

## Original Research Article

# Fingertip reconstruction: study of functional and cosmetic results of various local flaps and grafting techniques in patients attending a tertiary care center in North India

Shameem A. Khan<sup>1</sup>, Vivek Kumar<sup>2\*</sup>, Neeraj Srivastava<sup>3</sup>

<sup>1</sup>Department of Orthopaedics, Hind Institute of Medical Sciences, Safedabad, Barabanki, Uttar Pradesh, India

<sup>2</sup>Registered medical practitioner, Kasaya, Kushinagar, Uttar Pradesh, India

<sup>3</sup>Consultant, Shubham hospital, Varanasi, Uttar Pradesh, India

**Received:** 30 June 2019

**Accepted:** 07 September 2019

### \*Correspondence:

Dr. Vivek kumar,

E-mail: [dr.vivek2001@gmail.com](mailto:dr.vivek2001@gmail.com)

**Copyright:** © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

### ABSTRACT

**Background:** Finger injuries are becoming more common with the increasing use of mechanical, industrial, and household appliances. There are six main types of repair for this injury. The replacement of skin loss in digital injuries, particularly on the volar aspects, is an important part of hand-injury management. It would be of value to know the best type of cover, especially for sensory reinnervation as well as for subjective evaluation, cosmetic appearance and freedom from complications. The objective of this study was to measure incidence of age, sex, site, pattern of injury as well as to evaluate and compare the functional and cosmetic results of the various local flap and grafting techniques in finger reconstruction distal to metacarpophalangeal joint.

**Methods:** In a prospective study between May 2014 to October 2018 consisting of 50 patients (43 males, 7 females), aged between 2 years and 54 years, with soft tissue loss distal to metacarpophalangeal joint were treated with either free split-thickness skin grafts, palmar flaps, cross-finger flap or pedicle flaps from the abdomen. The follow-up period ranged from 10 days to 15 months from the date of surgery. Subjective and objective evaluation was done and graded as excellent, good, fair and poor.

**Results:** In this series there were 2 good and 6 fair results for split skin grafting; 9 good and 6 fair results for v-y plasty; 5 excellent, 12 good and 4 fair results for cross finger flap; 1 good and 1 fair result for radial artery based flap; 1 excellent and 1 good for first metacarpal artery based flap and 2 good results for abdominal flap. Overall 6(12%) had excellent, 27(54%) had good and 17(34%) had fair results. None of them had poor results.

**Conclusions:** The group of patients with cross-finger flaps had less subjective complaints and more normal objective testing results than the other groups. When an extensive tactile pad avulsion exists, the cross-finger pedicle flap offers the best long-term result with fewer secondary problems. The exclusive use of any one method cannot be advocated since each serves an useful purpose under proper conditions.

**Keywords:** Cross finger flap, Fingertip injury, Fingertip reconstruction, Palmer flap

### INTRODUCTION

Finger injuries are becoming more common with the increasing use of mechanical, industrial and household appliances. Several million cases occur each year, some

of which are avulsions of the tactile pad.<sup>1</sup> There are six main types of repair for this injury: primary closure by shortening of the bone, free split-thickness skin grafts, free full thickness skin grafts, palmar flaps, cross-finger flaps and pedicle flaps from the chest or abdomen.<sup>2-4</sup>

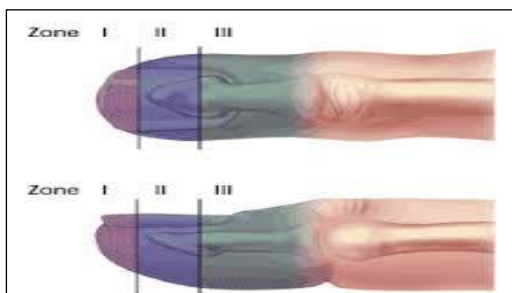
Many less common repairs have been described, but all fall into one of these main groups.<sup>1</sup>

The replacement of skin loss in digital injuries, particularly on the volar aspects, is an important part of hand-injury management. For one patient, shortening of the finger and closure by locally innervated flaps may be the best treatment; for another, it may be advantageous to reconstruct this area with a free graft or a pedicle flap. One should take into account such factors as the level of amputation, the digits involved (preservation of length in the thumb is important), the occupation, the age of the patient and complicating injuries. When skin replacement is necessary, conflicting opinions exist about the relative functional value of the different types of skin repair. Mannerfelt, Brody and co-workers and Lunn prefer grafts to flaps. However; Reid as well as Sturman and Duran, believe that cross-finger flaps or thenar flaps will give a better functional result and an improved reinnervation provided skilled surgery is available. It is not valid to suggest that work is necessarily resumed more quickly with free grafts; Barelay showed that time off from work was not increased by use of flaps and Reid demonstrated that in selected cases disability time could actually be reduced by pedicled reconstruction.<sup>5</sup>

It would be of value to know the best type of cover; especially for sensory reinnervation as well as for subjective evaluation, cosmetic appearance and freedom from complications since there are conflicting reports on which type of repair is best for sensory and functional return.<sup>1,6</sup> This study was carried out with aim to evaluate incidence of age, sex, site, pattern of injury and to compare the functional and cosmetic results of the various local flap and grafting techniques in finger reconstruction distal to metacarpophalangeal joint.

**Classification of Fingertip Injuries**

Many fingertip amputations can be classified consistent with the normal functional anatomy of the tip and perionychium. Injuries can be classified according to where the amputation has occurred or whether the injury primarily involves the pulp (soft tissue) or nail bed. These classification systems refer to the zone and the plane of injury.

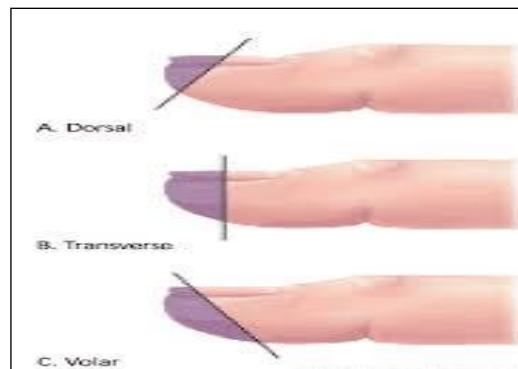


**Figure 1: Zonal classification of amputations involving the nail bed and fingertip.**

An injury classified as zone I occurs distal to the bony structures of the digit and the distal phalanx is preserved. Most of the nail bed and the integrity of the matrix are intact, allowing for normal nail contours following healing. Treatment of zone I injuries is usually conservative, such as leaving the wound open for secondary healing. Meticulous wound care and conservative debridement of these injuries are essential. Wound healing is facilitated by the use of topical antibiotic ointments and by monitoring of the injury to avoid the development of excessive granulation tissue.

Injuries classified as zone II are located distal to the lunula of the nail bed and are complicated by the bony exposure of the distal phalanx. These injuries require local or distant pedicle flap reconstruction. The plane of zone II injuries helps determine what type of repair technique should be used.

Injuries classified as zone III involve the nail matrix and result in the loss of the entire nail bed. Most patients with injuries in zone III are not candidates for elaborate reconstruction. The most effective management of these injuries is amputation of the distal phalanx.



**Figure 2: Planes of injury in fingertip amputations.**

Amputation injuries are also classified as dorsal and transverse or volar according to the plane of the amputation. The plane of the amputation and the condition of the tissue at the injury site help determine the best repair technique for these injuries. The V-Y plasty technique can be used to repair amputations with dorsal or transverse planes.

Allen’s and the PNB classifications are commonly used to describe the level of amputation for fingertip amputations. Additional information, that is useful to the hand surgeon when receiving a referral, is whether the amputation is volar neutral, volar favourable or volar unfavourable.

**METHODS**

The study was prospective in nature. The study group consisted of 50 patients (43 males, 7 females), aged between 2 years and 54 years, with soft tissue loss distal

to metacarpophalangeal joint. They were treated with either free split-thickness skin grafts, v-y advancement flaps, cross-finger flaps, first dorsal metacarpal artery based flap, radial artery based flap and pedicle flaps from the abdomen at the Department of Orthopedics, Hind Institute of Medical Sciences, Safedabad, Barabanki, Uttar Pradesh, India, between May 2014 to Oct 2018.<sup>3,4,8,9-12</sup>

Procedure to perform was decided based on factors such as the level of the digits involved, occupation of patient, age of the patient, complicating injuries, discussion with patient and relatives, written informed consent. Patients with poly trauma and burn contracture were not included in the study. The patients presented for initial evaluation because of pain, deformity and bleeding wound from involved fingers. In 37 patients (74%), the injury involved the right hand and in 13 patients (26%), it involved the left hand.

The follow-up period ranged from 10 days to 15 months from the date of surgery. Subjective complaints of tenderness, cold sensitivity, and disability were graded as none, slight, moderate, marked or severe. Disability was assessed on the basis of difficulty in picking up objects, grasping, tying shoes, buttoning clothes. Time lost from work was also recorded, as were the degree of pigmentation, the size of the graft, shortening of the finger and joint stiffness.<sup>1</sup>

Several objective measurements were made on the repaired fingertip, the corresponding normal fingertip of the opposite hand (opposite normal control), and the normal skin near the donor site (donor control site). Light touch was evaluated by a wisp of cotton.<sup>1</sup>

Size-discrimination was evaluated with various size coins. The patient held the coin between the repaired fingertip and the thumb, or if the thumb was the injured digit, between the thumb and the index finger. He then followed the same with the opposite normal hand. Responses were recorded with the patient blindfolded. Failure to respond within five seconds or incorrect identification was recorder as an error. The number of errors of the control normal hand was subtracted from the number of errors of the repaired hand.<sup>1</sup>

Texture discrimination was evaluated with three grades of sandpaper fine, medium and coarse. With the patient blindfolded one grade of sandpaper was held against the repaired fingertip, and the patient was allowed to feel and move it between his fingers. When one piece of sandpaper was withdrawn, another was immediately inserted. The patient was asked which piece was coarser. The ability to discriminate between different textures was tested by giving the patient first two pieces of the same texture, then one fine and one medium, one medium and one coarse, and one fine and one coarse. The number of errors for each hand was recorded. Errors, both of size and texture discrimination by the opposite control hand

were subtracted from errors by the repaired hand. Thus, a patient who could not discriminate with his normal hand was not recorded as having poor discrimination of his repaired fingertip.<sup>1</sup>

Two-point discrimination was done with a divider. The distance at which two points were felt as one was recorded.<sup>1</sup>

A finger dexterity test was utilized, patterned after the functional tests described by Moberg.<sup>13</sup> The choice of fingers used when putting objects into a box and pills into a tube was recorded. Since the index finger and thumb are generally used for this, only repairs of the index finger or thumb were evaluated with this test.

If the patient hesitated or had difficulty using his repaired finger, or if he used the long or other fingers instead of the index finger, it was considered that he was avoiding use of the repaired digit.<sup>1</sup> Temperature sensation was not evaluated since many statements in the literature indicate the unreliability and difficulties of this tests.<sup>1</sup>

Photographs were taken of the repairs to help correlate the functional results with the appearance. The entire evaluation took approximately thirty minutes for each patient. None of the patients complained about the testing.<sup>1</sup> The clinical results were analyzed and the criteria for the ratings were as follows:<sup>1</sup>

#### *Excellent*

Full range of motion in both digits; good or excellent appearance of the sites; and no functional disability noted by the patient.

#### *Good*

Minimum or slight limitation of motion in the donor digit, not of a disabling degree; slight to moderate limitation of motion in the joint of the recipient digit adjacent to the area of injury; hyperesthesia of flap in an important sensory area with no more than minimum dysesthesia; and good to excellent appearance of the graft sites.

#### *Fair*

Slight to moderate limitation of motion in the joints of the donor digit; moderate limitation of motion of the joints of the recipient digit, or slight to moderate limitation in both fingers; hyperesthesia in the flap with more than minimum dysesthesia in either the donor or recipient area; and good appearance of the graft sites.

#### *Poor*

Moderate limitation of motion in either the donor or the recipient digit; or more than slight dysesthesia in either digit; or both of these deficiencies.

## RESULTS

In this study 50 patients with soft tissue loss distal to metacarpophalangeal joint were analyzed. The follow-up period ranged from 10 days to 15 months from the date of surgery. The analysis of results obtained from this study is discussed as follows.

### Age Incidence

Of the 50 patients treated in this series, the youngest patient was 2 years of age and the oldest 54 years of age. The mean age was 28.9 years with average age of 29.8 years in males and 53.4 years in females. The maximum incidence was noticed between 21 to 30 years of age in males and bimodal i.e. 0 to 10 and 21 to 30 years of age in females. Both the youngest (2 years) and the oldest patients in this series were males. Overall maximum incidence of cases occurred between the age group of 21 to 30 years.

### Sex Incidence

44(88%) patients were males and only 6(12%) patients were females with male to female ratio of 7.3: 1.

### Side Incidence

In this series; 13 (26%) injuries occurred on left side and 37 (74%) on right side.

### Type of Injury

In this series; 32(64%) were crush injuries and 18(36%) were fingertip injuries.

### Finger Involved

In this series; 12(24%) patients had thumb involvement rest 38(76%) had other fingers involved.

### Treatment

In this series; 8(16%) patients underwent split skin grafting (Figure 3), 15(30%) underwent v-y plasty (Figure 4), 21(42%) underwent cross finger flap (Figure 5), 2(4%) underwent radial artery based flap (Figure 6), 2(4%) underwent first metacarpal artery based flap (Figure 7), rest 2(4%) underwent abdominal flap (Figure 8).

### Complication

In this series; 46(92%) patients did not have any complication, 2(4%) had stiffness of fingers, 1(2%) had infection and 1(2%) had partial necrosis of flap which was managed conservatively.

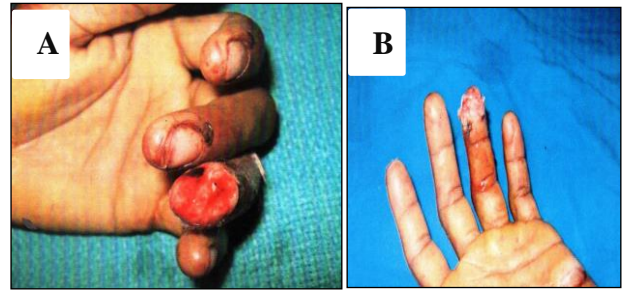


Figure 3: Split skin grafting for ring fingertip injury (3A Pre op) showing good result (3B Post op).

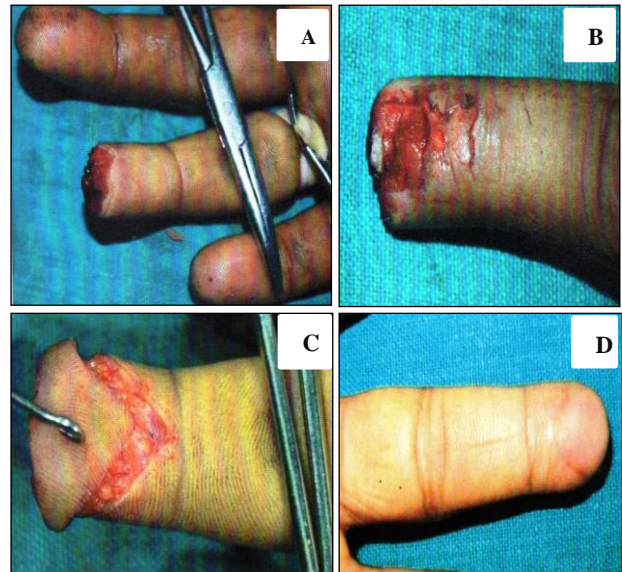


Figure 4: V-y plasty for ring fingertip injury (4A Pre op volar view, 4B Pre op dorsal view and 4C Intra op) showing good result (4D Post op 6 weeks).

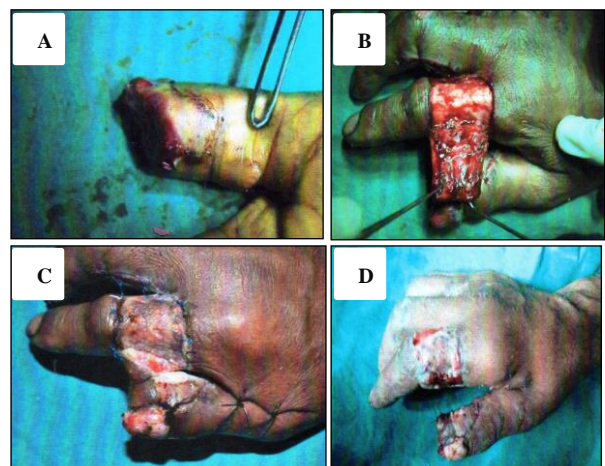
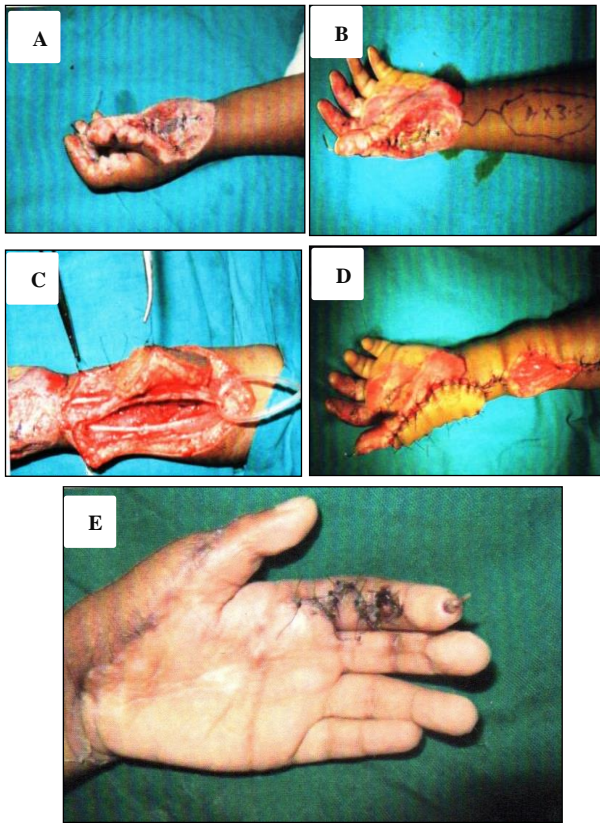
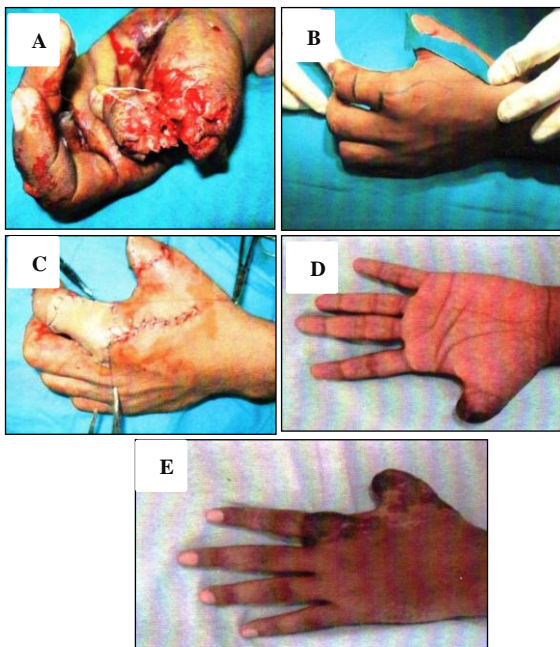


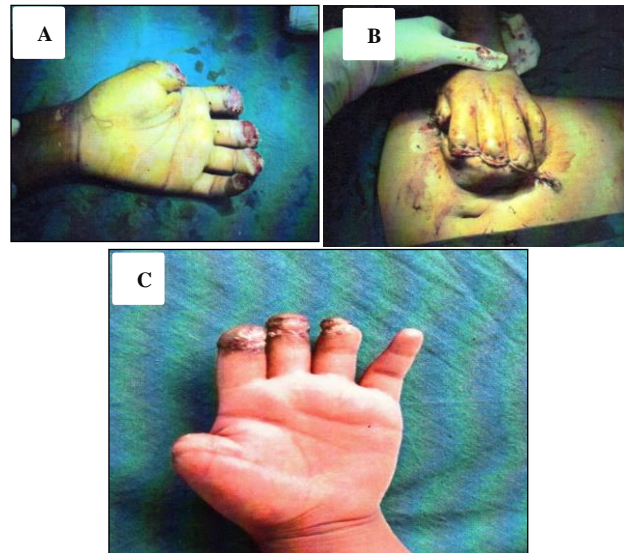
Figure 5: Cross finger flap for thumb tip injury (5A Pre op and 5B Intra op) showing fair result (5C Post op 3 wks., 5D After flap division).



**Figure 6: Radial artery based flap for thumb and radial aspect of hand injury (6A and 6B preop, 6C Intra op) showing good result( 6D Immediate post op, 6E 3 months post op).**



**Figure 7: First metacarpal artery based flap for thumb injury (7A preop, 7B intra op) showing excellent results (7C- immediate post op, 7D and 7E 4 months post op volar and dorsal view).**



**Figure 8: Abdominal flap for all five fingertips of hand (8A Pre op, 8B Immediate post op) showing good result (8C 3 Months post op).**

**Tenderness**

In this series; 28(56%) patients had no tenderness, 10(20%) had slight, 11(22%) moderate and 1(2%) patient had marked tenderness.

In patients with split skin graft 87% had tenderness (50% reporting marked tenderness), in cross-finger flap 19.5% had tenderness (5% had marked tenderness), in v-y plasty 33.33% had tenderness (none had marked tenderness) and in abdominal flap 100% had tenderness (all had moderate tenderness).

**Disability**

In this series; 31(62%) patients had no disability, 12(24%) had slight and 7(14%) had moderate disability.

**Time lost from work**

In this series; average time lost from work in case of split skin grafting was 9.75 days, 8.33 days for v-y plasty, 34.85 days for cross finger flap, 41 days for radial artery based artery based flap, 30 days for first metacarpal artery based flap and 69.5 days for abdominal flap.

**Two point discrimination**

In this series; average result for two point discrimination test on the injured finger was 5.25 mm for split skin grafting, 5.06 mm for v-y plasty, 6.47 mm for cross finger flap, 13 mm for radial artery based flap, 8.5 mm for first metacarpal artery based flap and could not be assessed for abdominal flap as the distance between the two points exceeded the size of the graft in each case.

**Analysis of results**

In this series; there were 2 good (Figure 3) and 6 fair results for split skin grafting; 9 good (Figure 4) and 6 fair results for v-y plasty; 5 excellent, 12 good and 4 fair (Figure5) results for cross finger flap; 1 good (Figure 6) and 1 fair result for radial artery based flap; 1 excellent (Figure 7) and 1 good for first metacarpal artery based flap; 2 good results (Figure 8) for abdominal flap.

Overall 6(12%) patients had excellent, 27(54%) had good and 17(34%) had fair results. None of them had poor results.

**DISCUSSION**

In this study, we have evaluated the merits and demerits of various techniques of finger reconstruction like skin grafts, cross-finger flaps, v-y plasty, radial artery based flap, first metacarpal artery based flap and abdominal pedicle flaps on the fingers.<sup>3-5,11</sup>

Only in the cross-finger flap and v-y plasty groups, less than 50% of patients complained of tenderness. Over 50% of the patients with free split thickness and abdominal pedicle graft had marked tenderness.

Patients with cross-finger flap and v-y plasty had less subjective disability than the patients in the other groups. Over 50% of patients with split skin grafting, radial artery

based flap, first metacarpal artery based flap and abdominal flap complained of subjective disability which interfered with their daily activities.

The two-point discrimination testing was good for split skin grafting cross-finger flap, v-y plasty and poor for radial artery based flap, first metacarpal artery based flap and abdominal flap.

The sample size in our series was of 50 patients; whereas in Sturman and Duran series it was 235 (Table 1). Ours is a prospective study.<sup>1</sup>

Sturman and Duran's is a retrospective study where cases, mostly from the private practice of several surgeons, were seen one year or more after repair. 66 patients had primary closure with or without shortening and use of local flaps, in our study we have excluded primary closure. 53 patients had free split-thickness skin grafts, 59 had free full-thickness skin grafts; in our study we used only split-thickness skin grafts for 8 patients. 20 patients had cross-finger flaps; in our study 21 patients had cross finger flap. 21 patients had palmar flaps and we did v-y plasty for 15 patients. 16 patients had distant pedicle flaps from the abdomen; we had radial artery based flap for 2, first metacarpal artery based flap for 2 and abdominal flap for 2 patients.

**Table 1: Comparison of methods of treatment in present and Sturman and Duran series.**

Study group	Primary closure	SSG/Full thickness	CFF	Palmar/ V-Y Plasty	Distant Flap	Total
HIMS (Barabanki) 2018	0	8	21	15	6	50
Sturman and Duran 1963	66	53+59	20	21	16	235

**Skin grafting**

In Sturman and Duran series among 112 patients with skin grafting; 69% complained of tenderness with 46% reporting marked tenderness. In our series of 8 patients treated with SSG; 87% had tenderness with 50% reporting marked tenderness. 63.5% reported some disability; this was marked in 25.5%. In our series 62.5% reported some disability which was marked in 20%. The average time lost from work was 10 days, in our series it was 9.75 days.

The average result of two-point discrimination test on the injured finger was 5mm, compared with 5.25 mm in our study.

Those patients complaining of tenderness and avoiding use of their repaired fingertips had the lowest pain

threshold. Those who avoided use lost more than the average time (10 days) from work.

There were no problems at the donor sites.

**Cross-finger flap**

In Sturman and Duran series among 20 patients with cross-finger flap 20% complained of tenderness none had marked tenderness. In our series 19.5 % had tenderness and only 5% had marked tenderness. 10% reported some disability but it was not marked. In our series 19% had disability but none had marked. The average time lost from work was 40 days. In our series it was 34.85 days.

The average result of two-point discrimination test on the injured finger was 6mm, compared with 6.47 mm in our study. There were no problems at the donor sites .

### **Palmar flap/v-y plasty**

In Sturman and Duran series among 21 patients with palmar flaps; 24% complained of tenderness that was marked in 19%, when compared with v-y plasty in our series 33.33% had tenderness and none had marked. 22% reported some disability, 19% had marked disability compared with v-y plasty only 26.66% had disability and none had marked.

The average time lost from work was 30 days, in our series with v-y plasty it was 8.33 days.

The average result of two-point discrimination test on the injured finger was 9mm, compared with 5.06 mm in our study of v-y plasty.

There were no problems at the donor sites.

### **Abdominal pedicle flap**

In Sturman and Duran series among the 16 patients with abdominal pedicle flap, 63% complained of tenderness, all severe. In our study 100% complained of tenderness, all moderate.

All complained of some disability which was severe in 38%. In our study all complained of disability and 100% had moderate.

Two-point discrimination test on the injured finger was unobtainable because the distance between the points exceeded the size of graft in each case, same happened in our series.

The average time lost from work was 108 days. Patients with flap repairs had more time lost from work than those with free grafts and v-y plasty. Some of this time is taken up by time lost between original repair and detachment of a pedicle.

Overall analysis of these results shows that patients with cross-finger flaps and v-y plasty had less subjective complaints and more normal results by objective testing than other groups. Patients with abdominal pedicle flaps had many complaints and poor objective testing results. However, the injuries in these patients could not have been covered in any other way. Patients with split-thickness free grafts had many subjective complaints; the majority avoided use of their repairs and complaints of tenderness which correlated with a low pain threshold. This should be expected since local skin is most like that of the normal fingertip.

From these results the cross-finger and v-y plasty are judged superior in sensory and functional return. Approximately 50 per cent of the patients with free split-thickness, radial artery based flap, first metacarpal artery based flap and abdominal pedicle flaps had problems. Thus, we believe that more critical criteria for follow-up

results are important and problems with certain type of repairs are more common than previously reported. Cross finger flap repair is recommended for long term results in cases of major tactile pad avulsion. This is recommended despite the fact that more time is lost from work during the period of repair.

V-y plasty even though superior to cross-finger flap in better cosmesis, 2 point discrimination, lesser time lost from work is feasible only for fingertip injuries involving zone I and ii transverse or dorsal plane amputations and these type of injuries are not very common, compared to crush injury of the finger.

### **CONCLUSION**

The results in patients with, free split-thickness skin grafts, cross-finger flaps, v-y plasty, and abdominal pedicle flaps on the fingertips were compared. The group of patients with cross-finger flaps had less subjective complaints and more normal objective testing results than the other groups. Approximately 50 per cent of patients with any treatment method had tenderness and disability in daily activities.

One should take into account such factors as the level of amputation, the digits involved (preservation of length in the thumb is important), the occupation and the age of the patient and complicating injuries. When skin replacement is necessary, conflicting opinions exist about the relative functional value of the different types of skin repair. It is not valid to suggest that work is necessarily resumed more quickly with free grafts. Although many factors must be considered before a type of repair is chosen; we believe that when an extensive tactile pad avulsion exists, the cross-finger pedicle flap offers the best long-term result with fewer secondary problems. The exclusive use of any one method cannot be advocated since each serves a useful purpose under proper conditions.

### **REFERENCES**

1. Sturman MJ, Duran RJ. Late Results of Finger-Tip Injuries, *J Bone Joint Surgery Am.* 1963;45(2):289-98.
2. Canale ST, Beaty J. *Campbell's Operative Orthopedics* 11<sup>th</sup> edition, Acute hand injuries chap. 62(4);3827-3829.
3. Johnson RK, Iverson RE. Cross-finger pedicle flaps in the hand. *JBJS.* 1971 Jul 1;53(5):913-9.
4. Hoskins HD. The versatile cross-finger pedicle flap: a report of twenty-six cases. *JBJS.* 1960 Mar 1;42(2):261-77.
5. Porter RW. Functional assessment of transplanted skin in volar defects of the digits: a comparison between free grafts and flaps. *JBJS.* 1968 Jul 1;50(5):955-63.
6. Muneuchi G, Tamai M, Igawa K, Kurokawa M, Igawa HH. The PNB Classification for Treatment of Fingertip Injuries: The boundary between

- Conservative Treatment and Surgical Treatment, *Ann Plast Surg.* 2005 Jun;54(6):604-9.
7. Atasoy E, Ioakimidis E, Kasdan MI, Kutz Je, Kleinert He. Reconstruction of the amputated fingertip with a triangular volar flap: A new surgical procedure, *J Bone Joint Surg.* 1970; 52(5):921-6.
  8. Fejjal N, Belmir R, El Mazouz S, Gharib N, Abbassi A, Belmahi A. Reversed cross finger subcutaneous flap: A rapid way to cover finger defects, *Indian J Plast Surg.* 2008;41(1):55.
  9. Gokrem S, Tuncali D, Terzioglu A, Toksoy K, Aslan G. The thin cross finger skin flap, *J Hand Surg Eur Vol.* 2007 Aug;32(4):417-20.
  10. Mishra S, Manisundaram S. A reverse flow cross finger pedicle skin flap from hemidorsum of finger. *J Plastic, Reconstructive and Aesthetic Surg.* 2010 Apr 1;63(4):686-92.
  11. Satish C, Nema S. First dorsal metacarpal artery islanded flap: A useful flap for reconstruction of thumb pulp defects. *Ind J pla sur: official publication of the Association of Plastic Surgeons of India.* 2009 Jan;42(1):32.
  12. B Jagannath Kamath , Comments on foucher's flap, *Indian J Plast Surg.* 2009;42:270-1.
  13. Moberg E. Aspects of sensation in reconstructive surgery of the upper extremity. *JBJS.* 1964 Jun 1;46(4):817-25.

**Cite this article as:** Khan SA, Kumar V, Srivastava N. Fingertip reconstruction: study of functional and cosmetic results of various local flaps and grafting techniques in patients attending a tertiary care center in North India. *Int J Res Med Sci* 2019;7:3708-15.