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Original Article

Comparison of Outcomes of Three Different Modalities for Treatment of Acute Fingertip Injuries

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ABSTRACT

The fingertip has a crucial role in providing tactile and sensory functions to the brain. Anatomically, it refers to the region behind the extensor tendons and point of insertion of the flexor digitorum superficialis at the distal phalanx or interphalangeal joint in the case of the thumb. **Objective:** To compare the outcomes of three different modalities for managing acute fingertip injuries involving healing by secondary intention, primary closure, and local flap coverage. **Methods:** A randomized control trial was conducted, employing non-probability consecutive sampling. The inclusion criteria consisted of patients aged 20 to 40 years with fingertip injuries and tissue loss categorized as Allen II, III, or IV injuries. Cold intolerance was assessed using the Cold Intolerance Severity Symptom (CISS) questionnaire, which assigns a score ranging from 0 to 100. The sensibility of the injured and uninjured fingers was evaluated using the Semmes-Weinstein monofilament test (SWF). The chi-square test was used to examine relevant relationships. **Results:** Statistically significant associations were observed between smoking, comorbidities, and treatment modalities ($p < 0.001$). Among smokers, 81% received Group A treatment, while only 38% of smoking patients were treated with Group B and 69% with Group C. In the Group A treatment, 54.8% of patients were left-handed, 57.1% had Allen III classification, 54.8% had transverse injuries, and only 8% experienced short-term complications (infection). **Conclusions:** Based on the study findings, no significant differences were identified among the three treatment modalities.

INTRODUCTION

The fingertip has a crucial role in providing tactile and sensory functions to the brain. Anatomically, it refers to the region behind the extensor tendons and point of insertion of the flexor digitorum superficialis at the distal phalanx or interphalangeal joint in the case of the thumb. The neurovascular supply to the fingertip is provided by the digital arteries and nerves branching near the distal interphalangeal joint [1]. Its dorsal surface includes the nail fold, nail bed, and nail plate, with the eponychium proximal to the nail, the paronychium in the lateral nail folds, and the hyponychium as a keratinous plug beneath the distal edge of the nail. The lunula, the white part near the proximal nail, represents the sterile area separating it from the germinal matrix below. The nail bed comprises a sterile matrix, responsible for nail attachment, and a germinal matrix, accounting for 90% of nail growth [2-4]. The inuries relared

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to the fingertip can be categorised based on the mechanism or level of injury using the commonly used Allen classification system [5]. These injuries often occur due to crushing forces, lacerations from household tools, or amputations involving soft tissue and partial or complete loss of the distal phalanx. Other injuries result from sudden flexion or extension forces causing avulsion of the distal tendon. Traumatic fingertip injuries are the most prevalent sort of injuries of the hands, resulting in millions of appointments to the general practioners and the department of emergency on annual basis. Finger lacerations alone causes around 50% of the non-work-related injuries [6]. The examination should include an assessment of tenderness, range of motion in the interphalangeal joints, and capillary refill. X-Rays of the affected finger and hand, including two to three views, are essential [7]. Allen's classification comprises four types ranging from 1 to 4. Type 1 injuries can often heal well without intervention, while type 3 and 4 injuries at times needs flap coverage [8]. The primary treatment goals include pain relief and bleeding control, which depend on the severity and the type of the injury [9]. Decisions regarding the treatment of fingertip injuries are based on patient needs, wound characteristics, and the expertise of the attending physician. The primary objectives of fingertip reconstruction are to restore a painless, sensory tip in a fully functional finger, maximize the achievable length, ensure rapid healing, and minimize functional disability duration. Treatment options for these injuries include primary closure, skin grafting, local or regional soft tissue flaps, and healing by secondary intention [10]. Existing literature lacks sufficient evidence to support guidelines on the optimal treatment strategy. Most scientific reports consist of retrospective case series examining different flaps for fingertip injuries, suggesting that flap surgery is the preferred treatment modality [11]. In a previous study, three treatment modalities were compared: reconstruction, primary closure, and secondary healing [12]. Postoperative results showed that normal sensitivity was observed in 56% of patients treated with reconstruction, 81.8% in the primary closure group, and 64.4% in the conservative group. Nail deformities were observed in 88%, 95.7%, and 81.8% of patients, respectively. This study aim was to compare the outcomes of three different modalities for the management of acute fingertip injuries: healing by secondary intention, primary closure, and local flap coverage. The goal of this research was to assist in selecting the most appropriate treatment approach for patients, considering optimal outcomes, and minimizing the morbidity associated with fingertip injuries.

METHODS

We conducted a randomized controlled trial at the Plastic Surgery unit, Civil Hospital Karachi, between January and June 2022, following ethical approval. Non-probability consecutive sampling was employed to collect data. The sample size was determined using OpenEpi Software, considering a 95% confidence interval, 80% study power, 10% absolute precision, and 56% normal sensitivity in the reconstruction group and 81% in the primary closure group. The intended sample size was 42 patients in each group, with an additional 42 patients for conservative treatment. A total of 126 injuries were recorded. Those patients were included who were aged 20 to 40 years with fingertip injuries and tissue loss categorized as Allen II, III, or IV injuries. Exclusion criteria included patients having a history of fingertip injury or a prior surgery and those who refused to provide consent. Injuries across or proximal to the distal interphalangeal (DIP) joint, as well as patients with three or more fingertip injuries on one hand, were also excluded to reduce potential bias in the outcome of the analysis. After obtaining ethical approval from the hospital board, eligible patients were enrolled in the surgical emergency department. The informed consent was taken in a written manner after explaining the study's purpose. The data related to the patient's demographics including age, sex, smoking status, and obesity, were recorded. A comprehensive history was obtained, and a ysical examination was performed. The basic blood workup, such as liver function tests (LFT), renal function tests (RFT), complete blood count (CBC), serum electrolytes, and an X-Ray of the hand, was conducted. The injuries were categorised according to the Allen's classification. The patients were then assigned to one of the 3 groups using computer-generated software and block randomization. Group A underwent reconstructive treatment with flap coverage, group B underwent primary wound closure, and Group C received conservative treatment with silver sulfadiazine dressing, dry dressings, lavage, and petroleum jelly-coated dressing for secondary healing. Patients were scheduled for weekly follow-up visits to monitor the progress of wound healing. After 12 weeks, a final subjective and objective assessment was performed using the methodology described in a previous study [12]. Data collection utilized a pre-validated questionnaire from the same study. Data entry and analysis were performed using the latest version of SPSS version. The values of the mean and standard deviation (SD) were determined for quantitative variables, such as age, while the frequency along with the percentage was calculated for the variables in categories such as gender and outcomes. Potential effect modifiers, including age, sex, affected fingers, Allen classification, smoking, and obesity, were addressed through data stratification. The relationship between different treatment modalities and outcomes was

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assessed using the chi square test.

RESULTS

Table 1 shows the demographic features of the patients who have been treated with different treatment modalities. The smoking and the relevant comorbidities were calculated to be significant having p-value of <0.001 concerning the treatment modalities. 81% of the smokers were treated with the Group A treatment while only 38% of the patients with smoking were treated with Group B and 69% of the smokers with Group C treatment.

Table 1: Association between the demographic variables and the treatment modalities

Variables	Treatment modalities			p-value
	Group A	Group B	Group C	
Age, Mean	45.2	39.43	34.67	-
Sex				
Males	30 (71.4%)	25 (59.6%)	32 (76.2%)	0.23
Female	12 (28.6%)	17 (40.5%)	10 (23.8%)	
Hand dominance				
Right	37 (88.1%)	34 (80.9%)	39 (92.8%)	0.51
Left	4 (9.5%)	7 (16.7%)	2 (4.8%)	
Ambidextrous	1 (2.4%)	1 (2.4%)	1 (2.4%)	
Smoking	34 (81%)	16 (38%)	29 (69%)	0.001
Relevant comorbidity				
None	39 (92.8%)	38 (90.5%)	40 (95.2%)	<0.001
Vascular disease	1 (2.4%)	1 (2.4%)	1 (2.4%)	
Diabetes mellitus	1 (2.4%)	6 (14.3%)	20 (47.6%)	
Hypertension	1 (2.4%)	8 (19%)	27 (64.3%)	

Table 2 shows the features of the fingertip injuries that were treated with different treatment modalities. In the Group A treatment, 54.8% of the patients were left-handed,57.1% of patients had Allen III classification, 54.8% of patients had a transverse injury, and only 8% of patients had a short-term complication (infection). As part of the long-term complication in the group A patients, 27 (64.3%) patients showed nail deformity, and 3 (7.1%) patients showed painful tight scars. In group B and C patients, the left hand was predominantly affected (33.3% and 78.6% respectively). Allen III injury was most common in all the 3 groups.

Table 2: Characteristics of the fingertip injuries

Variables	Treatment modalities		
	Group A	Group B	Group C
Injured finger			
Right finger	19 (45.2%)	28 (66.7%)	9 (2.1%)
Thumb finger	3 (7.1%)	7 (16.7%)	5 (12%)
Index,	5 (11.9%)	12 (28.6%)	2 (4.8%)
Middle,	10 (23.8%)	3 (7.1%)	1 (2.4%)
Ring,	1 (2.4%)	4 (9.5%)	1 (2.4%)
Small finger	0 (0%)	2 (4.8%)	0 (0%)
Left hand	23 (54.8%)	14 (33.3%)	33 (78.6%)
Thumb	4 (9.5%)	7 (16.7%)	12 (2.9%)
Index	11 (26.2%)	2 (4.8%)	11 (2.6%)
Middle	3 (7.1%)	3 (7.1%)	4 (9.5%)
Ring finger,	3 (7.1%)	1 (2.4%)	5 (11.9%)
Small finger	2 (4.8%)	1 (2.4%)	1 (2.4%)
Classification injury			
Allen II	8 (19%)	0 (0%)	13 (30.9%)
Allen III	24 (57.1%)	27 (64.3%)	29 (69%)
Allen IV	10 (23.8%)	15 (35.7%)	0 (0%)
Direction of injury			
Transverse	23 (54.8%)	21 (50%)	25 (59.5%)
Volar oblique	14 (33.3%)	15 (35.7%)	10 (23.8%)
Dorsal oblique	5 (11.9%)	6 (14.3%)	7 (16.6%)
Short-term complications			
None	34 (81%)	40 (95.2%)	38 (90.5%)
Bleeding	0 (0%)	0 (0%)	0 (0%)
Infection	8 (19%)	2 (4.8%)	4 (9.5%)
Flap necrosis	0 (0%)	0 (0%)	0 (0%)
Long-term complications			
None	12 (28.6%)	13 (31%)	16 (38.1%)
Nail deformity	27 (64.3%)	22 (52.4%)	26 (62%)
Painful tight scar	3 (7.1%)	7 (16.6%)	0 (0%)

Table 3 and 4 showed that the SWF test for zone 1 of the fingers that was injured and the CISS score was not significantly related to the treatment modalities.

Table 3: It shows the SWF Test score for the Zone 1 of the finger that was injured

Group (Score)	Treatment modalities			p-value
	Group A	Group B	Group C	
Normal sensibility to diminished superficial sensibility	28 (66.7%)	30 (71.4%)	24 (57.1%)	0.72
Diminished vital sensibility to absent vital sensibility	13 (31%)	11 (26.2%)	17 (40.5%)	
Not testable	1 (2.4%)	1 (2.4%)	1 (2.4%)	

Table 4: Results of the CISS Questionnaire

Variables	Treatment modalities			p-value
	Group A	Group B	Group C	
CISS score, Mean ± SD	26.3 ±18.2	17.8 ±15.8	25.1 ±13.9	- 0.84
Group (score)				
No cold intolerance	11 (26.2%)	7 (16.7%)	10 (23.8%)	
Mild	19 (45.2%)	20 (47.6%)	23 (54.8%)	
Moderate	5 (11.9%)	9 (21.4%)	4 (9.5%)	
Severe	6 (14.3%)	5 (11.9%)	4 (9.5%)	
Very severe	1 (2.4%)	1(2.4%)	1(2.4%)	

Table 5 shows that hook nail was the most common nail deformity with all the 3 treatment modalities with 57.1% in group A, 47.6% in group B and 64.3% in group C. The nail deformities were significantly associated with the treatment modalities (Table 5).

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Table 5: Resulting Nail Deformities

Nail deformities	Treatment modalities			p-value
	Group A n=42	Group B n=42	Group C n=42	
No deformity	11(26.2%)	2(4.8%)	3(7.1%)	0.002
Hook nail	24(57.1%)	20(47.6%)	27(64.3%)	
Hypertrophy of the nail	3(7.1%)	13(31%)	3(7.1%)	
Spike nail	1(2.4%)	4(9.5%)	5(11.9%)	
Absent nail	3(7.1%)	3(7.1%)	4(9.5%)	

DISCUSSION

Our study aimed to evaluate the outcomes in the short and longer run of patients treated with 3 categories of treatment options for injuries related to the fingertip, namely reconstruction, primary wound closure, and conservative management. To accomplish this, we selected an equal number of patients for each treatment option and conducted a comprehensive set of tests to compare the outcomes of each modality. As long as the literature suggests, no similar research has been done in our setting. The results of the study found no significant variations in the prognosis among the 3 available modalities for the treatment (reconstruction, wound closure, and supportive management). Currently, there is not even evidence that could recommend an effective treatment modality for fingertip injuries of composite nature. There is a lack of randomized clinical trials directly comparing different methods to determine the optimal treatment. Limited retrospective comparative studies have been conducted to evaluate the treatment of soft tissue loss. Additionally, the available case series found in the medical literature reports level IV evidence determining several methods of composite tissue reconstruction lacks consistency in evaluation methods, and subject numbers, making it difficult to draw definitive conclusions [13, 14]. To assess finger function, various tests can be utilized, with the Purdue pegboard test being one of the most practical and specific to measure the function of the hand and finger [15]. Although, we selected to not apply this test as a patient could achieve a higher score without utilizing the injured finger. Instead, we employed scoring systems used in another study to assess hand functionality [12]. Our study results revealed a predominance of male gender among patients with injured fingers, and the most common injury classification was Allen III, consistent with findings from a study by van den Berg *et al.*, [12]. Previous literature has demonstrated a reduction in power strength as the probability of the contralateral hand [16, 17], although these studies did not clarify whether the dominance of hand was uniformly distributed across the different groups. Taking this into account, we included the dominance of the hand in our tests. It came to our knowledge that there is a dearth of reports on the pinch or grip strength as outcome parameters following fingertip injury treatment. In our study, the grip of power did not differ among the 3 groups significantly, and the results obtained from multiple types of pinch tests were comparable. The Semmes-Weinstein monofilament test has shown to give similar results for all 3 groups, with more than half of the participants goring normal or diminished superficial sensibility. These findings align with other studies [17-19]. Mennen and Wise, in a sample of 200 conservatively treated fingertip injuries, found positive outcomes in terms of pulp size, bulk, and functional recovery [20]. A major limitation of our study was its single-center nature and small sample size. Conducting the study on a larger scale would have allowed for the inclusion of more variables.

CONCLUSIONS

We conclude from the study that no significant differences were found in the 3 treatment modalities.

Authors Contribution

Conceptualization: SG, FAAK, MH
Methodology: SR
Formal analysis: SI, SK[1], SK[2]
Writing-review and editing: SG, FAAK, MH, SR, SI, SK[1], Sk[2]

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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