e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2026; 18(6); 2729-2740

Original Research Article

Fingertip Trauma: Incidence and Management Patterns Over an Eight-Year Period

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Received: 01-04-2026 / Revised: 25-05-2026 / Accepted: 12-06-2026
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Conflict of interest: Nil

Abstract

Background: Fingertip trauma is a common hand injury with considerable functional and occupational consequences. Injury patterns vary with age, mechanism, and environment, while treatment ranges from conservative wound care to complex reconstruction. Long-term institutional data describing these patterns, particularly in the Indian setting, remain limited. This study evaluated the temporal distribution, injury characteristics, and management patterns of fingertip trauma over eight years.

Methods: A retrospective observational study was conducted among 89 patients presenting with acute fingertip trauma during an eight-year period at a tertiary-care centre. Demographic characteristics, mechanism and setting of injury, digit involved, anatomical injury pattern, associated fracture and bone exposure, and treatment modality were evaluated. Management was categorized as non-operative or operative/procedural. Associations between injury characteristics and operative management were assessed using appropriate categorical statistical tests, with $p<0.05$ considered statistically significant.

Results: The mean age was 31.8±18.4 years, and 71.9% were male. Occupational/industrial injuries accounted for 43.8% and domestic injuries for 40.4% of cases. Machinery/power tools were the commonest mechanism (25.8%). Distal phalanx fractures occurred in 24.7%, while 30.3% sustained partial or complete fingertip amputations. Overall, 38.2% were managed non-operatively and 61.8% underwent operative/procedural treatment; secondary-intention healing was the commonest individual modality (29.2%). Operative intervention increased significantly with anatomical severity ($\chi^2=37.63$, $p<0.001$). Exposed bone (OR=24.00, $p<0.001$), amputation (OR=13.33, $p<0.001$), machinery injury (OR=5.90, $p=0.005$), and distal phalanx fracture (OR=3.65, $p=0.042$) were associated with operative management.

Conclusion: Fingertip trauma predominantly affected working-age males and frequently resulted from occupational and machinery-related mechanisms. Management was strongly determined by anatomical severity, particularly bone exposure, fracture, and amputation. Appropriate case selection permits conservative healing, whereas complex injuries require individualized reconstructive treatment. Preventive strategies targeting occupational and domestic mechanisms may reduce the burden of these injuries.

Keywords: Fingertip Trauma; Fingertip Injury; Hand Injury; Fingertip Amputation; Nail-Bed Injury.

DOI: 10.25258/ijcpr.18.6.419

Introduction

Fingertip trauma is among the most common forms of hand injury presenting to emergency, orthopaedic, and plastic surgical services. The fingertip is a specialized anatomical unit comprising the distal phalanx, nail complex, pulp, and highly innervated soft tissues, and is essential for fine pinch, tactile discrimination, object manipulation, and hand aesthetics [1]. Consequently, even apparently minor injuries may cause considerable morbidity, including pain, hypersensitivity, cold intolerance, nail deformity, altered sensation, stiffness, reduced grip strength, and delayed return to work [1,2]. The epidemiology of fingertip trauma varies according to age, occupation, and environment. Door-crush injuries predominate among young children, whereas machinery-related, occupational, sharp-object, and domestic injuries are more frequent among adults [2,3]. An Indian retrospective study reported fingertip involvement in 551 of 1,498 patients presenting with hand injuries; 72% were males and approximately 42.5% were children. Among paediatric patients, 98% of injuries occurred at home, 74% involved children younger than five years, and door-crush injuries accounted for approximately 80% [3]. Recent tertiary-care data

also demonstrated male predominance (73.3%) and crush injury as the leading mechanism (50.9%), while amputations (43.5%) and fractures (22.5%) represented major injury patterns [4].

Clinical presentation ranges from simple pulp and nail-bed injuries to fractures, extensive soft-tissue loss, and partial or complete amputations. Management is individualized according to injury level and configuration, tissue loss, bone or tendon exposure, nail-bed involvement, age, occupation, hand dominance, and functional requirements [1,5]. Treatment options include secondary healing, dressings, primary closure, nail-bed repair, skin grafting, local or regional flaps, fracture fixation, revision amputation, and replantation. Notably, selected injuries may achieve satisfactory outcomes with conservative management; one clinical series reported healing without surgery in 64% of cases [6].

Despite their frequency, longitudinal data describing fingertip trauma and evolving management practices, particularly in the Indian setting, remain limited [3]. Therefore, the present study aimed to evaluate the incidence, injury characteristics, and management patterns of fingertip trauma over an eight-year period, providing evidence for prevention, treatment planning, and optimization of hand-trauma services.

Materials and Methods

Study design and setting: This retrospective observational study was conducted in the Department of Orthopaedics and Plastic Surgery, a tertiary-care teaching hospital in Mumbai. Medical records of patients presenting with acute fingertip trauma during a consecutive eight-year period from January 2018 to December 2025 were reviewed. The hospital provides emergency and definitive surgical care for traumatic hand injuries referred from both urban and surrounding rural areas. The study was designed to describe the frequency, demographic and injury characteristics, temporal distribution, and management patterns of fingertip trauma over the study period.

Study population and eligibility criteria: All patients, irrespective of age or sex, presenting during the study period with an acute traumatic injury involving one or more fingertips were eligible. For the present study, a fingertip injury was defined as traumatic involvement of the digit distal to the insertion of the flexor and extensor tendons, including injuries involving the pulp, nail complex, distal phalanx, or distal digital amputation. Patients with isolated fingertip lacerations, crush injuries, nail-bed injuries, distal phalangeal fractures associated with soft-tissue injury, partial amputations, and complete fingertip amputations were included. Patients presenting only with chronic sequelae of previous trauma, non-traumatic nail or fingertip disorders, infections without preceding acute trauma, injuries proximal to the defined fingertip region, and records with insufficient information to establish the injury pattern or treatment were excluded. Repeat visits for the same injury were considered part of the original episode and were not counted as new cases.

Sampling method and sample size: A total-enumeration approach was adopted, whereby all eligible fingertip trauma cases recorded during the eight-year study period were included. Therefore, no separate sample-size calculation was undertaken because the study aimed to analyse the complete available institutional experience during the predefined period. Where more than one digit was injured in the same patient, demographic characteristics were analysed at the patient level, whereas digit-specific injury characteristics were additionally analysed at the injured-digit level.

Data collection and study variables: Eligible cases were identified from emergency department registers, inpatient and outpatient records, operation-theatre registers, and departmental trauma records. Data were extracted using a standardized data-collection form. Recorded variables included age, sex, occupation where available, date and year of injury, hand involved, dominant hand, affected digit, number of digits injured, mechanism and place of injury, type and level of tissue damage, nail-bed involvement, exposed bone, associated distal phalangeal fracture, and partial or complete amputation. Mechanisms were categorized as crush/door-crush, machinery-related, sharp-cut or laceration, avulsion, road-traffic related, domestic, occupational, or other mechanisms according to the documented circumstances.

Injuries were categorized according to the predominant anatomical pattern as pulp/soft-tissue injury, nail-bed injury, fracture-associated injury, partial amputation, or complete amputation. Where adequate clinical documentation permitted, amputations were further categorized according to the documented anatomical level. Radiographs were reviewed when available to confirm distal phalangeal fractures and associated bony injury.

Assessment of management patterns: Management was classified broadly as conservative or operative. Conservative treatment included wound cleansing and debridement when required, appropriate dressings or healing by secondary intention, immobilization/splintage, and supportive treatment. Tetanus prophylaxis and antimicrobial therapy were recorded when clinically indicated. Operative management included primary closure, nail-bed repair, skin grafting, local or regional flap

reconstruction, fracture fixation, composite grafting, revision amputation, and replantation/revascularization, wherever performed. Treatment was determined by the treating surgical team according to the extent and configuration of tissue loss, bone exposure, fracture stability, viability of the amputated part, patient age, occupation, functional requirements, and associated injuries.

For temporal assessment, cases were grouped according to calendar year. Changes in the proportion of conservative and surgical treatments and the relative utilization of individual reconstructive procedures across the eight-year period were evaluated.

Measurement of incidence and outcomes: Because this was a hospital-based study without a defined population catchment denominator, population incidence rates were not calculated. The institutional incidence proportion of fingertip trauma was calculated as the number of eligible fingertip injuries divided by the total number of hand-trauma presentations during the corresponding period, expressed as a percentage. Annual case frequency and year-wise proportions were additionally examined to evaluate temporal trends. The principal outcomes were the distribution of injury mechanisms and patterns and the relative frequency of different management approaches. Secondary outcomes included associations of management modality with age, mechanism, digit involved, tissue loss, fracture, nail-bed injury, and amputation, where data were available.

Statistical analysis: Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics, version 20.0. Continuous variables were summarized as mean ± standard deviation or median with interquartile range, as appropriate, while categorical variables were expressed as frequencies and percentages. Associations between injury characteristics and management modality were evaluated using the chi-square test or Fisher's exact test, as appropriate. Unadjusted odds ratios (ORs) were calculated to quantify the strength of association between selected clinical factors and operative/procedural management. Year-wise case frequency was analysed descriptively using annual frequencies and proportions. Digit-specific analyses used the total number of injured digits as the denominator in patients with multiple-digit involvement. All statistical tests were two-sided, and a p value <0.05 was considered statistically significant.

Ethical considerations: The study was conducted after approval from the Institutional Ethics Committee. As the study involved retrospective analysis of existing medical records without direct patient contact or intervention, the requirement for individual informed consent was waived by the Ethics Committee, where applicable. Patient identifiers were removed before analysis, and confidentiality was maintained throughout the study.

Results

Fingertip trauma showed an overall increasing temporal pattern, from 8 cases (9.0%) in Year 1 to 17 (19.1%) in Year 8. Following a transient decline to 7 cases (7.9%) in Year 4, case numbers increased progressively to 12 (13.5%), 15 (16.9%), and 17 (19.1%) during Years 6–8, respectively (Table 1).

Table 1: Year-wise distribution and temporal pattern of fingertip trauma over the eight-year study period (N=89)

Study year	Frequency	%
2018	8	9
2019	10	11.2
2020	11	12.4
2021	7	7.9
2022	9	10.1
2023	12	13.5
2024	15	16.9
2025	17	19.1

The mean age was 31.8 ± 18.4 years, with the largest proportion aged 18–40 years (44.9%), followed by 41–60 years (25.8%). Males predominated (71.9%), giving a male-to-female ratio of approximately 2.6:1. Rural residents constituted 56.2% of patients, and manual/industrial workers were the largest occupational group (34.8%). The right hand was affected in 57.3%, while 56.2% sustained injury to the dominant hand (Table 2).

Table 2: Demographic and baseline characteristics of patients presenting with fingertip trauma (N=89)

Characteristic	Frequency (%) / Mean ± SD
Age, years	31.8 ± 18.4
Age group (years)	
≤5 years	11 (12.4)
6–17 years	9 (10.1)
18–40 years	40 (44.9)
41–60 years	23 (25.8)
>60 years	6 (6.7)
Gender	
Male	64 (71.9)
Female	25 (28.1)
Residence	
Rural	50 (56.2)
Urban	39 (43.8)
Occupation	
Manual/industrial worker	31 (34.8)
Child/student	20 (22.5)
Homemaker	11 (12.4)
Farmer/agricultural worker	10 (11.2)
Service/business	11 (12.4)
Others	6 (6.7)
Side	
Right-hand injury	51 (57.3)
Left-hand injury	38 (42.7)
Dominant-hand involvement	50 (56.2)
Multiple-digit injury	8 (9.0)

Occupational/industrial (43.8%) and domestic injuries (40.4%) accounted for most cases.

Machinery/power tools were the commonest mechanism (25.8%), followed by heavy-object crush (21.3%) and sharp-object injuries (20.2%). Distal phalanx fractures occurred in 24.7%, while partial and complete amputations accounted for 19.1% and 11.2%, respectively.

Bone exposure was present in 39.3% and nail-bed involvement in 47.2%. Among 98 injured digits, the middle finger was most frequently affected (29.6%) (Table 3).

Table 3: Mechanism, setting, severity and anatomical distribution of fingertip trauma (N=89 patients; 98 injured digits)

Injury characteristic	Frequency (%)
Setting of injury (N=89)	
Occupational/industrial	39 (43.8)
Domestic/household	36 (40.4)
Road/outdoor/recreational	14 (15.7)
Mechanism (N=89)	
Machinery/power-tool injury	23 (25.8)
Heavy-object/manual crush	19 (21.3)
Sharp-object/laceration	18 (20.2)
Door-crush injury	14 (15.7)
Road-traffic/fall/other trauma	15 (16.9)
Predominant injury pattern (N=89)	
Simple skin/pulp injury	22 (24.7)
Nail/nail-bed injury without fracture	18 (20.2)
Distal phalanx fracture ± nail-bed injury	22 (24.7)
Partial fingertip amputation	17 (19.1)
Complete fingertip amputation	10 (11.2)
Exposed bone	35 (39.3)
Nail-bed involvement	42 (47.2)
Injured digits (n=98 digits)	
Thumb	13 (13.3)

Index	22 (22.4)
Middle	29 (29.6)
Ring	20 (20.4)
Little	14 (14.3)

Overall, 34 patients (38.2%) were managed non-operatively, whereas 55 (61.8%) required an operative/procedural intervention. Dressings with healing by secondary intention were the commonest individual treatment (29.2%), followed by primary closure (14.6%), nail-bed repair (12.4%), and K-wire fixation (10.1%). Reconstructive procedures included V-Y/local flaps (7.9%), full-thickness skin grafting (5.6%), and composite grafting (4.5%) (Table 4 and Figures 1-7).

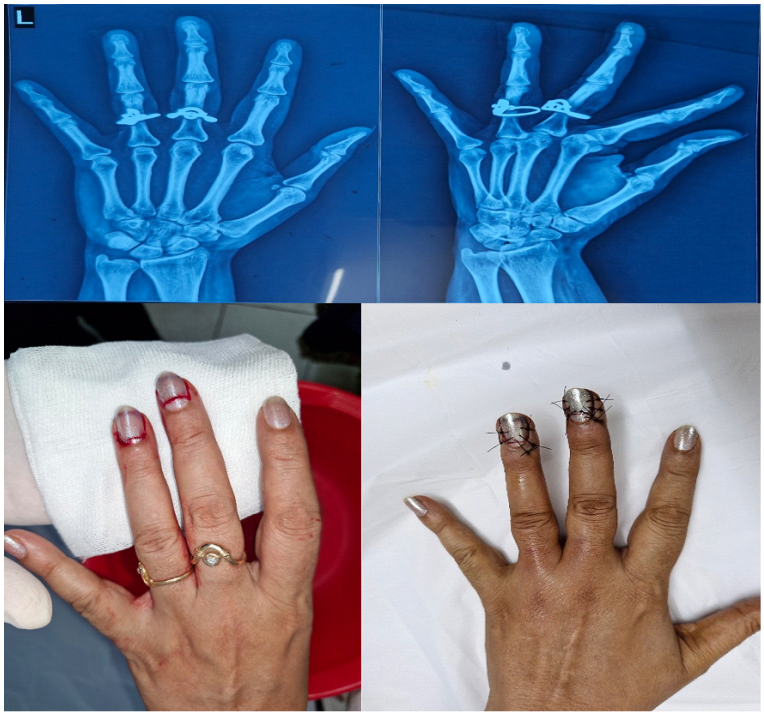
Table 4: Distribution and representative clinical patterns of conservative and operative management of fingertip trauma (N=89).

Primary management	**Frequency (%)**
Dressings/healing by secondary intention	26 (29.2)
Closed treatment/splintage	8 (9.0)
Primary closure/simple suturing	13 (14.6)
Nail-bed repair	11 (12.4)
K-wire fixation ± soft-tissue repair	9 (10.1)
Full-thickness skin graft	5 (5.6)
Local flap/V-Y advancement plasty	7 (7.9)
Composite graft from amputated segment	4 (4.5)
Revision amputation	5 (5.6)
Replantation/revascularization	1 (1.1)
Total	89 (100.0)

a. Pre Operative **b. Intra operative** **c. Late Post Operative**

Figure 1: V Y Plasty

Figure 2: Autoamputation following Dry Gangrene of Finger Tip



a. Pre Operative b. Post Operative

Figure 3: Nail Nailbed injury with # distal phalanx tip

Figure 4: Mixer grinder injury with # distal phalanx

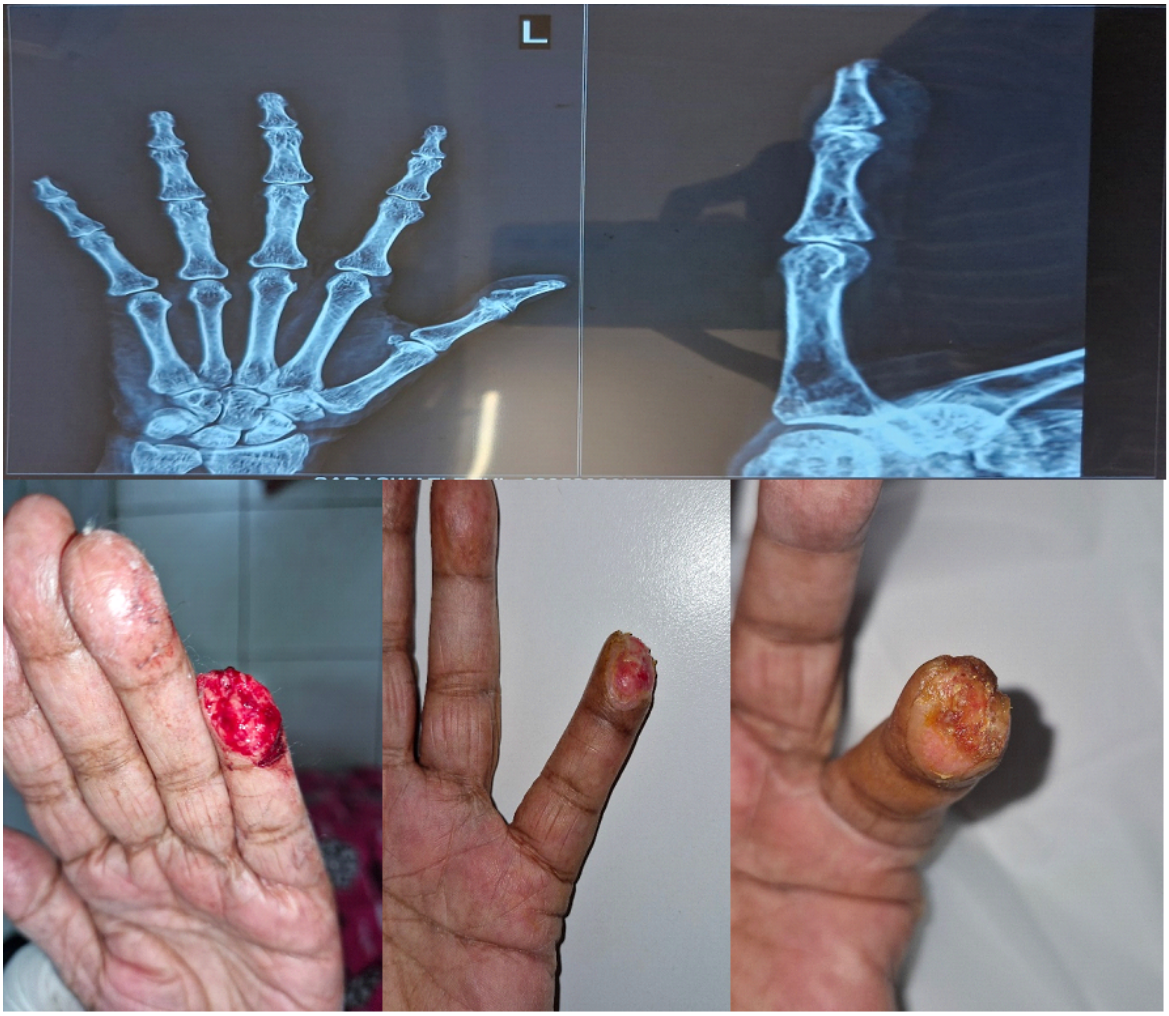


Figure 5: Healing by Dressings (Secondary Intention)

A. Pre Operative **B. Intra Operative** **C. Late Post Operative**

Figure 6: Nail Nailbed injury in 2 years Child

Figure 7: Full Thickness Skin Graft from ulnar border of Palm with K Wire Fixation 5th Metacarpal shaft

The requirement for operative intervention increased significantly with injury severity, from 13.6% among simple skin/pulp injuries to 50.0% for isolated nail/nail-bed injuries, 81.8% for distal phalanx fractures, 88.2% for partial amputations, and 100% for complete amputations. The overall association between injury severity and management modality was statistically significant (χ^2=37.63, df=4, p<0.001) (Table 5).

Table 5: Association between anatomical severity of fingertip trauma and requirement for operative management (N=89)

Predominant injury pattern	Non-operative	Operative/ procedural	p-value
	Frequency (%)		
Simple skin/pulp injury (n=22)	19 (86.4)	3 (13.6)	<0.001
Nail/nail-bed injury (n=18)	9 (50.0)	9 (50.0)	
Distal phalanx fracture (n=22)	4 (18.2)	18 (81.8)	
Partial amputation (n=17)	2 (11.8)	15 (88.2)	
Complete amputation (n=10)	0	10 (100.0)	
Total	34 (38.2)	55 (61.8)	

Operative management was significantly more frequent with machinery/power-tool injuries (87.0%; OR=5.90, p=0.005), exposed bone (94.3%; OR=24.00, p<0.001), distal phalanx fracture (81.8%; OR=3.65, p=0.042), and partial/complete amputation (92.6%; OR=13.33, p<0.001). Occupational injuries were also associated with intervention (OR=2.68, p=0.047), whereas sex was not significantly associated (p=0.332) (Table 6).

Table 6: Factors associated with operative/procedural management among patients with fingertip trauma (N=89)

Factor	Operative/total	Unadjusted OR	p-value
Age ≤17 years	8/20 (40.0)	0.31	0.035
Male sex	42/64 (65.6)	1.76	0.332
Occupational/industrial injury	29/39 (74.4)	2.68	0.047
Machinery/power-tool mechanism	20/23 (87.0)	5.9	0.005
Exposed bone	33/35 (94.3)	24	<0.001
Distal phalanx fracture	18/22 (81.8)	3.65	0.042
Partial/complete amputation	25/27 (92.6)	13.33	<0.001

OR = unadjusted odds ratio.

Discussion

The present eight-year analysis demonstrates that fingertip trauma predominantly affected young and middle-aged adults, particularly males, with occupational and domestic environments accounting for most injuries. The annual case frequency increased from 8 cases in the first year to 17 in the eighth year, with a transient decline in Year 4. Although this suggests an increasing institutional burden, the absence of a population or total hand-trauma denominator precludes interpretation as a true rise in incidence. The increase may reflect greater mechanization, referral volume, healthcare utilization, or improved case capture rather than a change in population risk.

The mean age of patients was 31.8±18.4 years, 44.9% were aged 18–40 years, and 71.9% were male. This demographic concentration is clinically relevant because it involves the economically productive population in whom even a small loss of fingertip sensation, length, or dexterity can substantially affect employment. Similar male predominance has been reported from India. Samantaray et al., found that 72% of patients with fingertip injuries were male [3], while George et al., in an Indian series of 240 nail-bed-associated fingertip injuries, reported 80% males [7]. The recent study by Alanazi et al., similarly reported 73.3% males [1]. These similarities probably reflect greater occupational exposure of males to machinery, tools, construction, agriculture, and manual work in the populations studied.

Occupational/industrial injuries constituted 43.8% of cases, while another 40.4% occurred in domestic settings. Machinery/power tools (25.8%), heavy-object crush (21.3%), and sharp objects (20.2%) were the predominant mechanisms. Importantly, machinery-related injuries were associated with a substantially greater likelihood of operative treatment (OR=5.90, p=0.005), probably because high-energy mechanisms cause combined damage to pulp, nail bed, bone, and neurovascular structures rather than isolated superficial injury. Indian data support this mechanism-specific pattern: Samantaray et al., reported machinery-related injuries in 17.6% of adults and two-wheeler-chain injuries in 22.5% [3]. In contrast, door-crush injuries dominate in young children; in the same Indian study, 80% of paediatric injuries were door-crush injuries and 98% occurred at home [3]. Yorlets et al. likewise identified doors and windows as major sources of paediatric fingertip trauma [2]. Thus, prevention needs to be age-specific—door guards and supervision in children, but machine guarding, training, and appropriate occupational safety measures in working adults.

The anatomical spectrum in the present series was broad: simple pulp injuries accounted for 24.7%, nail/nail-bed injuries for 20.2%, distal phalanx fractures for 24.7%, partial amputations for 19.1%,

and complete amputations for 11.2%. Overall, therefore, 30.3% sustained partial or complete amputation, while exposed bone was present in 39.3%. Alanazi et al., reported amputations in 43.5% and fractures in 22.5%, broadly supporting the substantial burden of structurally severe injuries encountered at tertiary centres [1]. Nail-bed involvement in our series was common (47.2%), emphasizing the close anatomical relationship between the nail complex and distal phalanx. George et al., stressed that nail-bed injuries should not be considered in isolation because associated distal phalangeal and soft-tissue injuries frequently determine treatment and subsequent nail morphology [7]. The middle finger was the most frequently injured digit (29.6%), strikingly similar to the 29% reported by Samantaray et al., [3] and also consistent with the middle finger being the commonest digit in the series of George et al., [7]. Its greater projection during grasping and manual activity may increase exposure to crushing and cutting mechanisms.

Management demonstrated a clear relationship with anatomical severity. Overall, 38.2% were treated non-operatively, whereas 61.8% required operative or procedural treatment. Nevertheless, dressings with secondary-intention healing represented the single commonest treatment (29.2%). Weichman et al., reported that 64% of 100 fingertip injuries healed without surgery, with only 18% undergoing operative intervention; crush injuries accounted for 46% of their cases [8]. The higher operative proportion in the present study probably reflects its greater burden of exposed bone, fractures, and amputations. Conversely, George et al., reported surgery in 92.5% of their patients because their cohort specifically comprised nail-bed injuries, demonstrating how case selection markedly influences reported treatment patterns [7]. Increasing evidence also supports conservative treatment in appropriately selected defects. In a randomized trial of 44 patients, Bensa et al., found satisfactory healing and sensory recovery with semi-occlusive dressings, without increased infection; healing averaged 4.9 weeks with dressing treatment versus 3.6 weeks after surgery [9]. Rautio et al., similarly followed 10 amputations with exposed bone treated conservatively and reported healing without complications and high patient satisfaction [10].

A particularly important finding was the strong association between increasing injury severity and operative intervention (χ^2=37.63, p<0.001). Surgery was required in only 13.6% of simple pulp injuries but increased to 81.8% with distal phalanx fracture, 88.2% with partial amputation, and 100% with complete amputation. Exposed bone emerged as the strongest individual correlate (OR=24.00, p<0.001), followed by amputation (OR=13.33, p<0.001), machinery injury (OR=5.90, p=0.005), and distal phalanx fracture (OR=3.65, p=0.042). These findings are anatomically logical: loss of the soft-tissue envelope over bone compromises durable padding and may require shortening, grafting, or vascularized flap coverage, while unstable fractures additionally require skeletal stabilization. The operative spectrum in our series—primary closure, nail-bed repair, K-wire fixation, full-thickness skin grafting, composite grafting, and V-Y/local flaps—therefore reflects a rational reconstructive ladder based on defect characteristics. Supporting the role of local advancement flaps, Jayachandiran et al., recently reported favourable functional outcomes in 19 Indian patients undergoing double V-Y reconstruction, with mean total advancement of 12.94 mm and good total active motion in all patients [11].

Limitations

This study has several limitations. Its retrospective, single-centre design may limit generalizability and is dependent on completeness of medical records. The relatively small sample restricted subgroup and multivariable analyses, while variations in documentation and treatment practices across eight years may have introduced information bias. Functional, sensory, cosmetic, return-to-work, and long-term patient-reported outcomes were not consistently available. Additionally, absence of a population-based denominator precluded estimation of true incidence.

Conclusion

Fingertip trauma predominantly affected young and middle-aged adults, especially males, with occupational, machinery-related, and domestic injuries accounting for most presentations. Injury severity strongly influenced management, as exposed bone, distal phalanx fracture, and partial or complete amputation were associated with substantially greater need for operative intervention. Nevertheless, secondary-intention healing remained an important treatment for appropriately selected injuries. The broad use of suturing, nail-bed repair, fixation, grafting, and local flaps highlights the need for individualized reconstruction based on anatomical characteristics. Strengthening workplace safety and preventing household crush injuries, particularly in children, may reduce avoidable morbidity. Standardized prospective studies incorporating functional and patient-reported outcomes are warranted.

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