



CROSS FINGER FLAP VS THENAR FLAP FOR FINGER TIP RECONSTRUCTION - A COMPARATIVE STUDY IN A TERTIARY CARE HOSPITAL

Plastic Surgery

Tamoghna Das

Academic Resident, Department Of Plastic And Reconstructive Surgery, IPGMER And SSKM Hospital, Kolkata

Oli Das Adhikary*

Academic Resident, Department Of Plastic And Reconstructive Surgery, IPGMER And SSKM Hospital, Kolkata *Corresponding Author

ABSTRACT

Introduction: Fingertip injuries are common hand injuries ranging from simple laceration to larger defects with amputations. Different methods are used to reconstruct the affected finger. Cross finger flaps and thenar flaps are commonly used but it is difficult to select among these two flaps for finger reconstruction. These flaps are reliable and simple to perform without the need for neurovascular dissection. **Materials And Method:** It is an Institutional based, comparative study conducted in patients with finger tip injuries in SSKMCH between 18-70 years of age. The study period was 12 months (From February 2024 to January 2025). 50 patients were included in this study. The aesthetic (sensibility, appearance and function as subjective assessment) and functional outcomes (2 point discrimination and range of motion) were measured. Data were analyzed using SPSS version 25. **Results:** There was male predisposition with average age of 35.33 years. The common etiology of injury was crush injury with right hand most commonly involved hand and middle finger being commonly injured digit. On subjective assessment, the difference on rating scale on sensibility, function and appearance was not statistically significant among two groups. There were statistical significant differences in mean of static and moving 2 point discrimination among thenar flap and cross finger flap. **Conclusion:** We concluded that there is no precise characteristics for the selection of thenar and cross finger flap based on aesthetic and functional outcomes in reconstruction of fingertip injury.

KEYWORDS

Aesthetic; Flaps; Finger Reconstruction, Thenar flap, Cross finger flap

INTRODUCTION

Fingertip injury is a serious injury to the hand that can lead to significant functional consequences. If the amputated portion is not recovered or cannot be replanted, covering the defect as a minimum is the treatment modality.

Fingertip injuries can occur after thermal or traumatic accidents at any age groups^{1,2}. The pattern of injuries varies from simple laceration to soft tissue defects exposing vital structures. Most commonly injured fingers are middle finger followed by index, ring, little finger and thumb³. The amount of soft-tissue loss, the integrity of the nail bed, the age and physical demands of the patient should be considered when selecting a treatment method⁴.

Treatment goals are pain reduction, optimising the healing time, preserving local tissue metabolism, pulp sensitivity and finger length, preventing neuromas and restoring an acceptable appearance to the patient.

The aim of fingertip defect reconstructions is to provide a painless tip with good quality skin and adequate protective sensation, preserve the length, and prevent nail deformities^{5,7}. Different methods available for treatment of fingertip injury are secondary healing, split thickness skin graft (STSG) and flap coverage⁸.

The various native flaps used for fingertip reconstruction are bilateral v-y flaps, cross finger flap, thenar flaps and island flaps^{8,9}. The thenar flap (TF) is mostly done to the index and middle fingers with significant pulp loss¹⁰. The greatest advantage of thenar flap is it provides glabrous skin with adequate sensation over a time period of 6 to 8 months and without injuring adjacent finger¹¹. Cross finger flaps (CFF) is a robust flap that uses dorsal skin of an adjacent finger to construct volar fingertip injuries in two stages thereby providing durable cover for volar oblique defects with exposed bone, tendon or joint when available local flaps are inadequate and preservation of length is essential¹².

The management of fingertip injuries is complex and not without controversy as a variety of treatment options are available¹³. In this study the functional and aesthetic outcome of thenar flaps and cross finger flaps was compared in fingertip reconstructions.

Methodology

This prospective comparative study conducted in a tertiary care hospital from February 2024 to January 2025, after getting approval from Institutional Ethical Committee and informed written and verbal consent were taken from each participants.

The total subjects were 50 which were divided into 2 groups in non-randomized manner as, first group for thenar flap included 25 and second group for cross finger flap included 25.

Inclusion Criteria for the study are Age group between 15 years – 60 years, acute fingertip injuries of index, middle, ring, little fingers, exposing bone or tendon, Transverse or oblique amputation distal to distal interphalangeal joint (DIP) joint and scarcity of soft tissue and more volar loss.

Exclusion criteria of this study are age group below 15 years or above 60 years, thumb injury, chronic non healing wound of finger, osteomyelitis of distal phalanx and patient not willing for immobilization of fingers for 2 weeks. All routine pre-operative investigations including imaging were done prior to the surgical procedure. Patient were kept nil per oral as per guidelines: 2 hour for clear fluid like water, 4 hours for breast milk, 6 hours for formula milk, 8 hours for solid food. Intravenous drip were started with the appropriate size cannula and continued throughout the duration of surgery. The size and design of flap required were determined by the size and shape and location of the fingertip. In case of bony injuries (Distal, middle, proximal phalanx and metacarpal fractures) and joint dislocations (DIP, PIP, MCP Joints) K wire fixation is done prior to flap harvesting.

According to the site of amputation (involves the pulp or nail bed), plane of injury and the mechanism of injury or the level of injury, the fingertip injuries are classified by Allen classifications into the four types listed below¹⁵.

Type 1: involves only the pulp

Type 2: involves the pulp and nail bed

Type 3: includes partial loss of the distal phalanx

Type 4: injury proximal to the lunula

Operative Procedure

Cross Finger Flap (Fig 1,2): The finger adjacent to the injured finger was chosen as it was easiest to position as the flap donor. The template was created to select the optimal location and orientation of the flap, then the flap was marked on the dorsal aspect of middle phalanx of the adjacent finger. Incision was made through the skin and subcutaneous tissues extending it to paratenon overlaying the extensor tendons. Then the flap was raised between the paratenon and the subcutaneous tissue, beginning at the mid-lateral incision and progressing towards the opposite mid lateral hinge.

The flap was sutured to the wound on the adjacent finger. Full Thickness Skin graft was taken from the ipsilateral medial arm and graft was secured with tie over bolster suture



Fig 1



Fig 2

Wound dressing was done with nonadherent paraffin gauze. Care was taken by placing soft dry gauze between all the fingers to prevent maceration. Fingers and palm were padded with cotton and dorsal pop splint applied to prevent tension on the flap. The wound was inspected after 48 hours and FTSG of flap donor site on 10th day. The finger were divided after 2 weeks under local anesthesia and finger bandages was applied. Active physiotherapy was started after 3-5 days for both donor and injured finger^{5,9,16}.

Thenar Flap (Fig 3,4): A thenar flap was done by flexing the injured fingertip into the palm (Fig 6). A proximal or distally based thenar flap, slightly larger than the fingertip defect was elevated at the level of the thenar muscle fascia under tourniquet control. The finger was flexed into the palm to rest in a relaxed position (Fig 7). Donor defect was closed primarily with 3-0 ethilon suture.

The tourniquet was released and the blood supply to the flap determined by observation. The thenar flaps were immobilized for 14 days using dorsal plaster or thermoplastic splint. Early active and passive range of motion was encouraged after flap was divided to prevent digital stiffness and to restore full thumb motion. Sensory re-orientation and desensitization instructions, scar massage and pressure garments were advised when necessary^{5,7,9}.



Fig 3



Fig 4

Data collection were done by filling proforma containing the demographic details (age, sex, mode of injury, mechanism of injury, finger distribution), type of injury, duration of flap division, donor site morbidity, range of motion, sensation, appearances and, complications.

Subjective assessments were done by questionnaire mentioning sensibility, function and appearance. Patients were asked about the function, appearance and sensibility of hand after surgery and were given the options of "excellent", "good", "fair" and "poor". Objective assessment for sensation was done by moving and static two-point discrimination (2 PD) test in both affected and unaffected hand. The result of this test was expressed in millimeter (mm).

Objective assessment for movements was observed by measuring the active range of motion of MP, PIP and DIP joints of the reconstructed finger as well as corresponding finger of the contralateral hand. Range of motion was measured with a standard hand goniometer and expressed in degree (°). Complications, secondary procedures (if done any) and sequelae in the post-operative period in all patients were recorded. The patients were followed up for 6 months. Collected data were analyzed by means of statistical software such as SPSS (Statistical Analysis in Social Science) version 25. Overall significance level was maintained at 'p' value < 0.05 and T-test was performed.

Analyzed data were presented in tables in the form of mean $\pm$ standard deviation.

Ethical Consideration

Ethical committee approval was taken from the concerned authorities.

RESULTS

In Thenar Flap Group, 5 patients were ≤ 30 years old, 7 patients were 31-40 years old, 7 patients were 41-50 years old and 6 patients were 51-60 years old. (Table 1)

In Cross Finger Flap group, 4 patients were ≤ 30 years old, 6 patients were 31-40 years old, 6 patients were 41-50 years old and 9 patients were 51-60 years old. (Table 1)

Table 1: Association Between Age In Group

GROUP			
Age in group	Thenar Flap Group	Cross Finger Flap Group	TOTAL
≤ 30	5	4	9
31-40	7	6	13
41-50	7	6	13
51-60	6	9	15
TOTAL	25	25	25

In Thenar Flap Group, 18 patients were Male and 7 patients were Female. (Table 2)

In Cross Finger Flap Group, 15 patients were Male, 10 patients were Female. (Table 2)

Table 2: Association Between Sex: Group

GROUP			
Sex	Thenar Flap Group	Cross Finger Flap Group I	TOTAL
Male	18	15	33
Female	7	10	17
TOTAL	25	25	50

Around 62% of patients were housewives and labourer/factory workers followed by in-service and school going students (Fig 5)

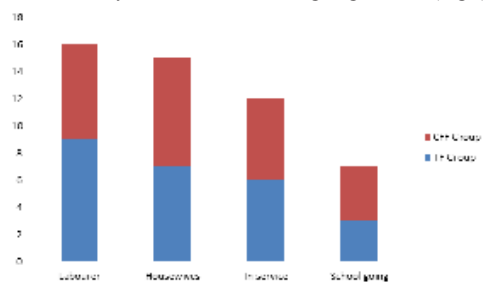


Fig 5 – Bar diagram showing occupation distribution

The different modes of injuries are listed in table 3. The most common mode of injury was crush injury and least common was avulsion injury.

Table 3: Different Modes Of Finger Tip Injury

MODE	NUMBER OF PATIENTS (THENAR FLAP GROUP)	NUMBER OF PATIENTS (CROSS FINGER FLAP GROUP)	TOTAL
CRUSH INJURY	7	12	19
CHOP INJURY	7	8	15
CLEAN CUT	5	5	10
AMPUTATION			
AVULSION	4	2	6

The right hand was commonly involved with middle and ring fingers being most commonly injured (Table 4). According to Allen classification of fingertip injuries, type 3 was most common followed by type 4 (Fig 6).

Type 4: Table On Hand And Fingers Involved

GROUP	THENAR FLAP(TF)	CROSS FINGER FLAP(CFF)
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SIDE FINGERS	RIGHT HAND	LEFT HAND	RIGHT HAND	LEFT HAND
MIDDLE	6	4	5	4
RING	4	3	5	2
INDEX	3	2	4	3
LITTLE	1	0	2	1

Type of finger tip injury(Allen Classification)



Fig 6 – Pie chart showing type of finger tip injuries

Out of 50 patients, 18 responded the sensibility of digits as excellent after surgery whereas 15 responded it as good. Poor sensibility was seen in 9 patients and fair with 8 patients. The subjective response as excellent was recorded by 15 and 18 patients on function and appearance whereas 5 and 7 of them rated it as poor function and poor appearance respectively (Table 5).

Table 5 - Subjective Assessments (Sensibility, Function And Appearance)

	EXCELLENT		GOOD		FAIR		POOR	
	TF	CF	TF	CF	TF	CF	TF	CF
SENSIBILITY	10	8	9	6	3	5	4	5
FUNCTION	9	6	11	13	2	4	2	3
APPEARANCE	10	8	8	10	2	5	3	4

Out of 50 patients, 23 responded the static 2 point discrimination as excellent after surgery whereas 14 responded it as good. Poor sensibility was seen in 5 patients and fair with 8 patients. The dynamic 2 point discrimination recorded excellent in 18 patients whereas 3 of them rated it as poor response (Table 6).

Table 6 : Objective Assessment: Sensation (2 Point Discrimination /2 PD)

	EXCELLENT		GOOD		FAIR		POOR	
	TF	CF	TF	CF	TF	CF	TF	CF
STATIC 2 PD	12	9	8	6	3	5	2	3
DYNAMIC 2 PD	10	8	12	10	2	4	1	3

In terms of objective assessment of sensation, the mean 2 point sensation was compared among each group and with contralateral side (Table 7). The mean static 2 point discrimination (2 PD) of reconstructed finger of thenar flap group and cross finger flap group were found to be statistically significant (p-value= 0.001) whereas mean of contralateral side static 2 point discrimination (2 PD) of thenar and cross finger flap were found to be not significant (p-value= 0.13). Similarly, the mean moving 2 point discrimination (2 PD) of thenar group and cross finger flap group, and mean of contralateral side moving 2 point discrimination (2 PD) of thenar and cross finger flap were found to be not significant (p-value = 0.1 and p-value= 0.32 respectively). The comparison of mean of thenar flap and cross finger flap groups with their contralateral side mean was found significant (p-value= 0.01 and p-value < 0.0001 respectively)

Table 7 : Objective Assessment: Sensation (2 Point Discrimination /2 PD) (In mm)

	Static 2 PD		P Value	Moving 2 PD		P Value
	TF	CFF		TF	CFF	
Flap side (Mean $\pm$ SD)	5.62 $\pm$ 1.07	4.21 $\pm$ 0.67	0.001	3.74 $\pm$ 0.65	3.42 $\pm$ -0.29	0.1
Normal (Contralateral side) (Mean $\pm$ SD)	3.06 $\pm$ 0.61	2.75 $\pm$ 0.52	0.13	3.03 $\pm$ 0.63	2.82 $\pm$ -0.52	0.32
P Value	<0.00001	<0.00001	-	0.01		

Regarding the objective assessment of active range of motion, the mean active range of motion was compared among both group (thenar flap group and cross finger flap group) and with contralateral side (Table 8). The mean MP, PIP and DIP joint motion in the reconstructed finger of thenar flap group were 97.66 $\pm$ 5.30°, 82.66 $\pm$ 6.77° and 38.66 $\pm$ 4.41° compared to 101.66 $\pm$ 3.08°, 88.33 $\pm$ 3.08° and 42.33 $\pm$ 2.58° in the non-affected contralateral side respectively. Similarly, The mean

MP, PIP and DIP joint motion in the reconstructed finger of cross finger flap group were $88.33 \pm 11.12^\circ$, $78.66 \pm 6.67^\circ$ and $33.66 \pm 7.18^\circ$ compared to $95.66 \pm 5.62^\circ$, $86.33 \pm 4.80^\circ$ and $39.33 \pm 4.95^\circ$ in the non-affected contralateral side respectively. The differences in mean were not statistically significant.

Table 8 : Objective Assessment: Active Range Of Motion

	TF			CFF		
	Affecte d digit	Contralat eral digit	P value	Affecte d digit	Contralat eral digit	P value
Mean DIP joint motion (degrees+-SD)	38.66+- 4.41	42.33+- 2.58	0.85	33.66+- 7.18	39.33+- 4.95	0.99
Mean PIP joint motion (degrees+-SD)	82.66+- 6.77	88.33+- 3.08	0.99	78.66+- 6.67	86.33+- 4.80	0.93
Mean MCP joint motion (degrees+-SD)	97.66+- 5.30	101.66+- 3.08	0.98	88.33+- 11.12	95.66+- 5.62	0.99

There were few complications that include 3 marginal necrosis of flap and 4 developed wound infections developed in reconstructed finger in thenar flap group whereas, out of 25 cross finger flaps, 4 developed marginal necrosis and 6 developed wound infections. Marginal necrosis was managed conservatively and wound infection was managed with antibiotics and wound dressings. There was no complete loss of flaps in both cases. Time taken from injury to operation theatre was ranged from 3 hours to 35 hours and time taken for operation with thenar flap ranged from 1.5-3 hours and cross finger flap ranged 1-3 hours. The time taken for division of finger in both cases ranged from 14 to 18 days. The movement of digits were mildly restricted in both injured and donor finger in both flap groups which eventually improves at follow up of 6 months. Similarly, pain in fingertip and numbness were complained by all patients post-operatively. Out of 25 of thenar flaps, 8 complained of pain persisting for 2-4 weeks which eventually relieved after 4 weeks once physiotherapy started. Out of 25 of cross finger flaps, 11 complained of persisting pain in fingertip and donor area for 3-5 weeks.

Out of 50 patients, 5 suffered from donor site morbidity in Thenar flap group whereas 18 in cross finger flap group (Table 9).

Table 9 : Assesment Of Donor Site Morbidity

Donor site	Thenar Flap Group	Cross Finger Flap Group
Cold Intolerance	1	3
Pain	2	5
Scar Contracture	2	6
Joint Contracture	0	4

DISCUSSION

In this study conducted on flap treatment of fingertip injuries, total patients were 50. The male to female ratio was 0.65 and average age of patients was 34.66 years. The average age was 30.28 years and 29.3 years as reported in the study conducted by H Koch et al and Singh R et al respectively^{18,19}. The female preponderance in our study is in contrast with the study conducted by Saraf et al and Singh R et al in India which reported that there was male preponderance with ratio 1.5:1 and 3:1 respectively^{17,19}.

Fingertip injuries were carefully evaluated for hands involved, mode and types of injuries. The study published in Indian journal of orthopedics showed crush injuries (32%) as commonest mode of injury and middle finger (25.3%) as commonly injured digit which is similar to our study findings (38% and 38% respectively)¹⁷. The fingertip of right hand was found to be commonly injured in the study conducted by Singh R et al (83.3%) and Ranganathan S et al (58.8%) which is similar to our study (60%) but both of their studies observed index finger (40% and 35.2% respectively) as most commonly injured finger^{19,20}. However, Zienowicz RJ et al mentioned that middle finger is the most vulnerable because it is the most distal and the last to be withdrawn in case of any trauma²¹. According to Allen classification, type 1 and 2 injuries may heal well by secondary intention and type 3 and 4 often requires flap coverage^{15,22}. Our study demonstrated that type 3 (50%) fingertip injuries was most common and type 4 (32%) was second most common whereas study conducted by Singh R et al reported type 2 (41.2%) as most common and type 4 (29.4%) as second most common fingertip injuries¹⁹. On subjective assessment of

aesthetic outcomes, around 76% and 56% patients rated good-excellent sensibility with thenar flap and cross finger flap respectively. On rating the function of reconstructed finger, 48% and 32% of patients reported function as excellent and good respectively in thenar flap group whereas 32% and 40% patients reported excellent and good function respectively in cross finger flap group. Similarly, 40% and 32% of them rated the appearance of reconstructed finger as excellent and good respectively in thenar group and 32% and 40% of them reported appearance as excellent and good respectively in cross finger flap group. The difference on rating scale was not statistically significant for sensibility, function and appearance among two groups which indicates that for fingertip injuries, thenar flap and cross finger flap have similar aesthetic outcomes in 6 months follow up. When there is bony exposure, soft-tissue coverage to restore finger pulp volume and sensation becomes essential²³. As thenar flap provides good bulk with good aesthetic outcome, it is a good choice for reconstruction of the finger pulp^{23,24}. The functional outcome of flap was assessed by static 2PD and moving (dynamic) 2 PD along with range of motion at each joints of reconstructed digit. The mean static 2 PD and moving 2 PD was 5.62 mm and 3.74 mm in thenar flap reconstructed finger whereas it was 4.21 mm and 3.42 mm in cross finger flap reconstructed finger which is comparable to static 2 PD (5.6 mm) and moving 2PD (4.4 mm) reported by Sahu RK et al. and 5.6 mm and 3.3 mm reported by Dellon et al^{7,24}. In our study the static 2PD and moving 2PD measured in mm were found to be greater in reconstructed finger than normal contralateral finger. The difference in mean in both static PD and moving PD among thenar flap group and cross finger flap group as well as in comparison to normal contralateral side were found to be statistically significant ($p < 0.00001$).

On analysis of hand function, active range of motion of MP, PIP and DIP joints measured in degree (0) for period of six months were found to be lesser than the motion of normal contralateral digit in both thenar and cross finger flap groups. The mean active range of motion at three types of joint (MP, PIP, DIP) of finger were 97.660, 82.660 and 38.660 in thenar group and 88.330, 78.660 and 33.660 in cross finger group respectively. Our finding of MP joint was similar to Rinker et al (99.580) but the PIP and DIP joint motion were lesser than his study (92.40 and 50.410) but almost similar to results. On analysis of hand function, active range of motion of MP, PIP and DIP joints measured in degree (0) for period of six months were found to be lesser than the motion of normal contralateral digit in both thenar and cross finger flap groups. The mean active range of motion at three types of joint (MP, PIP, DIP) of finger were 97.660, 82.660 and 38.660 in thenar group and 88.330, 78.660 and 33.660 in cross finger group respectively. Our finding of MP joint was similar to Rinker et al (99.580) but the PIP and DIP joint motion were lesser than his study (92.40 and 50.410) but almost similar to results of Sahu RK et al (890 and 420).^{7,24} Though there was difference in active range of motion among groups, the difference was not found statistically significant.

The complications in cross finger flap reconstruction (40%) were more than in thenar flap reconstructed finger (28%). Marginal necrosis was managed conservatively and wound infection was managed with antibiotics and wound dressings. There was no complete loss of flaps in both cases. There was pain, numbness and difficulty in movement of both reconstructed fingers and donor fingers in both groups which gradually improves with physiotherapy. The complications were much more less than that reported by Koch et al and Al-Qattan MM et al in their studies^{18,27}. This study was successful in preserving the useful sensation, maximizing functional outcomes, providing satisfactory appearance and preventing the complications. However, no definitive distinction was observed in aesthetic and functional outcomes between thenar flap and cross finger flap reconstruction in fingertip injuries. Koch H et al mentioned that the cross finger flap is a reliable method in soft tissue reconstruction of the long fingers¹⁸. However, our study showed outcome of thenar flap reconstruction is almost similar to outcome of cross finger flap reconstruction. Study was conducted in single centre with small sample size. The follow up was done up to 6 months only. Hand aesthetic outcomes were solely based on patient reported rating. Few outcome instruments like Michigan Hand Outcomes Questionnaire, Vancouver scar scale, Buck-Gramcko Score could have been used for assessing hand aesthetics²⁹. Hand function analysis was measured only with active range of motion. The study depicts the donor site morbidity is higher in cross finger flap group than thenar flap group which is almost similar to study conducted by Koch H et al³⁰.

CONCLUSION

Thenar flap and cross finger flap are commonly employed in treating fingertip injuries. The aesthetic and functional outcomes of thenar and cross finger flap on fingertip reconstruction showed no significant differences. The further study at multicenter with larger sample size and longer follow up is required before recommending whether thenar flap or cross finger flap is superior in reconstruction of fingertip injuries.

Limitations Of The Study

1. The sample size was small. Only 50 cases are not sufficient for this kind of study.
2. The study has been done in a single centre.
3. The study was carried out in a tertiary care hospital, so hospital bias cannot be ruled out.
4. Follow-up was conducted for only 6 months
5. More sophisticated scoring systems could have improved aesthetic evaluation.

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Ethical Approval: The study was approved by the Institutional Ethics Committee

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