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Assessment of Functional Recovery, Aesthetic Outcomes, and Patient Satisfaction Following Flap-Based Fingertip Reconstruction: A Prospective Observational Study

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ABSTRACT

Background: Injuries to the fingertips may cause functional, sensory, length-related, and aesthetic problems. Flap reconstruction offers effective coverage of the soft tissues along with length preservation and sensibility restoration. The study evaluated the functional and sensory results, aesthetic outcomes, patient satisfaction, and complications after flap-based finger reconstruction.

Methods: This is an observational study, conducted on 100 patients who had fingertip reconstruction done at a tertiary care centre in Kochi. Patients selected for the study underwent clinical examination and flap reconstruction, followed by postoperative assessment of functional recovery, sensation, aesthetics, complications, and patient satisfaction. Analysis of data was done using SPSS version 27.

Results: Among all of the 115 reconstructed fingers, 82.6% were from individuals under 50 years old and 60.9% of them were right-sided injuries. The index finger cases (34.8%) and transverse injuries (47.0%) were common, and road traffic accidents were noted among 44.4% of the patients. Common flaps included CFF (67.8%) and VY (18.2%). Postoperative complications were not observed in 92.1% of patients, with stiffness only in 6.1%.

Conclusion: The study concluded that the flap-based fingertip reconstruction showed the effective functional and aesthetic recovery with low rate of the complication, contributing to the selected flap procedure to restore the function of the finger.

Key-words: Fingertip injury; Flap reconstruction; Functional recovery; Aesthetic outcome; Sensory function

INTRODUCTION

Fingertip injuries are one of the most common traumatic injuries of the hand and can be caused by crushing, cutting or traumatic amputation of the finger in occupational or domestic environments. Tissue loss is likely to affect both hand function and the appearance of the digit, as the fingertip is the focus of tactile discrimination, fine manipulation, pinch and precision grip.

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The injuries can include loss of pulp, loss of nail bed, loss of distal phalanx, and the reconstructive plan should be tailored to the structures lost. Goals of fingertip reconstruction go beyond simply closing the wound. They include preserving functional digit length, durable soft-tissue coverage, protective and discriminative sensibility, the nail complex (when possible), an appropriate pulp contour, and recovery of hand use. Current management is tailored to the extent and shape of the tissue loss, the exposure of bone or tendon, the health of the remaining tissues, the digit involved and patient-specific functional demands. Options for secondary healing, grafting, composite grafting, local flaps, regional flaps and microsurgical reconstruction are available, and of particular interest will be the flap coverage where exposed bone or tendon cannot be covered with simpler methods [1,2].

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Local and regional flaps ensure vascularized tissue and preserve digit length and sensibility when applicable [3]. This includes, but is not limited to, V-Y flap advancement, thenar flaps, cross-finger flaps, homodigital neurovascular flaps, digital artery perforator flaps, and reverse-flow flaps. They have their own indications and limitations, and they should be chosen depending on the size and shape of the defect, the amount of tissue needed, the vascularity, and the amount of sensation the area will require, where the donor area is, and the occupation and expectations of the patient, not on the fact that it's the preferred technique. This is evident from comparative evidence. A prospective study comparing a parallelogram flap with a homodigital island flap showed similar two-point discrimination and total active motion at 6 months, with the parallelogram flap favouring aesthetic and satisfaction scores. Likewise, prospective studies comparing cross-finger and thenar flaps found better recovery of sensation and higher satisfaction with the appearance of the thenar flap, but with a higher incidence of partial flap loss [4].

Assessment of functional recovery after a finger reconstruction should be based on specific clinical criteria instead of general terms like “good function” or “normal sensation.” Relevant domains are range of motion, total active motion if applicable, static or moving two-point discrimination, monofilament sensibility (if applicable), pain or hypersensitivity, cold intolerance, neuroma-related symptoms and return to work/activities of daily living. A systematic review of reverse homodigital island flaps found a mean postoperative static two-point discrimination of 7.2 mm, moving two-point discrimination of 6.7 mm, mean time to return to work of about 8 weeks, a pooled flap survivorship of 98.4% and clinically relevant complications such as venous congestion, hypersensitivity, contracture and cold intolerance. Another systematic review conducted in 2026 confirmed improved sensibility with innervated over non-innervated local flap reconstruction in finger reconstruction, reinforcing the value of sensation in finger reconstruction [5,6].

Clinically relevant aesthetic outcome is a separate aspect of reconstruction. Pulp contour, the shape of the nails, the colour and texture of the tissue, the scar characteristics and the appearance of the donor site can affect the way that the result is perceived by the patient. Homodigital neurovascular island flaps were evaluated by the patient’s years after reconstruction, and although some patients had an objective sensory and functional abnormality, subjective global and aesthetic outcomes remained favourable years after reconstruction. Comparative evidence also suggests that aesthetic and satisfaction measures can differentiate reconstructive techniques even if functional measures are comparable. Thus, a direct measure of patient satisfaction, not a measure of flap survival, wound healing or the range of motion, should be used to evaluate patient satisfaction.

Another area that needs to be interpreted carefully is the selection of flap reconstruction versus less invasive options. While occlusive dressings require multiple dressing changes, which may lead to delays in soft tissue coverage, flap reconstruction has been shown to increase the risk of symptomatic neuroma and joint stiffness in a systematic review and meta-analysis performed in 2026. It is not the purpose of these findings to suggest that flaps are bad or worse in every clinical scenario; rather, they should highlight the significance of choosing the appropriate method to reconstruct the defect to the function that is anticipated and the morbidity that will result. In selected complex defects, microsurgical options like free toe pulp transfer can offer successful coverage, with recent literature reporting very high flap survival rates and inconsistent reporting of outcomes regarding sensory and patient-reported outcomes [7-9].

Thus, evaluation of fingertip reconstruction should incorporate objective functional and sensory evaluation, complications and patient satisfaction with the reconstruction. The present prospective observational study aimed to assess these domains, especially pertaining to functional recovery, sensory function, aesthetic result, patient satisfaction and postoperative complications, after flap reconstruction of fingertip defects.

MATERIALS AND METHODS

Research design- The study was a prospective observational study to evaluate functional recovery, aesthetic outcome and patient satisfaction, which was followed by the reconstruction of the flap-based fingertip. The study was conducted among 100 patients in the Department of Plastic and Reconstructive Surgery in a Hospital in Kochi, Kerala. The functional recovery, the aesthetic outcomes or complications in the

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postoperative period, sensory function and patient satisfaction were evaluated during the follow-up stage. The study evaluated the outcomes of reconstructive surgery of the fingertips, including the type of flaps used and clinical outcomes. Patients were selected on the basis of the predefined inclusion and exclusion criteria. Both verbal and written consent were taken for the study from all of the patients.

Inclusion criteria

- Patients of age >5 and <75 years were included.
- Those who had undergone acute fingertip injury with exposed bone were included.
- Patients with thumb-tip amputation with exposed bone were included,
- Patients with various injuries in the fingertip of the same hand that needed soft-tissue reconstruction were included.

Exclusion criteria

- Patients with fracture or tendon injuries which required repair were excluded.
- Patients with the mangled extremity, crush injury, or early injury were excluded
- Stiff finger joints were included.
- Patients with other systemic illness or comorbid conditions were not allowed.

Sample Size Calculation

The formula for sample size in a prospective study is given as $\mathbf{n= Z^2pq/d^2}$

Where n= sample size
Z= standard deviation from normal= 2
p= maximum expected prevalence=0.5
q= 1-p= 0.5
d= maximum allowable error of p= 20% X0.5= 0.1
From the simple calculation,
n=100

Procedure- The study approval was obtained from the Institutional Ethics Committee. Only eligible patients who had experienced injuries to the fingertips were included in the study based on the predefined inclusion and exclusion criteria. Both verbal and written informed consent were obtained for the study. The patients underwent comprehensive clinical evaluation, including their age, sex, the mode of injury, and the extent of the injury in terms of how many fingers were injured. Subsequently, the injury was assessed to determine the appropriate reconstructive modality before implementing the treatment procedure per the study protocol. Follow-up was done to evaluate the outcomes of the reconstruction, both in terms of functionality and aesthetics, and regarding any complications. The patient satisfaction was measured and recorded.

Statistical Analysis- Data analysis was done using SPSS version 27. The results were represented by the use of tables, bar diagrams and pie charts. The continuous variables were represented in the form of mean ± standard deviation. Also, the independent two-tailed Student's t-test, chi-square test, and ANOVA were used. The $p<0.05$ was considered statistically significant.

RESULTS

Table 1 demonstrated the demographic and injury-related characteristics for the participants aged <50 years, accounting for 82.6% of cases. The right-hand injuries were more frequent than the left-hand injuries. In cases of the finger involvement, the most commonly affected finger was the index finger (34.8%, followed by the middle finger (31.3%, while the little finger was noted in 5.2% of cases. 47% of the transverse injuries were noted for the pattern of the injury, which was followed by 25.2% of the volar oblique injuries and 19.1% of the dorsal oblique injuries. The leading mode of injury was the road traffic accidents, accounting for 44.4% of cases, followed by worksite injuries at 21.7%. In terms of the amputation level, the most frequent was the Allen type 2 at 45.2%, followed by the 33.9% of the Allen type 3.

Table 2 showed the distribution of the 115 reconstructed fingers; the most frequent was the 67.8% of CFF, which was followed by the 18.2% of the VY flap and the 8.7% of the thenar flap. The VY flap showed no association with the injured finger, and the p-value was >0.05. The association was noted between the selection of the VY flap and the dorsal oblique, which indicated the use of the VY flap. In the case of the level of injury, the VY flap use was associated with Allen type 2 injuries. No VY flap was used for the Allen type 3 or type 4 injuries.

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Table 1: Overall Distribution of Demographic and Injury-Related Characteristics of the Study Participants

Distribution	Category	Number of fingers	Percentage (%)
Age distribution	Age <50	95	82.6
	Age ≥50	20	17.4
	Total	115	100
Gender distribution	Male	94	18.3
	Female	21	81.7
	Total	115	100
Laterality distribution	Left	45	39.1
	Right	70	60.9
	Total	115	100
Finger distribution	Thumb	11	9.6
	Index	40	34.8
	Middle	36	31.3
	Ring	22	19.1
	Little	6	5.2
	Total	115	100
Type of injury distribution	Dorsal oblique	22	19.1
	Transverse	54	47
	Volar oblique	29	25.2
	Oblique	6	5.2
	Lateral oblique	4	3.5
	Total	115	100
Mode of injury distribution	Bikechain	20	-
	Doortrap	7	6.1
	RTA	51	44.4
	Worksite	25	21.7
	Mixi grinder	-	-
	Total	115	-
Level of amputation distribution	Allen type 1	9	7.8
	Allen type 2	52	45.2
	Allen type 3	39	33.9
	Allen type 4	15	-
	Total	115	-

Table 2: Distribution of Flap Types and Their Association with Finger, Angle, and Level of Injury

Characteristic	Category	VY flap	Others	p-value
Type of flap used	VY	21 (18.2%)	-	-
	Lateral VY	1 (0.9%)	-	-
	CFF	78 (67.8%)	-	-
	FDMA	1 (0.9%)	-	-
	Venkatswamy	4 (3.5%)	-	-
	Thenar	10 (8.7%)	-	-
	Total	115	-	-
Finger involved	Thumb	4	7	0.261

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	Index	10	30	0.358
	Middle	4	32	0.222
	Ring	4	18	0.861
	Little	0	6	NA
Angle of injury	Dorsal oblique	8	14	0.047
	Transverse	10	44	0.936
	Volar oblique	2	27	0.096
	Oblique	1	5	0.707
	Lateral oblique	1	3	0.732
Level of injury	Allen type 1	4	5	0.117
	Allen type 2	18	34	0.0003
	Allen type 3	0	39	NA
	Allen type 4	0	15	NA

Table 3 showed that the complications were not known among 106 fingers, which was not reported with any complication. The most frequent complication was stiffness among 7 patients (6.1%, while complete and partial flap necrosis showed 0.9%. The most significant association was noted among flap type for VY and CFF flaps. Mostly, 15 of 21 VY flaps showed sensory function of ≤5, while 75 of 78 CFF flaps showed sensory function >5. Venkatswamy and thenar flaps do not show any significant associations. Functional recovery was observed in 112 fingers (97.4%). The return to function was noted for the flap type.

Table 3: Distribution of Complications, Sensory Function, and Return to Function Following Flap Reconstruction

Characteristic	Category	Number of fingers	Percentage (%)	p-value
Complications	None	106	92.1	-
	Complete necrosis	1	0.9	-
	Partial necrosis	1	0.9	-
	Stiffness	7	6.1	-
	Total	115	100	-
Sensory function	VY	≤5: 15	>5: 6	<0.00001
	Lateral VY	≤5: 1	>5: 0	NA
	CFF	≤5: 3	>5: 75	<0.00001
	FDMA	≤5: 0	>5: 1	NA
	Venkatswamy	≤5: 1	>5: 3	0.648
	Thenar	≤5: 5	>5: 5	0.062
Return to function	Good	112	97.4	-
	Fair	3	2.6	-
	Total	115	100	-
Return to function by flap	VY	Good: 20	Fair: 1	0.942
	Lateral VY	Good: 1	Fair: 0	-
	CFF	Good: 76	Fair: 2	-
	FDMA	Good: 1	Fair: 0	0.56
	Venkatswamy	Good: 4	Fair: 0	NA
	Thenar	Good: 10	Fair: 0	NA

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Table 4 stated that aesthetic outcome following flap reconstruction was noted among the 103 fingers (89.5%), while the 11 fingers (9.6%) were classified. Only one finger was noted with partial necrosis (0.9%. For the flap-specific aesthetic outcomes, satisfactory outcomes were noted for 20 of 21 VY flaps, 68 of 78 CFF flaps, all 1 lateral VY flap, the FDMA flap, and all 4 Venkatswamy flaps. In the case of the thenar flaps, about 9 to 10 outcomes were noted. The association was noted between the flap type and aesthetic recovery for VY (p=0.585) or CFF (p=0.374) flaps, which indicated the aesthetic recovery.

Table 4: Aesthetic Outcome and Its Association with Flap Type Following Finger Reconstruction

Characteristic	Category	Number of fingers	Percentage (%)	p-value
Aesthetic outcome	Partial necrosis	1	0.9	-
	Stiffness	11	9.6	-
	Not applicable	-	-	-
	Satisfactory	-	-	-
	Very satisfactory	103	89.5	-
	Total	115	100	-
Aesthetic outcome by flap type	VY	Very satisfactory: 20	Others: 1	0.585
	Lateral VY	Very satisfactory: 1	Others: 0	NA
	CFF	Very satisfactory: 68	Others: 10	0.374
	FDMA	Very satisfactory: 1	Others: 0	NA
	Venkatswamy	Very satisfactory: 4	Others: 0	-
	Thenar	Very satisfactory: 9	Others: 1	-

Fig. 1 demonstrated the postoperative complications and aesthetics noted among 115 reconstructed fingers. Majority of the fingers, 106 (92.1%) showed no postoperative complications without any favorable postoperative period. Stiffness was the most common complication, affecting 7 fingers (6.1%), while partial necrosis affected only 1 finger (0.9%). Also, the effective aesthetics of the reconstructed fingers were noted among 103 fingers (89.5%), with a favourable outcome for aesthetics. However, only 11 fingers (9.6%) had effective aesthetics, while 1 finger (0.9%) was not applicable.

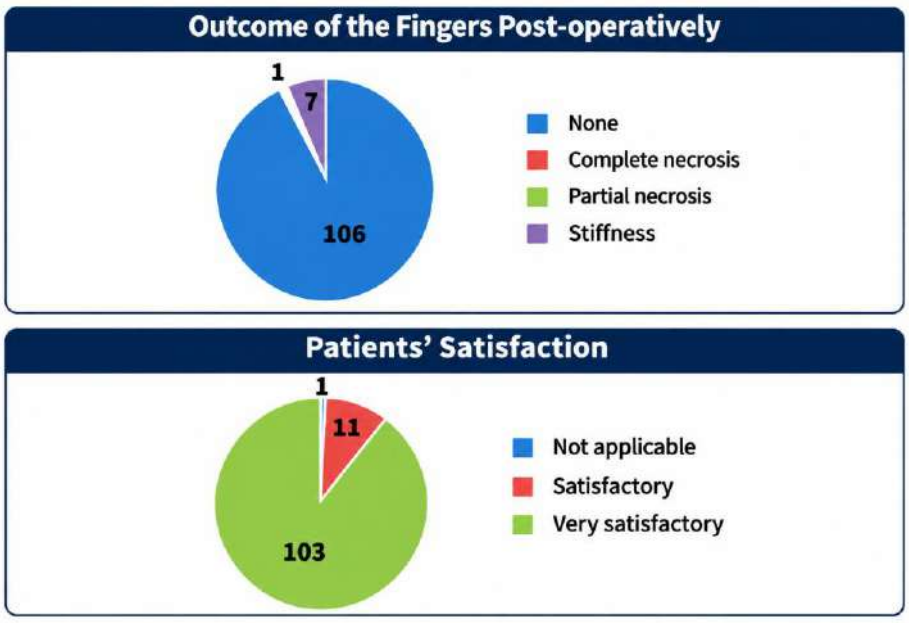


Fig. 1: Distribution of Postoperative Complications and Aesthetic Outcomes Following Finger Reconstruction

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Fig. 2 demonstrated the outcome of the aesthetic and sensory recovery in the reconstructed fingers. Among all of the fingers studied, 112 fingers (97.4%) had effective aesthetic outcomes, whereas 3 fingers (2.6%) had fair aesthetic outcomes. In terms of sensory function, the results were found in CFF flaps, where 75 fingers had >5 sensory function results, while 3 fingers had ≤5 sensory results. VY flap had 6 fingers with>5 sensory results and 15 fingers with ≤5 sensory results. Thenar flaps had 5 fingers each with>5 and ≤5 sensory results. Venkatswamy flaps had 3 fingers each with >5 sensory results, while FDMA had 1 finger with >5 sensory results.

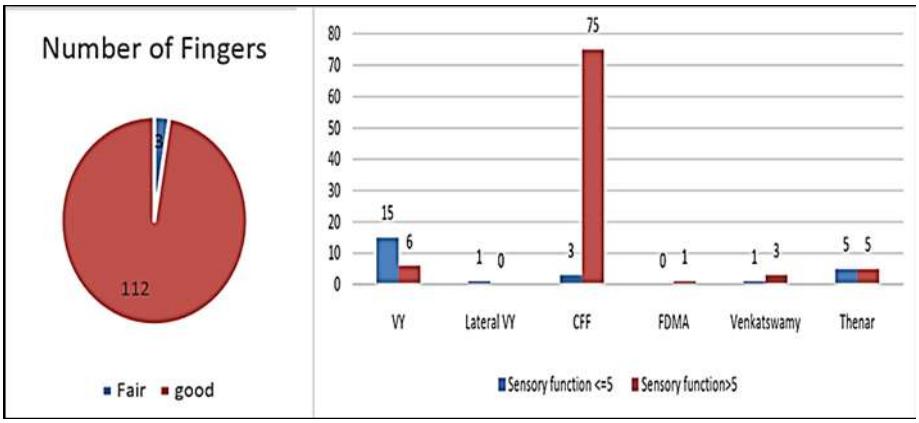


Fig. 2: Distribution of Aesthetic Outcome and Sensory Function According to Flap Type

DISCUSSION

Fingertip reconstruction should be evaluated as a multidimensional clinical outcome rather than by flap survival or wound healing alone. The relevant endpoints include preservation of digit length, durable soft-tissue coverage, sensibility, range of motion, pain, cold intolerance, aesthetic appearance, donor-site morbidity, and patient-reported satisfaction. This framework aligns with contemporary reviews that emphasise functional length, nail preservation, soft-tissue coverage, sensory recovery, and chronic pain as key considerations in fingertip injury management [10].

The literature also demonstrates that objective functional outcomes and patient-reported outcomes measure related but distinct aspects of recovery. In a long-term series of 20 patients treated with homodigital neurovascular island flaps, the median subjective global score was 7.5/10, and the median aesthetic score was 8/10 at a median follow-up of 4.4 years [11]. These findings illustrate the value of obtaining patient-reported assessments in addition to clinical examination. They also support avoiding unqualified terms such as “successful,” “good,” or “normal” unless these terms are linked to predefined measurements or validated instruments.

Sensory recovery is particularly important because the fingertip is involved in tactile discrimination and precision handling.

Evidence from a systematic review of innervated local flaps indicates that innervated reconstruction is associated with better sensibility than non-innervated local flaps [12]. In a separate systematic review of reverse homodigital island flaps, pooled postoperative static and moving two-point discrimination were 7.2 and 6.7 mm, respectively [5]. These data provide clinically interpretable benchmarks, but direct comparison with an individual prospective cohort requires the same sensory method, assessment timing, and reporting scale. The present manuscript should therefore report the exact sensory instrument used and the corresponding numerical results rather than describing sensation generically.

Flap selection should likewise be interpreted in the context of defect characteristics and patient requirements. Comparative studies have not demonstrated universal superiority of one local flap over all others. A 2023 meta-analysis comparing reverse homodigital artery and reverse dorsal homodigital island flaps found no significant differences in flap necrosis, static or moving two-point discrimination, total active motion, satisfaction, or sensory recovery grade, although donor-site complications and venous congestion differed between techniques [13]. Similarly, a prospective comparison of cross-finger and laterally based thenar flaps found better sensory recovery and aesthetic satisfaction with thenar flaps, but partial flap loss

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occurred more frequently in that group. [14]. These findings support individualised reconstruction based on defect geometry, required tissue characteristics, donor-site considerations, and patient priorities.

Aesthetic outcome deserves independent consideration because preservation of length and soft-tissue contour may influence satisfaction even when conventional functional measures are acceptable. In the prospective comparison of parallelogram and homodigital island flaps, total active motion and two-point discrimination did not differ between groups at 6 months, whereas Michigan Hand Questionnaire aesthetics and satisfaction scores favored the parallelogram flap [15]. This illustrates why functional measurements alone may not capture the patient's perception of the reconstructive result. Assessment should therefore specify how aesthetics and satisfaction were measured and should avoid unsupported qualitative descriptions.

Complications must be considered when interpreting the overall value of flap reconstruction. The 2026 systematic review and meta-analysis of local flaps versus occlusive dressings reported symptomatic neuroma in 11% of flap-treated digits compared with 1% after local wound care, and joint stiffness in 24% versus 8%, respectively; nail deformity and infection rates were comparable [16]. These findings reinforce the importance of patient selection and postoperative rehabilitation but should not be interpreted as evidence that flap reconstruction should be avoided categorically. Flaps remain an important option when immediate durable coverage is required, particularly when the defect cannot be managed adequately with secondary healing or graft-based methods.

Rehabilitation is an integral component of recovery. Depending on the procedure and injury pattern, postoperative management may include protected mobilisation, range-of-motion exercises, scar management, desensitisation or sensory retraining, strengthening, and progressive return to functional use. The systematic review of reverse homodigital island flaps identified contracture, pain or hypersensitivity, venous congestion, and cold intolerance among reported complications and emphasised postoperative rehabilitation [17]. The discussion of the present study should therefore distinguish complications observed in the cohort from complications reported in the literature and should report their frequency, severity, treatment, and final status where available.

Recent evidence also supports careful interpretation of more complex reconstructive options. Free toe pulp flaps demonstrate very high reported survival, with a 2026 systematic review and meta-analysis reporting pooled survival of 99.8%, but sensory and aesthetic outcomes were heterogeneously reported and the evidence base was dominated by retrospective studies [18]. This illustrates a broader issue in fingertip reconstruction: survival is comparatively easy to standardise, whereas sensibility, aesthetics, function, and satisfaction are reported using heterogeneous methods. Prospective studies should therefore use predefined and reproducible outcome measures and specify the timing of assessment.

Taken together, the available evidence supports a patient- and defect-specific approach to flap selection and emphasises that reconstructive quality should be judged across multiple outcome domains. The present study is appropriately positioned to contribute prospective data on these domains; however, interpretation of its findings should be based on the actual cohort-level numerical results, including the magnitude of functional and sensory recovery, aesthetic scores, satisfaction measures, and complication rates. Claims of correlation, superiority, effectiveness, or overall success should only be retained when supported by the study's statistical analysis. Longer-term prospective studies using standardised functional, sensory, aesthetic, and patient-reported measures would improve comparability across reconstructive techniques.

CONCLUSIONS

This study concluded that the reconstruction utilising flaps yielded favourable outcomes regarding functional recovery, sensation recovery, and aesthetically pleasing reconstruction in patients requiring fingertip reconstruction. The injuries involved young people less than 50 years old, mostly involving the index finger and middle finger, where road traffic accidents were the main cause of the injuries. The most common reconstructions involved the use of CFF, followed by the VY flap. The use of the VY flap was significantly associated with dorsal oblique injuries and Allen type 2 amputation, suggesting that the use of the VY flap is based on the injury pattern. Post-operative

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complications were rare, with 92.1% of the fingers undergoing reconstruction showing no post-operative complications, with stiffness as the most common complication (6.1%) followed by necrosis (0.9%). The functional recovery achieved was high, with 97.4% of the fingers showing effective functional recovery.

CONTRIBUTION OF AUTHORS

One author has only contributed to this article.

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