Section: General Surgery

Original Research Article

A STUDY OF PATTERN AND FUNCTIONAL OUTCOME OF FOREARM AND HAND INJURIES IN A TERTIARY CARE CENTRE

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ABSTRACT

Background: Forearm and hand injuries cause substantial functional impairment because of the complex interaction of bones, tendons, muscles, nerves, and soft tissues. Early assessment, appropriate reconstruction, and rehabilitation are essential to preserve wrist and hand movements and minimize long-term disability. The study aimed to assess demographic characteristics, associated risk factors, mechanisms, anatomical patterns, treatment modalities, and functional outcomes of forearm and hand injuries, with particular emphasis on progressive recovery of wrist range of motion following surgical management.

Materials and Methods: This prospective observational study included 80 patients treated from April 2024 to September 2025. Clinical characteristics, injury patterns, treatment, hospital stay, and wrist movements were recorded preoperatively and during follow-up. Statistical significance was considered at $p<0.05$.

Results: Most patients were male (76.30%), with a mean age of 32.43 ± 19.00 years. Machine cuts and road traffic accidents each accounted for 36.30%. All wrist movements improved significantly by six months, with $p<0.0001$.

Conclusion: Forearm and hand injuries primarily affected young males and frequently involved the distal forearm and soft tissues. Individualized surgical reconstruction and structured follow-up produced significant improvement in wrist mobility, emphasizing the importance of timely intervention and rehabilitation.

Keywords: Forearm injury, hand injury, wrist range of motion, tendon repair, fracture fixation, soft-tissue injury, functional outcome, rehabilitation.

INTRODUCTION

Forearm and hand injuries involve damage to the skin, bones, joints, muscles, tendons, nerves, or blood vessels located between the elbow and fingertips. They may be closed or open and can range from minor wounds to severe crushing or amputation.[1] The hand is a highly organized structure designed for grip, touch, precision, and coordinated movement. Its bones, joints, muscles, tendons, ligaments, nerves, and vessels work together, so injury to even one structure may disturb several everyday activities and occupational tasks.[2] Thumb function is especially important because it allows strong grasp, pinch, and handling of objects. The adductor pollicis supports thumb movement and stability; therefore, damage around this muscle or its nerve supply can reduce pinch strength and practical hand use.[3] The interosseous muscles help spread and bring together the fingers and also assist coordinated bending and straightening at different finger joints. Injury to these small muscles, their tendons, or ulnar nerve supply

may cause weakness, imbalance, deformity, and reduced dexterity.[4] Forearm muscles control many wrist and finger movements required for lifting, holding, writing, and self-care. The flexor carpi ulnaris contributes to wrist flexion and deviation, showing how muscle, tendon, and nerve injuries in the forearm can directly affect hand performance.[5] Hand injuries create a major clinical and social burden because they may cause pain, time away from work, treatment expenses, permanent disability, and loss of income. Their effects are particularly serious where manual work supports the patient and family members.[6] The pattern of injury refers to the affected side and part, type of tissue damaged, severity, mechanism, occupation, treatment delay, and patient characteristics. Reported causes include machinery, road traffic accidents, falls, sharp objects, agricultural work, assault, burns, and domestic incidents.[7] Studies from tertiary hospitals show that forearm and hand trauma includes lacerations, fractures, tendon injuries, nerve injuries, crush injuries, amputations, and combined tissue damage. Young and working-age adults are commonly affected, making early assessment and appropriate treatment important for recovery.[8]

Traumatic hand injuries often reach emergency departments and may require specialized coordinated care from orthopaedic, plastic, vascular, and rehabilitation teams. Treatment may include wound care, fracture fixation, tendon or nerve repair, soft-tissue coverage, pain control, occupational therapy, and structured physiotherapy.[9] Functional outcome describes how well the injured limb works after treatment. It can be assessed through movement, grip and pinch strength, deformity, pain, sensation, ability to perform daily activities, and disability scores such as DASH, especially after complex forearm injuries.[10]

MATERIALS AND METHODS

Study Design: The study was conducted as a prospective observational study on patients with forearm and hand injuries, who were treated in the Department of General Surgery, Shri Ram Murti Smarak Institute of Medical Sciences, Bareilly during 1st April 2024 to 30th September 2025.

Sample Size: 80

Inclusion Criteria:

1. Patients of all ages who presented and operated at the tertiary care center for forearm and hand injuries.
2. Patients with complete medical records containing sufficient information for analysis.
3. Cases documented within the specified time frame.
4. Patient of either sex and of all age groups.

Exclusion Criteria:

1. Cases of forearm and hand injuries resulting and associated with congenital conditions.
2. Patients with incomplete follow-up data for assessing functional outcomes.
3. Forearm and hand injuries that are a part of systemic trauma or polytrauma
4. Patient with pre-existing forearm and hand deformities or chronic diseases affecting hand function.

Study tool: Standardized techniques were used for measuring accurate ROM to ensure reliability and validity, which included universal goniometer.

Study Methodology: After informed consent, 80 patients with forearm and hand injuries were enrolled. Demographics, injury characteristics, treatment, hospital stay, and wrist range of motion were recorded preoperatively and at 1 week, 1, 3, and 6 months, with injuries categorized by location.

Data Analysis: Data were analyzed using Epi Info 7.2.2.2. Descriptive statistics, proportion tests, chi-square tests, one-way ANOVA, and Tukey's post hoc tests were applied; $p<0.05$ indicated statistical significance at the five-percent level.

RESULTS

The study included 80 patients aged 5–82 years, with a mean age of 32.43 ± 19.00 years and a median age of 31 years. The largest age group was 15–29 years (26.3%), followed by 30–44 years (25.0%) and ≤15 years (22.5%). Most patients were male (76.3%), with a male-to-female ratio of 3.2:1. Regarding comorbidities, 66.3% had no comorbidity, while 13.8% had hypertension, 12.5% had diabetes mellitus, and 7.5% had both conditions. Right-hand dominance was observed in 92.5% of patients, whereas 7.5% were left-hand dominant.

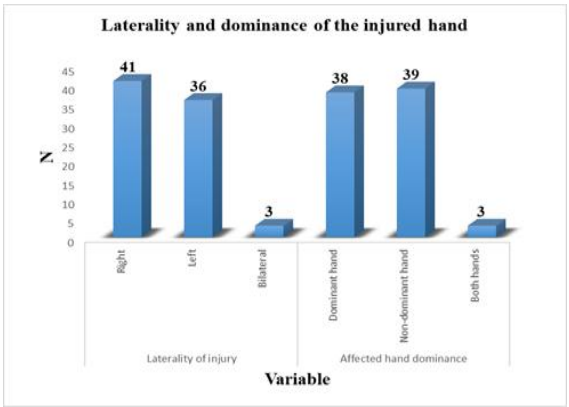

Figure 1: Laterality and dominance of the injured hand

In [Figure 1] Right-sided injuries were slightly more common, affecting 41 patients (51.3%), while left-sided injuries occurred in 36 patients (45.0%). Bilateral injuries were uncommon and were seen in only 3 patients (3.8%). Regarding hand dominance, the non-dominant hand was affected in 39 patients (48.8%), followed closely by the dominant hand in 38 patients (47.5%). Both hands were involved in 3 patients (3.8%).

Table 1: Anatomical location, nature and forearm compartment of injury

Variable	Category	Number	Percentage
Location of injury	Distal forearm	23	28.80%
	Middle forearm	15	18.80%
	Fingers	14	17.50%
	Proximal forearm	11	13.80%
	Wrist	10	12.50%
	Palm	4	5.00%
	Palm and fingers	3	3.80%
Nature of injury	Soft-tissue injury	28	35.00%
	Combined injury	27	33.80%
	Fracture	21	26.30%
	Dislocation	4	5.00%
Forearm compartment involved	Flexor compartment	30	37.50%
	Extensor compartment	21	26.30%
	Flexor and extensor compartments	7	8.80%
	No forearm compartment involvement	22	27.50%

In [Table 1] the distal forearm was the most common site of injury, affecting 23 patients (28.8%), followed by the middle forearm in 15 (18.8%) and fingers in 14 (17.5%). Soft-tissue injuries were most frequent, occurring in 28 patients (35.0%), closely followed by combined injuries in 27 (33.8%) and fractures in 21 (26.3%). The flexor compartment was most commonly involved in 30 patients (37.5%), while 21 (26.3%) had extensor compartment injuries. Both compartments were affected in 7 patients (8.8%), and 22 patients (27.5%) had no forearm compartment involvement.

Table 2: Mode of injury and duration of hospital stay

Variable	Category	Number	Percentage
Mode of injury	Machine cut	29	36.30%
	Road traffic accident	29	36.30%
	Cracker/blast injury	17	21.30%
	Workplace injury	3	3.80%
	Electrical burn	1	1.30%
	Thermal burn	1	1.30%
Hospital stay (days)	<7	10	12.50%
	7–13	19	23.80%
	14–20	22	27.50%
	21–27	16	20.00%
	28–34	13	16.30%
Hospital-stay summary	Mean ± SD	16.79 ± 8.39 days	
	Median	16 days	
	Range	2–30 days	

In [Table 2] Machine-cut injuries and road traffic accidents were the most common modes of injury, each affecting 29 patients (36.3%). Cracker or blast injuries occurred in 17 patients (21.3%), while workplace injuries and burns were uncommon. Most patients stayed in the hospital for 14–20 days (27.5%), followed by 7–13 days (23.8%) and 21–27 days (20.0%). The mean hospital stay was 16.79 ± 8.39 days, with a median of 16 days and a range of 2–30 days.

Table 3: Treatment modalities used in study patients

Treatment modalities	Number	Percentage
Combined procedures	13	16.30%
Tendon repair with plating	11	13.80%
Flap coverage	10	12.50%
Tendon repair with ORIF	8	10.00%
Wound debridement	8	10.00%
Muscle and tendon repair with ORIF	7	8.80%
Tendon repair	6	7.50%
Muscle repair with plating	5	6.30%
Muscle repair	3	3.80%
ORIF	3	3.80%
Muscle repair with ORIF	1	1.30%
Nerve repair	1	1.30%
Tendon repair with flap coverage	1	1.30%
Tendon and nerve repair	1	1.30%
Wound debridement with flap coverage	1	1.30%
Wound debridement with tendon repair	1	1.30%
Total	80	100.00%

In [Table 3] Combined procedures were the most commonly used treatment modality, performed in 13 patients (16.3%). This was followed by tendon repair with plating in 11 patients (13.8%) and flap coverage in 10 patients (12.5%). Tendon repair with ORIF and wound debridement were each performed in 8 patients (10.0%), while muscle and tendon repair with ORIF was used in 7 patients (8.8%). Tendon repair alone was performed in 6 patients (7.5%), and the remaining procedures were used less frequently.

Table 4: Comparison of wrist range of motion at different follow-up intervals

Wrist movement	Preoperative, Mean ± SD	Postoperative 1 week, Mean ± SD	Postoperative 1 month, Mean ± SD	Postoperative 3 months, Mean ± SD	Postoperative 6 months, Mean ± SD	F-value	p-value
Wrist flexion (°)	9.66 ± 1.53	24.53 ± 2.62	30.14 ± 2.98	53.10 ± 4.18	69.07 ± 6.15	2247.58	<0.0001
Wrist extension (°)	6.27 ± 1.76	19.19 ± 2.32	27.34 ± 2.79	39.08 ± 4.35	56.98 ± 4.57	1971.21	<0.0001
Radial deviation (°)	6.63 ± 1.51	7.58 ± 1.45	9.42 ± 1.53	13.59 ± 1.52	17.76 ± 1.54	554.71	<0.0001
Ulnar deviation (°)	19.86 ± 1.62	21.92 ± 1.64	23.85 ± 1.53	27.81 ± 1.62	31.93 ± 1.75	513.66	<0.0001

In [Table 4] Wrist range of motion improved progressively during follow-up. Mean wrist flexion increased from 9.66 ± 1.53° preoperatively to 69.07 ± 6.15° at 6 months, while extension increased from 6.27 ± 1.76° to 56.98 ± 4.57°. Radial deviation improved from 6.63 ± 1.51° to 17.76 ± 1.54°, and ulnar deviation increased from 19.86 ± 1.62° to 31.93 ± 1.75°. The improvement in all four wrist movements was statistically significant, with $p<0.0001$.

DISCUSSION

In the present study of 80 patients, forearm and hand injuries mainly affected younger individuals: 21 patients were aged 15–29 years (26.30%), 20 were 30–44 years (25.00%), and 18 were ≤15 years (22.50%); mean age was 32.43 ± 19.00 years, median 31 years, and range 5–82 years. Males accounted for 61 patients (76.30%) and females 19 (23.80%), with a male-to-female ratio of 3.2:1. No comorbidity was present in 53 patients (66.30%), whereas hypertension, diabetes mellitus, and both conditions occurred in 11 (13.80%), 10 (12.50%), and 6 (7.50%), respectively. Right-hand dominance was recorded in 74 patients (92.50%), yet injuries were evenly distributed between the right side (41, 51.30%) and left side (36, 45.00%), with bilateral injuries in 3 (3.80%); dominant-hand, non-dominant-hand, and bilateral involvement occurred in 38 (47.50%), 39 (48.80%), and 3 (3.80%) patients, respectively. The distal forearm was most common (23, 28.80%), followed by the middle forearm (15, 18.80%), fingers (14, 17.50%), proximal forearm (11, 13.80%), wrist (10, 12.50%), palm (4, 5.00%), and palm with fingers (3, 3.80%). Soft-tissue injuries predominated (28, 35.00%), followed by combined injuries (27, 33.80%), fractures (21, 26.30%), and dislocations (4, 5.00%). Flexor-compartment involvement occurred in 30 patients (37.50%), extensor involvement in 21 (26.30%), combined involvement in 7 (8.80%), and no compartment involvement in 22 (27.50%). These patterns are anatomically consistent with Javed et al. (2023).2 who described upper-limb muscle function, and Lung et al. (2024).5, who detailed flexor carpi ulnaris activity in wrist flexion and ulnar deviation. Acosta et al. (2023).3 and Valenzuela et al. (2025).4 emphasized intrinsic hand muscles in pinch, grip, and digital control, supporting the relevance of finger, palm, and soft-tissue injuries. Machine cuts and road traffic accidents were equally frequent, each involving 29 patients (36.30%), followed by cracker or blast injuries in 17 (21.30%), workplace injuries in 3 (3.80%), and electrical and thermal burns in 1 each (1.30%). Mean hospital stay was 16.79 ± 8.39 days, median 16 days, and range 2–30 days; 22 patients (27.50%) stayed 14–20 days. Treatment reflected complexity: combined procedures were performed in 13 patients (16.30%), tendon repair with plating in 11 (13.80%), flap coverage in 10 (12.50%), tendon repair with ORIF and wound debridement in 8 each (10.00%), and muscle and tendon repair with ORIF in 7 (8.80%). Arain et al. (2018).11 discussed reconstruction of extremity soft-tissue defects, relevant to flap coverage and combined procedures, although comparable numerical outcomes were not reported. Akhondi et al. (2025).12 described anterior interosseous nerve dysfunction, providing context for nerve repair and motor assessment, but not comparable injury frequencies. Wrist flexion improved from 9.66 ± 1.53° preoperatively to 69.07 ± 6.15° at 6 months ($F=2247.58$, $p<0.0001$), extension from 6.27 ± 1.76° to 56.98 ± 4.57° ($F=1971.21$, $p<0.0001$), radial deviation from 6.63 ± 1.51° to 17.76 ± 1.54° ($F=554.71$, $p<0.0001$), and ulnar deviation from 19.86 ± 1.62° to 31.93 ± 1.75° ($F=513.66$, $p<0.0001$). This progressive recovery supports effective reconstruction and rehabilitation; however, exact statistical similarity or contrast cannot be stated because the supplied studies are anatomical or review-based rather than outcome cohorts.

CONCLUSION

This study of 80 patients demonstrated that forearm and hand injuries predominantly affected young males, with machine cuts and road traffic accidents as the leading mechanisms. Distal forearm involvement, soft-tissue injury, combined injury, and flexor-compartment damage were most frequent. Nearly equal involvement of dominant and non-dominant hands highlighted the functional burden of these injuries. Treatment was individualized according to tissue damage, commonly requiring combined procedures, tendon repair, plating, open reduction and internal fixation, flap coverage, and debridement. Wrist flexion, extension, radial deviation, and ulnar deviation improved progressively from the preoperative assessment to six months, with highly significant changes in all movements ($p<0.0001$). These findings support timely surgical reconstruction, structured rehabilitation, and sustained follow-up to optimize functional recovery and reduce disability.

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