RESEARCH PAPER

Aesthetic and Functional Outcomes of Flap Reconstruction in Acute Fingertip Injury: A Prospective Study in Tertiary Care Center

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ABSTRACT

Background: Fingertip injury is the single most significant category of traumatic injuries encountered in emergency and outpatient plastic surgery services globally. The aim was to study and compare the aesthetic and functional outcomes of surgical intervention (flap reconstruction) in patients presenting with acute fingertip injuries.

Methods: This prospective comparative observational study evaluated the aesthetic and functional outcomes of Thenar Flap reconstruction versus Terminalisation for acute fingertip injuries in 50 patients managed between March 2024 and March 2026. Patients aged 18–50 years with acute fingertip injuries requiring operative management (defect > 1 cm², with exposed bone or tendon) were enrolled by consecutive sampling into two equal groups: Group A (Thenar Flap, n = 25) and Group B (Terminalisation, n = 25).

Results: The study population had a mean age of 30.1 ± 10.2 years with a markedly higher number of males (88%). Crush injury was the leading mechanism (56%); Allen Zone IV injuries were most frequent (42%). Pre-operative sensation was absent in 46%; surgical intervention restored it to 98% (McNemar $\chi^2 = 20.17$, $p < 0.001$). Overall complete flap take was 86%. The Thenar Flap group achieved better (lower) total FIOS scores (mean 15.44 ± 5.29) compared to the Terminalisation group (mean 22.08 ± 4.71; Mann-Whitney U = 509.0, p = 0.0001). Patient satisfaction was better in the Thenar Flap group (3.36 ± 0.86 vs 2.76 ± 0.83, p = 0.014).

Conclusion: Both procedures are safe and effective; Thenar Flap reconstruction is recommended for appropriate patient and injury, given its superior functional, aesthetic, and patient-reported outcomes.

Key **words:** fingertip injury; thenar flap; terminalisation; Finger Injury Outcome Score (FIOS); Allen classification; patient satisfaction

How to cite this article: Dr. Varsha Kalyanpur, Dr. Darshansingh. U. Rajput, Aesthetic and Functional Outcomes of Flap Reconstruction in Acute Fingertip Injury: A Prospective Study in Tertiary Care Center, International Journal of Drug Delivery Technology, 2026;16(90s): 1089-1091; DOI: 10.25258/ijddt.16.90s.107

Source of support: Nil.

Conflict of interest: None

INTRODUCTION

Fingertip injury is the single most significant category of traumatic injuries encountered in emergency and outpatient plastic surgery services globally.[1] The human hand is one of the most complex and functionally indispensable organs in the human body, serving as the primary instrument through which individuals interact with the physical world.[2] It enables the performance of skilled prehensile movements, fine sensory exploration, and non-verbal communication that are fundamental to human expression and occupational capability.[2] Of all the anatomical components of the hand, the fingertip occupies a position of singular importance by virtue of its unique combination of specialized sensory end-organs, resilient pulp architecture, and the nail apparatus.[3] Its role as the most sensitive and discriminating tactile structure in the human body renders it indispensable for precision grip, object recognition, and the execution of tasks requiring delicate manual dexterity.[4]

The distal and exposed position of the fingertip renders it disproportionately vulnerable to contact with hazardous machinery, cutting instruments, and blunt forces in occupational, industrial, domestic, and recreational settings.[1] The hand may come into direct contact with cutting machines, fast-moving industrial equipment, knives, glassware, hammers, door entrapments, pulleys, and stone — mechanisms capable of producing injuries ranging in severity from simple lacerations to complex amputations involving the distal phalanx, nail, nail bed, extensor or flexor tendons, and digital neurovascular bundles.[3]

AIMS AND OBJECTIVES

To study and compare the aesthetic and functional outcomes of surgical intervention (flap reconstruction) in patients presenting with acute fingertip injuries at the Department of Plastic and Reconstructive Surgery, KAHER's Jawaharlal Nehru Medical College and Hospital, Belagavi.

MATERIALS AND METHODS

A hospital-based prospective comparative study, to evaluate the aesthetic and functional outcomes of Thenar flap reconstruction in patients presenting with acute fingertip injuries.[2] The prospective design was chosen to allow standardized pre-operative assessment, intraoperative documentation, and structured postoperative follow-up using validated outcome instruments, thereby minimizing the recall bias and incomplete documentation that characterize retrospective designs.[3]

The study was conducted in the Department of Plastic and Reconstructive Surgery, KAHER's Jawaharlal Nehru Medical College and Hospital (JNMC), Belagavi, Karnataka.

The study was conducted for a period of 2 years- from March 2024 to March 2026.

The study protocol has been submitted to the JNMC Institutional Ethics Committee (JNMCIEC) for review and approval.The study was conducted in full accordance with the Declaration of Helsinki (revised 2013) and the Indian Council of Medical Research (ICMR) National Ethical Guidelines for Biomedical and Health Research Involving Human Participants (2017).[11]

Pre-operative assessment. All enrolled patients underwent a structured pre-operative assessment using the standardized proforma developed for this study, recording patient demographics, mechanism of injury, past medical history, local

examination, sensory examination, and investigations (X-ray, Doppler).

Post-operative assessment and follow-up. All patients were assessed at discharge, and at around 1 month, 3 months, and 6 months following surgery, recording flap survival, colour match, sensation, 2-PD, joint motion, FIOS score, donor site outcome, complications, patient satisfaction, and duration of physiotherapy. All patients received a standardized postoperative care protocol: wound dressing changes every 48 hours, elevation of the operated hand, analgesics as required, and prophylactic antibiotics for 5–7 days. Suture line was assessed and suture removal done on POD 10–14. For terminalisation patients, physiotherapy and hand therapy were initiated from postoperative day 3. For thenar Flap patients, physiotherapy was initiated after pedicle division (typically at 3 weeks) - gentle passive mobilisation commenced at day 3; active and continued for a minimum of 4 weeks post-division.[12]

Primary outcome measures: FIOS (Finger Injury Outcome Score) at 6 months post-operatively;[8] flap survival (complete take vs. partial/complete loss).

RESULTS

The most common mechanism was crush injury (56%), followed by avulsion (36%). Injury severity by Allen zone: Zone IV injuries were most common (42%), followed by Zone II (32%). Wound types were nearly equally distributed: Transverse 38%, Oblique 36%, Crush 26%. There is no statistically significant association between Allen zone of injury and wound type (chi-square χ^2 = 2.155, df = 6, p = 0.905), and the Spearman correlation is negligible ($\rho = -0.132$, p = 0.361). This means that the zone of fingertip injury does not predict the morphology of the wound.

Bone exposure was the most common local finding (64%), and nail bed involvement was present in 52% of cases (Table 2). These findings highlight the severity of the injuries, which frequently involved multiple tissue layers, including bone and nail.

Pre-operative sensation was present in 27 (54%), absent in 23 (46%), patients. Post-operatively, 49 (98%) had present sensation. A McNemar test was applied for this paired comparison. There was a statistically significant improvement in sensation following surgery (McNemar χ^2=20.17, p<0.001). The proportion of patients with present sensation improved dramatically from 54% pre-operatively to 98% post-operatively.

Complete flap take was achieved in 43 patients (86%). Partial survival occurred in 5 (10%) and complete loss in 2 (4%). Good colour match was achieved in 45 patients (90%) and good joint motion in 44 (88%). Donor site healing was complete in 98% of patients, and only one patient (2%) required a secondary procedure. This reflects the excellent reliability of primary closure and the low donor site morbidity associated with both the thenar flap and terminalisation.

Thenar Flap patients reported significantly higher satisfaction (mean 3.36 ± 0.86) than Terminalisation patients (mean 2.76 ± 0.83; U=191.5, p=0.014). The higher satisfaction in the Thenar Flap group, which paralleled its better FIOS scores, may reflect patients' subjective appreciation of preserved finger length and cosmesis, highlighting the importance of incorporating patient-reported outcomes alongside objective functional scores.

Terminalisation was associated with a significantly higher (worse) FIOS compared to Thenar Flap reconstruction (mean 22.08 ± 4.71 vs 15.44 ± 5.29; Mann-Whitney U=509.0, p=0.0001). This statistically significant difference suggests that Thenar flap yields superior overall functional and cosmetic outcomes as measured by FIOS, despite comparable flap survival rates between the two procedures. Each of the nine FIOS sub-domains was individually compared between operative groups using the Mann-Whitney U test.

A Kruskal-Wallis test compared FIOS scores across the four Allen zones to assess whether injury severity influenced functional outcome. FIOS scores increased significantly with Allen zone severity (Kruskal-Wallis H=26.37, p<0.001). Zone IV injuries, being the most severe, had the highest FIOS scores (mean 23.76), indicating greater functional impairment, consistent with the biological correlation between injury severity and functional outcome

DISCUSSION

Crush injury was the predominant mechanism of injury in our cohort (56%), followed by avulsion (36%), incision (6%), and laceration (2%). This distribution contrasts with patterns in high-income countries where saw and industrial machinery injuries predominate[16]. In rural North Karnataka, agricultural threshers, sugarcane cutters, and power tillers are important injury mechanisms[15]. The high proportion of crush injuries is clinically relevant because crush mechanisms produce a greater zone of injury than clean amputations, creating more challenging wound beds for flap reconstruction and increasing the risk of partial flap necrosis[3].

The overall complete flap survival rate of 86% (43 of 50 patients), with partial survival in 10% and complete loss in 4%, compares favourably with published benchmarks. For VY advancement and thenar flap reconstruction, reported complete survival rates of 92–98% have been documented[9,10,18,19]. The slightly lower overall rate in our series may reflect the severity of the crush mechanism predominating in our cohort, which is known to be associated with higher rates of partial necrosis due to the greater zone of tissue injury[3,20]. Terminalisation achieved a numerically higher complete take rate (92% vs 80%), but not significant (χ^2=2.409, p=0.300), consistent with the understanding that both procedures are reliable for achieving durable soft tissue coverage when performed with meticulous technique[2].

The mean overall FIOS score across all 50 patients was 18.76 (SD ±5.98, range 10–29). The FIOS is a validated, multi-domain patient-reported outcome measure specifically designed for digit trauma populations, and its reliability and responsiveness have been well documented[8]. In interpreting FIOS scores, higher values in this instrument denote greater functional impairment; thus Terminalisation's higher mean FIOS (22.08 ± 4.71) compared to Thenar Flap (15.44 ± 5.29) indicates poorer outcomes in the Terminalisation group. The Mann-Whitney U test confirmed that this difference was highly statistically significant (U=509.0, p=0.0001), indicating that the two procedures serve distinct patient and injury profiles rather than being interchangeable for identical defects.

CONCLUSION

This study provides prospective, evidence-based data demonstrating that both Terminalisation and Thenar Flap reconstruction are safe, effective, and reliable approaches to acute fingertip injury management in the tertiary care setting. The selection between them should be individualized to the zone and geometry of the injury, the patient's age, occupation, aesthetic expectations, and the preference for single- versus two-stage reconstruction. The prospective study demonstrates that flap reconstruction by thenar flap provides reliable tissue coverage with satisfactory functional and aesthetic outcomes in acute fingertip injuries. Patients achieved good sensory recovery, acceptable fingertip contour, high flap survival rates and satisfactory return to daily and occupational activities.

At the follow up of 6 months, Thenar Flap group achieved better total FIOS scores compared to the Terminalisation group, the superiority being consistent across the individually tested FIOS sub-domains such as Nail, Length, Pulp, Bone, Cosmesis, Pain, ROM, Grip, return to work. FIOS scores increased significantly with Allen zone severity and, most importantly, patient satisfaction was better in the Thenar Flap group despite being a 2 stage procedure.

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