

## Role of Local and Regional Flaps in Fingertipinjuries - A Prospective Study.

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### I. Introduction

Fingertip is defined as the skin, soft tissues, bone and nail of the digit distal to the insertion of the extensor and flexor tendons at the base of the distal phalanx.

They are the most common injuries of the hand and can lead to a significant functional and cosmetic deficit if they are not treated appropriately.

The fingertips are used for expression, for defence, for identifying and picking and holding objects. They are the instruments of reading in blind people. As man explores his surroundings, they act as sensory probes, which are so richly innervated that they are called the eyes of upper limb.

The most common injury to the hand requiring attention in the emergency room is a fingertip injury. These injuries may occur after thermal or traumatic accidents which may result in full thickness tissue loss with or without bony exposure. Achieving an excellent result in repair of fingertip injury remains a challenge in terms of providing not just adequate but appropriate soft tissue reconstruction and achieving a fingertip that has a normal pain free sensibility.

In choosing a method of reconstruction, one must consider the factors such as number of digits injured, location of the wound, primary function of the digit, occupation, sex, age, time factor, facilities available and above all socio-economic factors.

Fingertip injuries are classified into four types based on the level of injury.

TYPE 1: Injuries involve only the pulp.

TYPE 2: Injuries involve the pulp and nail bed.

TYPE 3: Injuries include partial loss of distal phalanx.

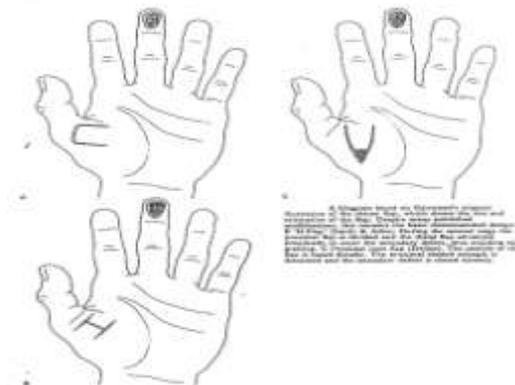
TYPE 4: Injuries are proximal to the lunula.

This classification is useful as it allows the surgeon to help organize treatment options. The basic principle in treatment of fingertip injuries is to select a technique that is simple reliable and cost effective.

**Various local and regional flaps used for coverage of fingertip injuries are:**

#### 1. Thenar Flap:

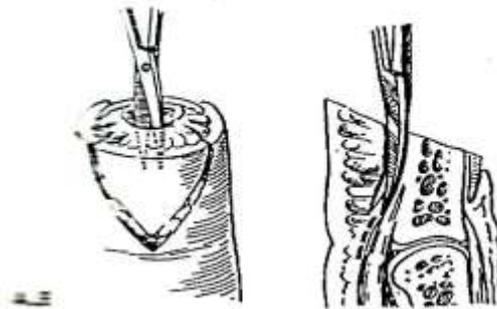
Thenar flap is used for the reconstruction of the tips of the index and the middle fingers. The thenar flap, based proximally or distally is elevated off the muscles of the thenar eminence. The index or long fingertip is flexed in to the palm to meet the flap, and the donor site is skin grafted.



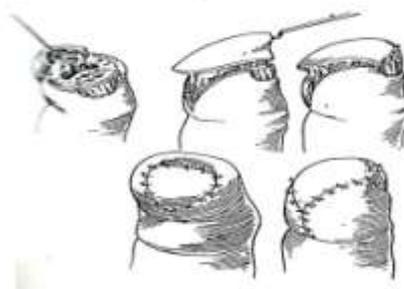
**2.Volar V-Y Flap:**

The volar V-Y flap is used for finger tip amputation and is suited for transverse mid nail or dorsally directed tip amputation. The apex of the V is placed on distal digital crease. The base of the triangle, which lies on the free distal margin, should be marked as wide as the nail bed but no wider or the tip may have a flattened appearance. The flap is made by cutting through the skin but leaving the subcutaneous tissue intact. The flap is then mobilized by separating its deep attachments from the periosteum distally and the flexor sheath proximally, especially at the level of distal flexion crease. The closure of the flap is commenced at the apex, creating the vertical limb of the Y and so advancing the flap. Overall results with this technique have been good but dysaesthesia and cold intolerance have been reported.

**VOLAR V-Y FLAP: OPERATIVE TECHNIQUE**



A,B: The skin is incised, leaving the subcutaneous tissue and vascular supply intact. The fibrous septa are then cut, releasing the flap from the periosteum and the flexor tendon sheath.

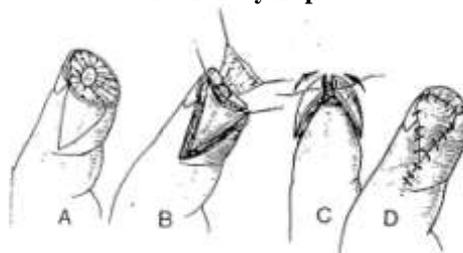


A-E: The flap is advanced distally and sutured to the nailbed. Any excess subcutaneous tissue along the base of the flap may be removed to facilitate closure. Starting proximally, the remainder of the incision is closed in a V-Y fashion. It is essential to avoid tension.

**3.Local V-Y Advancement Flap (Or Lateral V-Y Flap)**

This flap is raised from the sides of injured digit and advanced to cover the amputated tip. This is best suited for distal transverse amputations with exposed bone where material tissue remains intact and proximal nail bed preservation is desired.

**lateral v-y flap**

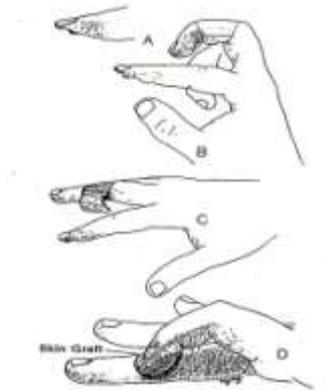


- A) A midnail transverse amputation with bilateral flaps drawn on the sales of the digit. B) Flaps cut through the skin only, dividing fibrous septa from the bone, but preserving the arborising digital nerves and vessels  
C) The flaps advanced gently over the tip. D) The flaps sutured together in the midline over the tip, and the donor defect closed in a Y.

#### **4. Cross Finger Flap:**

cross finger flap for volar-oblique amputations through the middle of the distal phalanx. The rectangular flap is raised on the dorsum of a finger middle phalanx with the base of the flap along the medial or lateral side and the flap turned over through 180 degrees. Division of the cleland's ligament in the base of the flap improves it's mobility and if done carefully should not endanger the palmer digital artery branches which support the flap. The donor defect is covered by full thickness skin graft. The tension or twisting of the flap can be avoided by pinning the digits together. Multiple digits can be covered by means of this technique, each successive ulnar finger serving as a donor site for it's radial neighbor. Cross finger flaps are divided across the base in 14 to 21 days. Variations of cross finger flap subsequently given by many other authors.

#### **Standard Cross-Finger Flap: Illustration Of Operative Technique**



Standard cross finger flap. A: A volarly directed tip amputation with exposed bone. B: A cross finger flap centered over the dorsum of the middle phalanx of an adjoining finger with the base along the midlateral line. C: The flap elevated at the level of the extensor tendon peritenon, which is preserved. D: The finger flexed and the flap sutured over the defect, with the donor site skin grafted.

#### **5. Digital Neurovascular Island Flap:**

This flap transfer the soft tissue of the border of a finger with its neurovascular bundle to the thumb. The ulnar aspects of long or ring fingers are usually the donor sites. A digital Allen's test is used to assess the arterial flow of the donor finger and the digit adjacent to the flap because the adjacent vessel is ligated. The palmar incision radiate in a zigzag fashion from the central palm to the bases of the flap and the recipient site. At the bifurcation the proper artery to the adjacent finger is isolated. The flap is elevated proximally from its distal end leaving the thin areolar layer over the extensor tendons and the flexor sheath. On reaching the proximal end of the flap, the nerve-vessel pedicle is dissected in to the palm, preserving the adherent fatty areolar tissue. The proper digital vessel to the adjacent finger is then severed and ligated freeing the common digital artery. Slightly more proximally the dorsal interosseous branch of the common digital artery must also be divided as well as several small arterial branches. The proper digital nerve and the artery with their attendant areolar investment are thus mobilized to the central palmar rotation point from superficial arterial arch. The incision from the rotation point to the recipient bed is opened. Beneath the zigzag flaps, a straight subcutaneous course atleast 1 cm in width is prepared for the neurovascular pedicle. The flap is transferred to the recipient site. The donor defect is resurfaced with a free graft.

#### **6. Volar Advancement Flaps:**

In these flaps bilateral mid-axial skin incisions are made proximally along the dorsal aspect of the IP joint flexion creases. The entire volar skin of the digit is elevated at the level of the flexor tendon sheath, maintaining the neurovascular bundles within the flap. The digit is flexed and the flap advanced distally to cover the tip. The flap in all cases can be advanced only by about 1cm and is used in selected thumb tip amputations.

#### **7. Rotation Advancement Skin Flap For The Thumb Tip.**

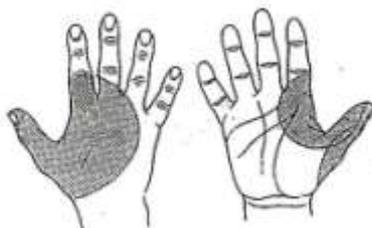
The flap is based on the radial side of the thumb. The flap is elevated from the defect just dorsal to the mid-axial line of the ulnar side of the thumb. At the level of MP crease , a back cut is made to allow the flap to

rotate and advance in to the defect. Once the flap is inset, a triangular shaped defect is created at the base of the thumb. The open area may be resurfaced by a skin flap transposed from the dorsal skin of the first web. The flap can be 2cm in width. The thumb is kept in palmer abduction for about 10-14 days.

#### **8. Neurovascular Skin (KITE):**

Neurovascular skin (KITE) flap from the index finger to the thumb (**first dorsal metacarpal artery flap**). The flap extends proximally from the level of the MP joint and distally to the level of PIP joint. The neurovascular pedicle contains the first dorsal metacarpal artery, one or two dorsal nerves and the terminal branches of radial nerve. A reverse S-shaped incision is made over the radial border of the second metacarpal. The fascia overlying the interosseous muscle is then cut at its radial side and lifted from the muscle en-bloc with the artery. The dissection then proceeds to free one or two nerves and the sensory radial nerve branches. The length of the neurovascular pedicle provides a wide arc of rotation and allows the flap to reach even to the tip of the thumb. The kite flap is a single stage procedure that provides the neurovascular skin cover.

#### **First Dorsal Metacarpel Artery Flap Planning**



The outline of a possible flap is marked with diagonal lines. The center of arc of rotation lies at the proximal end of the dorsal incision and the limits of arc of rotation are indicated by shading.

#### **9. Cross Thumb To Index Fingertip Skin Flap:**

The flap has a randomly based circulation, preserving paratenon over extensor pollicis longus tendon to allow donor site to be skin grafted. The base of the flap is placed on the radial side of the thumb in a slightly oblique direction. Flap necrosis can be avoided by pinning the index finger to the thumb in the optimal position.

#### **10. Reverse Dermis Cross Finger Flap:**

In these flaps the raw under surface has to be covered with a free skin graft. This flap can be used for reconstruction of an avulsed eponychial fold. It can also be used for reconstruction of large full thickness sterile matrix nail bed defects with exposed bare distal phalanx.

#### **11. Triangular Lateral Neurovascular Island Skin Flap:**

This procedure provides durable skin with normal sensibility in a single stage operation. This is an island flap based on one of the neurovascular bundles, preferably on the ulnar side of the digit. The triangular island is dissected free down to the bone with its full complement of subcutaneous tissue.

Volar cross finger flap is an excellent method of reconstruction for major dorsal oblique, guillotine, or volar amputation of the distal thumb. Positioning is much easier than a dorsal cross finger flap from the index finger and the donor site is hidden on the volar side of the finger. There is a limit to the size of volar flaps that can be safely elevated. The flap is elevated in a plane just superficial to the tendon sheath. If the tissue has been lost only on the volar surface of the thumb, the flap should be based ulnarly. Most cases of guillotine or dorsal oblique thumb amputations are more suitably handled by a flap based on the radial side of the finger.

## **II. Material And Methods**

A prospective study of 30 patients having sustained fingertip injuries needing coverage by local and regional flap coverage was conducted in GMC hospital Jammu, over a period of one year w.e.f 1st November 2013 to 31st October 2014. All patients were thoroughly investigated and examined according to the proforma.

An adequate history was taken in all cases, including cause of trauma, the time of injury, and the presence of pre-existing medical conditions. The patient's age, hand dominance, occupations were also noted to choose the type of reconstruction for a particular injury.

A thorough examination of the injured fingertip, including severity of injury, the status of the distal phalanx, the nail bed circulation, sensibility and tendon function was noted. The examination of the normal hand and injured hand was carried out and the findings recorded.

### III. Results

#### Age Distribution Of Cases

**Table 1**

AGE GROUP	NO. OF PATIENTS	PERCENTAGE
< 10 years	3	10.0 %
11-20 years	2	6.7 %
21-30 years	8	26.6 %
31-40 years	13	43.3 %
41-50 years	2	6.7 %
51-58 years	2	6.7 %
<b>Total</b>	<b>30</b>	<b>100.0 %</b>

Out of a total of 30 patients, the maximum number of cases were in the range of 31-40 years and accounted for 40% of cases. Mean age of the patients was 29.3 years. Youngest patient was 3 years old and the oldest patient was 58 years old.

#### Sex Distribution Of Cases

**Table 2**

SEX	NO. OF PATIENTS	PERCENTAGE
Male	23	76.7 %
Female	7	23.3 %
<b>Total</b>	<b>30</b>	<b>100 %</b>

There were 23 males (76.7 % cases) and 7 females (23.3 % cases) in our study. The male to female ratio was approximately 3:1.

#### Occupation Wise Distribution

**Table 3**

OCCUPATION	NO. OF PATIENTS	PERCENTAGE
<b>Labourer /Factory Worker</b>	20	66.7 %
<b>School Going</b>	5	16.7 %
<b>In service</b>	3	10.0 %
<b>House wives</b>	2	6.6 %
<b>Total</b>	<b>30</b>	<b>100.0 %</b>

Most of the affected patients were labourers (63.3 % cases). Children and school going group was the next affected (16.7 % cases).

#### Cause Of Injury

**Table 4**

CAUSE OF INJURY	NO. OF PATIENTS	PERCENTAGE
Trap door Injury	5	16.7 %
Fall of heavy objects	8	26.7 %
Knife / sharp objects	5	16.7 %
Road traffic injury	8	26.7 %
Others	4	13.2 %
<b>Total</b>	<b>30</b>	<b>100.0 %</b>

Fall of heavy objects and road traffic accidents accounted for most of injuries (26.7 % each). Whereas trapdoor injury and sharp objects accounted for injuries in 16.7 % cases each.

#### Hand Injured

**Table 5-A**

HAND INJURED	NO. OF PATIENTS	PERCENTAGE
<b>Right</b>	25	83.3 %
<b>Left</b>	5	16.7 %
<b>Total</b>	<b>30</b>	<b>100.0 %</b>

Right hand was injured in majority of patients (83.3 % cases), whereas left hand was injured in the rest cases (16.7 % cases).

**Table 5-B**

HAND INJURED	NO. OF PATIENTS	PERCENTAGE
Dominant	26	86.7 %
Non-Dominant	4	13.3 %
<b>Total</b>	<b>30</b>	<b>100.0 %</b>

Dominant hand sustained injury in majority of cases (86.7 %), where as non dominant hand sustained injury in rest of cases (13.3 %).

**Table 5-C**

FINGERS INJURED	NO. OF PATIENTS	PERCENTAGE
One finger	22	73.3 %
Two fingers	6	20.0 %
More than two fingers	2	6.7 %
Total	30	100.0%

Single finger was injured in 73.3 % cases. Two fingers were injured in 20 % cases, where as more than two fingers were injured in 6.7 % cases.

**Table 5-D**

TYPE OF FINGER INJURED	NUMBER	PERCENTAGE
Index finger	16	40.0 %
Middle finger	11	27.5 %
Ring finger	6	15.0 %
Little finger	1	2.5 %
Thumb	6	15.0 %
Total	40	100.0 %

Index finger was most commonly affected (40.0% cases), little finger was least injured (2.5 % cases).

**Type Of Injury**

**Table 6**

TYPE OF INJURY	NUMBER OF FINGERS	PERCENTAGE
Type A	2	5.9 %
Type B	14	41.2 %
Type C	8	23.5 %
Type D	10	29.4 %
<b>Total</b>	<b>34</b>	<b>100.0 %</b>

Maximum number of fingers sustained type B injury(41.2 % cases) followed by type D injury (29.4 % cases).

**Mode Of Treatment**

**Table 7-A**

INJURY TYPE	MODE OF TREATMENT	NUMBER
<b>Type A (2)</b>	Moberg flap	<b>1</b>
	First Dorsal Metacarpal Artery flap	<b>1</b>
<b>Type B (14)</b>	Cross Finger flap	<b>5</b>
	Thenar flap	<b>2</b>
	First Dorsal Metacarpal Artery flap	<b>2</b>
	Moberg flap	<b>1</b>
	Volar Advancement flap	<b>1</b>
<b>Type C(8)</b>	Oblique Triangular flap	<b>3</b>
	Volar Advancement	<b>1</b>
	Lateral Kutler flap	<b>4</b>
	Cross-finger flap	<b>2</b>
<b>Type D (10)</b>	Thenar flap	<b>1</b>
	Reverse Dorsal Digital flap	<b>2</b>
	V-Y flap	<b>8</b>
<b>Total</b>		<b>34</b>

**Table 7-B**

MODE OF TREATMENT	NUMBER
<b>Local flaps (19)</b>	
Volar V-Y flap	<b>8</b>
Kutler flap	<b>4</b>
Volar Advancement flap	<b>2</b>
Oblique Triangular flap	<b>3</b>
Moberg flap	<b>2</b>
<b>Regional flaps (15)</b>	
Cross-Finger flap	<b>7</b>
Thenar flap	<b>3</b>
First dorsal metacarpal artery flap	<b>3</b>
Reverse Dorsal Digital flap	<b>2</b>
Total	<b>34</b>

**Period Of Unfitness For Work**

**Table 8**

PROCEDURE	PERIOD (IN DAYS)
Local flaps	10 to 14
Regional flaps	14 to 30

**Table 9**

PROCEDURE	SENSORY RECOVERY
Volar V-Y flap	S3+, S4
Kutler flap	S3+, S4
Volar Advancement flap	S4
Oblique Triangular flap	S4
Moberg flap	S3+
First Dorsal Metacarpal Artery flap	S3
Cross-Finger flap	S2, S3
Thenar flap	S1,S2
Reverse Dorsal Digital flap	SO

#### IV. Discussion

As a digit is shortened, end-to-end contact replaces the lost pulp-to-pulp contact. The need for a stable pad of skin with sensation is important in the radial tripod of fingertips, to provide manipulation in a prehensile grip. The need to conserve length is important in the ulnar two digits where the distal phalanges provide stability in a power grip .

A local or regional flap cover provides good cover, contour and maintains length that is critical to finger function. An analysis of the 30 cases of fingertip injuries requiring local or regional flap cover for preserving finger function is presented.

In our study, 30 cases of fingertip injuries needing local or regional flaps were included. Maximum number of patients were in the age group of 31 to 40 years of age, accounting for 40% of the cases. Mean age of patients in our study was 29.3 years. The youngest patient was 3 years old child while the oldest patient was 58 years old male.

The number of male patients in our study accounted for 76.7% of all the cases, where as females contributed about 17.9 % of all the total cases.

In our study, incidence of fingertip injury was found to be highest among labourers or factory workers (63.3 %) whereas school going children constituted the second largest group (16.7 % ) sustaining such injuries.

It was observed in our study that fall of heavy objects and road traffic accidents accounted for most of the injuries (26.7 % each), where as trapdoor injury and trauma with sharp objects accounted for injuries in 16.7 % cases each requiring coverage with local and regional flaps.

In our study, all the children (n=4) sustained fingertip injury due to trapdoor (100 %).

The right hand was more frequently injured (83.3 % cases). The dominant hand suffered trauma in majority of cases (86.7 %).This pattern of injury is quite expected since in our society males predominate in occupations requiring manual labour and most of the injuries were work-related and the dominant hand was also right hand.

In our study, index finger was the most affected digit (40 %) followed by the middle finger (27.5 %). In our study, type B injury was found to be the commonest and was seen in 14 cases (41.2 % cases), the injuries being classified depending upon level and angle.

In this study, eight patients had volar V-Y flap for fingertip reconstruction. Three patients had hypersensitivity in the initial period for three weeks which settled at 3 months follow up. Flap necrosis did not occur in any of these cases. Sensory recovery was good in all cases (S3+ to S4).

In the present study, Kutler flap was used in four patients with Type C injury. Two had scar tenderness that responded to conservative treatment of light massage and analgesics. All four had good sensation and were able to carry out all normal activities. Normal contour of fingertip was achieved in all cases.

In the present study, 2 cases of volar advancement flap were done for cover of Type B and Type C defects. The flaps were islanded to obtain more advancement so that the defect could be covered without flexion of PIP joint. The proximal defect created was skin grafted. Normal sensation was retained in both cases and flexion contracture was not noted.

In our study, three cases of oblique amputation were reconstructed with the oblique triangular flap. Full contour was obtained. Normal sensation was seen at one-month follow-up without hyperesthesia. Tenderness over the scar persisted for two months in one patient.

Two cases of oblique volar pulp loss of thumb were treated with volar thumb advancement flap (Moberg flap). Sensory recovery was excellent in both cases (S4 in BMRC sensory grading). Stiffness of interphalangeal joint persisted in one case even after two months of physiotherapy. However, the mild flexion contracture did not come in the way of daily activities of the patient.

In this study, seven patients were offered cross finger flap coverage for fingertip injury. Of the seven patients, five patients had Type B injury and two patients had Type C injury. At three-month follow-up none of the patients had any two-point discrimination. All seven patients had protective sensation (sensory recovery grading S2 and S3). one patient developed joint stiffness, which persisted even after six weeks of physiotherapy. Three patients in our study underwent First Dorsal Metacarpal Artery Flap for coverage of thumb defects. In this study sensory recovery grading was S3+.

In this study, three patients required thenar flap cover for pulp reconstruction. Both patients were young and joint stiffness was not noted. At six-month follow-up, sensory recovery was S1 to S2. There was no donor site tenderness and full contour was obtained.

Two cases of reverse dorsal digital flap were done in the present study of dorsal injuries over distal phalanx with no complication.

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