22 yrs./M	Middle phalanx middle finger	Ring	2.1 x 1.5 cm	Nil
7*	10 yrs./M	Proximal phalanx index finger	Middle	2.0 x 1.6 cm	Nil
8	37 yrs./F	Middle phalanx middle finger	Index	2.2 x 1.6 cm	Nil
9	25 yrs./M	Distal phalanx ring finger	Middle	2.1 x 1.5 cm	Nil
10	47 yrs./M	Middle phalanx ring finger	Middle	2.3 x 1.6 cm	Nil
11	31 yrs./M	Middle phalanx ring finger	Middle	2.2x 1.6cm	Nil
12	27 yrs./M	Distal phalanx ring finger	Middle	2.2 x 1.5 cm	Nil
13	55 yrs./M	Distal phalanx ring finger	Middle	2.4 x 1.6 cm	Nil
14	31 yrs./F	Distal phalanx little finger	Ring	2.2 x 1.5 cm	Nil
15	46 yrs./M	Distal phalanx little finger	Ring	2.3 x 1.6cm	Nil
16	39 yrs./M	Index finger Amputee, DIP Level	Middle	2.2 x 1.6 cm	Nil
17	41 yrs./M	Little Finger Amputee, DIP Level	Ring	2.2 x 1.6 cm	Nil
18	24 yrs./M	Index finger Amputee, DIP Level	Middle	2.1 x 1.5 cm	Nil
19	22 yrs./F	Index finger Amputee, DIP Level	Middle	2.1 x 1.6 cm	Nil
20	18 yrs./M	Index finger Amputee, DIP Level	Middle	2.0 x 1.5cm	Nil
21*	45yrs./F	Middle finger Amputee, DIP Level	Index	2.0 x 1.6 cm	Nil
22	46 yrs./M	Middle finger Amputee, DIP Level	Index	2.1 x 1.6 cm	Nil

* All soft tissue defects over the palmar region of the finger

Finger injuries with significant soft tissue defects exposing bone and tendons, coverage must be obtained by local flaps. Soft tissue deficit is the major problem while reconstructing these fingers, so choice of flap should be chosen according to the availability of sufficient soft tissue to elevate the flap.

In complete finger amputation cases, level of amputation should be accessed at first to make a decision of replantation. Amputation below the distal interphalangeal joint micro vascular reconstruction should be considered if possible. Amputations accompanied by severe crush injuries that are not suitable for replantation should be covered by some local flaps. In cases of larger defects, free flap reconstruction from planter area of toes are preferred, however, it requires expertise and advance resources. Shortening and closure should be preferred with the patients who are not suitable for the flap procedure and patients with advance age.¹²⁻¹⁵

Local flaps are superior in terms of sensory recovery and should be considered as the choice of flap when enough soft tissue is confined to the defects. It maintains similar quality, texture and color to the recipient site and does not require a skin graft. V-Y advancement flap is appropriate

for dorsal oblique and palmar oblique amputation. Kutler flap is indicated for distal transverse amputation when adequate soft tissue on both radial and ulnar side is present. Small flap size and advancement difficulty are the major disadvantages.¹⁶

A neurovascular island flap requires sacrifice of one side of proper digital artery and nerve and sensory recovery on the donor site is relatively poor.¹⁷

Regional flaps are indicated in larger digital defects that do not permit local flaps. Thener flap and cross finger flaps are the most commonly used flaps. The thener flap is not suitable for small finger defects due to difficulty in maintaining position of the finger.¹⁸

Cross finger flap is able to cover the two-thirds pulp defect, larger defects in phalangeal region and in all types of amputation with significant amount of tissue loss. It provides satisfactory soft tissue padding and adequate sensibility.

Sturman and Duran have found in their 235 patients that the cross finger flap is superior to these other methods in terms of sensibility, cold intolerance and size.^{19,20} Since its introduction in the literature 30 years ago,⁴ it has become the single best reconstructive methods for the

significant soft tissue loss of pulp and palmar phalangeal region of the finger,^{6,8} however it couldn't achieved wide popularity due to requirement of second surgery, division and inset of the flap after 3 weeks and delay in return to work. Despite the weakness, it saves the time for definite secondary reconstruction than multiple unsatisfactory primary procedures and it allows the workers to return to previous job.

In various article we have found the modifications of flap and also has been used as a "one stage" procedure and also as a multiple cross- finger flaps,^{21, 22} nevertheless, it should not be performed when surgeons are less experienced in a poor infrastructures setting.

Several other articles insist on innervated cross finger flap and have compared the recovery of sensation in between innervated and non-innervated flap. It has shown that it is better in comparison to the traditional cross finger flap and two point discrimination test which is 1.5 – 2 times greater than in non- innervated ones.²³⁻²⁹ There is no doubt that sensation is far better in re innervated flap how ever we performed non innervated cross finger flap and the recovery of sensation were satisfactory in all our cases.

In our study, radical debridement followed by flap coverage was performed in one setting except in 3-post infectious cases in which coverage was done after 24 hours of debridement. The flap was elevated with meticulous dissection not crossing the neuro-vascular line with adequate radius of rotation to cover front and lateral defects with out any tension. All flaps survived completely with out any marginal necrosis and donor site morbidity. We have observed that to improve flap survival rate, sub-fascial meticulous elevation, tension less inset of the flap and comfortable position of donor and recipient fingers should be maintained. With this method, we were able to achieve the goal of reconstruction that is restoring normal or near normal form, function with preserved length, sensation and aesthetics.

This method is advantageous because it is a simple and versatile, an excellent option for palmar phalangeal region defects, lateral oblique, palmar oblique and transverse amputation defects. The flap is superior in terms of sensibility, function, pain and cosmetic outcome because of the skin thinness, good flexibility, and retention of contour. It avoids shortening of finger and preserves length in different types of finger amputation.

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