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Research Article

The Treatment of Interphalangeal Joint Fracture Dislocations with the Pin and Rubber Method

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Abstract

Aim: This study aimed to evaluate the clinical and radiological results of interphalangeal joint injuries treated with the pin-and-rubber method and to determine the effectiveness of this treatment method.
Material and Method: Patients aged 18 years or older who presented with injuries of the interphalangeal joints of the hand and were treated with the pin-and-rubber method were included in the study. Patients with open fractures, multiple finger injuries, or those who underwent open surgery were excluded. Total of 32 interphalangeal joint injuries were evaluated retrospectively. Eight of those patients declined to participate in the study and the final analysis included 24 fingers of a total of 24 patients. Age, sex, injured finger, type of injury, and time until treatment were recorded for all patients. Union was evaluated based on joint radiographs from patients final follow-up appointments. For the evaluation of functional results, joint range of motion was measured with a finger goniometer and Disabilities of the Arm, Shoulder, and Hand Questionnaire (DASH) and visual analog scale (VAS) scores were evaluated.
Results: The median age of the analyzed patients was 30 (18-69) years. The most frequent mechanism of injury was fall (52.4%) and the most frequent injured finger was the fourth. The median follow-up duration for these patients was 25 (16.25-31.75) months. The median DASH score was 4.16 (0.00-7.50) and the median VAS score was 4 (0.00-8.00). The median range of motion of the proximal interphalangeal joint was 90° (80.00-98.75°), while that of the distal interphalangeal joint was 55° (36.25-80.00°). Union was achieved in all cases. Condylar fractures were observed in two patients over the course of follow-up.
Conclusion: The treatment of interphalangeal joint fractures or fracture dislocations by the pin-and-rubber method was confirmed to be an easily applicable and effective treatment method that does not cause a significant loss range of motion.

Keywords: Finger fracture, hand surgery, pin and rubber

INTRODUCTION

Although hand injuries are commonly experienced in society, fracture dislocations and comminuted fractures of the fingers are relatively less common. The prognosis of intraarticular fractures, comminuted fractures, and fracture dislocations is generally worse. These types of fractures can result in significant pain, joint stiffness, and limitation in range of motion (1-6).

There is no consensus on the ideal treatment modality for fracture dislocations of the fingers (5,7). Prolonged immobilization can cause stiffness in the affected joints (8), while open surgical methods may entail excessive soft tissue stripping, resulting in stiffness and loss of motion (9).

In these cases, the main goal of treatment is to obtain a finger that is free of pain without functional limitation (5,10,11). Many relevant treatment methods have been described in the literature, such as conservative, closed, and open surgical fixation or dynamic external fixator and joint reconstruction methods (5,10,12).

The aim of this study was to evaluate the clinical and radiological results of patients with interphalangeal joint fractures or fracture dislocations who were treated with the pin-and-rubber method and to compare those results with the previous literature. This study hypothesized that the pin-and-rubber method is a reliable approach for eligible patients with interphalangeal injuries because it allows for early movement and does not impair biological healing.

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MATERIAL AND METHOD

Patient Selection

This study was designed as a retrospective case series. Approval was obtained from the relevant clinical ethics committee before the research began.

The patients applied for interphalangeal joint fracture or fracture dislocation between 2015 to 2020 were included. For patients applying to our clinic with interphalangeal joint fractures or fracture dislocations, conservative treatment was preferred in cases in which there was no displacement, the fractured part accounted for less than 30% of the total joint, and the fracture was stable. Surgery was performed for patients for whom joint alignment and stability could not be achieved with conservative treatment. In the event of ongoing joint dislocation, joint malalignment, or sagittal or coronal plane malreduction in patients for whom a traction system was utilized during surgery, open reduction and internal fixation was added.

The inclusion criteria of the study were as follows: 1) being 18 years of age or older, 2) being diagnosed with acute interphalangeal fracture or fracture dislocation (i.e., within 21 days after the initial trauma), 3) having a fracture or fracture dislocation not suitable for conservative treatment and 4) having a minimum of 1 year of follow-up after surgery. 1) Patients with open fractures, 2) multiple finger injuries and 3) fractures or fracture dislocations that required open surgery for reduction were excluded. Accordingly, 32 interphalangeal joint injuries were retrospectively examined. Eight of those patients declined to participate in the study and the final analysis included 24 fingers of a total of 24 patients.

Surgical Technique

All surgical interventions and postoperative follow-up examinations were conducted by the same surgical team. Patients were operated on in the supine position under general or local anesthesia. After the necessary surgical preparations, a 1.2-mm Kirschner (K) wire was applied proximally to the joint, passing the head of the proximal phalanx from the center in the sagittal plane. Pliers were used to bend the wire 90° some distance from the skin. The K-wire was then bent again distally 3 cm past the fingertip and the axial traction pin was prepared (Figure 1).

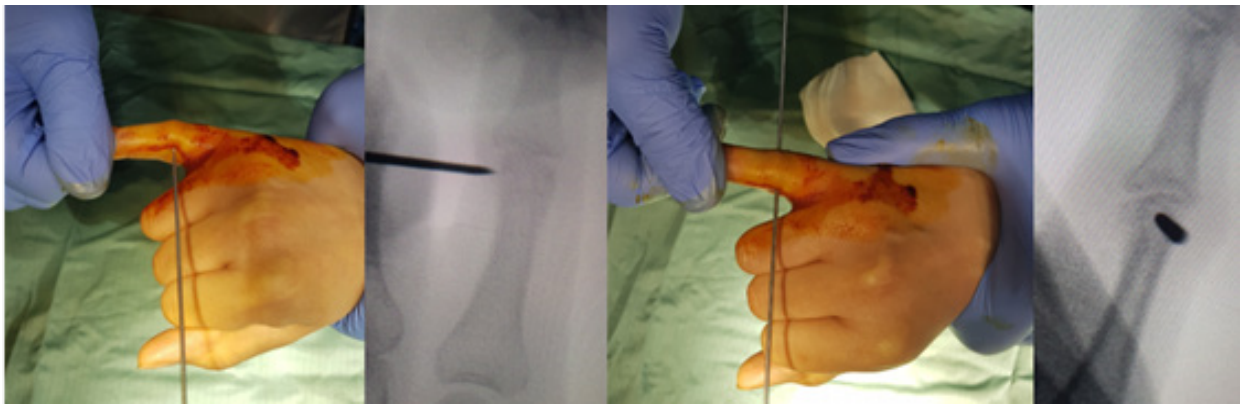

Figure 1. Application of the axial traction pin

A 1-mm K-wire (1 mm) was applied transversely to the fracture, distal to the middle phalanx. It was bent immediately above the skin with the help of pliers and the hook pin was prepared. For patients with dislocation, a 1-mm K-wire was applied to serve as a reduction pin just distal to the fracture and as close to the volar aspect of the phalanx as possible (Figure 2).

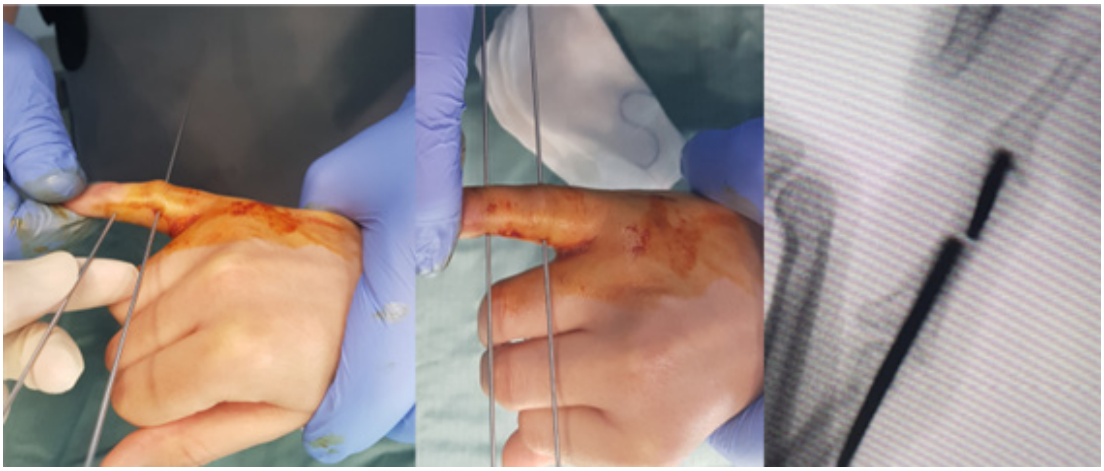

Figure 2. Application of the hook pin

Two rubber bands were subsequently added to the pin-and-rubber traction system and the achievement of appropriate reduction was checked under fluoroscopy considering the tension of the rubber bands. The tension and/or number of the bands was increased if necessary to achieve the appropriate reduction. When appropriate reduction was confirmed by fluoroscopy, the mobility of the finger was checked and the operation was terminated (Figure 3).

Figure 3. The bending of wires and the setup of the traction system

Postoperative Follow-up

Patients began routine postoperative movement immediately after leaving the operating room. After patients were discharged, they were called for weekly follow-up appointments to monitor the reduction. During these follow-up appointments, reduction was monitored via direct radiography and the joint movements of the patients were evaluated. For patients found to have experienced a loss of reduction in follow-up, reduction was regained by adjusting the tension of the rubber bands. The pin-and-rubber traction systems were routinely removed in the postoperative 6th week. After the removal of the traction system, patients were shown active finger movements to practice at home. Patients were then called for follow-up visits once a month for the first six months and every three months thereafter.

Patient Evaluations

The demographic data of all patients (age, sex, injured finger, type of injury, time until treatment) were recorded before surgery.

Joint range of motion (ROM) was examined for all patients at the final follow-up visit and X-rays were obtained. The functional status of the patients was evaluated with the Disabilities of the Arm, Shoulder, and Hand Questionnaire (DASH) score, while the presence and amount of pain was evaluated with a visual analog scale (VAS) with possible scores ranging from 0 to 100. Finger joint range of motion was measured with a finger goniometer and recorded.

RESULTS

The median age of the 24 patients included in this study was 30.0 (18-69) years, and 17 (70.8%) of these patients were male while 7 (29.2%) were female. Their injuries most often occurred after a fall (54.2%) and the fourth finger was most commonly injured (54.2%). The median time between the injury and surgical intervention was 3 (1.2-5.7) days. The median follow-up period was 25 (16.25-31.75) months. Demographic details of the study population were presented in Table 1.

Table 1. Demographic data of the patients included in the study

Variables	Values
Sex, n (%)	
Male	17 (70.8)
Female	7 (29.2)
Age, years	
X±SD	32.5±14.6
M (min-max)	30.0 (18.0-69.0)
Injured side, n (%)	
Right	12 (50)
Left	12 (50)
Injured finger, n (%)	
Second	1 (4.2)
Third	5 (20.8)
Fourth	13 (54.2)
Fifth	5 (20.8)
Affected joint, n (%)	
DIP	2 (8.3)
PIP	22 (91.4)
Mechanism of injury, n (%)	
Fall	13 (54.2)
Door closing on finger	3 (12.5)
Contact with a ball	2 (8.3)
Traffic accident	1 (4.2)
Injured while punching	5 (20.8)
Time interval between injury and treatment, days	
M (Q1-Q3)	3.0 (1.2-5.7)

The patients functional results were provided in Table 2. The median proximal interphalangeal (PIP) joint ROM was 90° (80.00-98.75°), while that of the distal interphalangeal (DIP) joint ROM was 55° (36.25-80.00°). The median DASH score was 4.16 (0.00-7.50) and the median VAS score was 4 (0.00-8.00).

Table 2. Functional scores

Functional scores	
M (Q1-Q3)	
DASH	4.16 (0.00-7.50)
VAS	4 (0.00-8.00)
PIP ROM (degrees)	90 (80.00-98.75)
DIP ROM (degrees)	55 (36.25-80.00)

M: median, Q1: first quartile, Q3: third quartile, DASH: disabilities of the arm, shoulder, and hand questionnaire, VAS: visual analog scale, PIP ROM: proximal interphalangeal joint range of motion, DIP ROM: distal interphalangeal joint range of motion

Union was observed to have occurred in all cases. No cases of coronal plane deformity were observed. Condylar fractures were observed during follow-up in two patients (8%), one occurring in the condyle of the middle phalanx and the other in the condyle of the proximal phalanx. The condylar fracture of the middle phalanx was observed the third week after surgery. The patient refused surgical treatment, and so the pin-and-rubber system was removed and no further surgical intervention was performed. The condylar fracture of the proximal phalanx was observed the fourth week after surgery. The patient had no fracture displacement and was therefore treated with a finger splint for two weeks, restricting active movement after the pin-and-rubber system had been removed. In three cases (13%), infection was observed at the base of a pin. In all three cases, the infection occurred at the base of the axial traction pin and these patients were treated with oral antibiotics; pin removal was not required. None of the patients developed osteomyelitis.

DISCUSSION

Interphalangeal joint fractures and fracture dislocations are complex injuries that most frequently occur in the PIP joint (13,14). Fractures accompanied by intraarticular fragments and dislocations may have extremely poor prognosis (1-4,6). In the literature, many treatment methods have been described for finger joint fractures and fracture dislocations (5,10,12). The most important finding of this study is that satisfactory joint range of motion was achieved in the long-term follow-up of patients with interphalangeal joint fractures or fracture dislocations following treatment with the pin-and-rubber traction system.

Capsuloligamentotaxis forms the basis of dynamic traction in the treatment of these injuries (1,8,15). The movement that occurs with the application of traction to the joint is a biological process. Ensuring fracture reduction and preventing the shortening of the ligaments around the joint facilitates the protection and healing of the articular surfaces (1,8,16).

Keramidas et al. reported reported 11 patients treated by Suzuki frame with PIP joint injuries, and after a mean follow-up period of 18 months, the mean active range of motion of the PIP joint was found to be 84° (17). In the study conducted by De Smet et al., which included 8 PIP joint fracture dislocations and had a mean follow-up period of 16.5 months, the mean total active joint range of motion was found to be 82° (16). Debus et al. found the mean active range of motion of the PIP joint to be 56° while that of the DIP joint was 39.6° (18). The study conducted by Agarwal et al. had a mean follow-up period of 12.8 months and the mean active range of motion of the PIP joint was found to be 67.2° while that of the DIP joint was 40.7° (19). In the present study, the median follow-up period was 25 months and the median values of total active range of motion were 90° for the PIP joint and 55° for the DIP joint. Compared to other studies in the literature in terms of follow-up, the present study is seen to have a relatively long follow-up period. Furthermore, compared to previous findings in the literature, the ranges of motion obtained in this study for both the PIP and DIP joints are higher. This may be due to the fact that previous studies involving the pin-and-rubber traction system also included patients who had undergone open reduction.

Ellis et al. retrospectively evaluated 14 patients, the mean VAS score was reported as 2.5 (0-10) (20). The study conducted by Finsen included 18 patients and the mean VAS score was 5.5 (0-10) (21). In the present study, the median VAS score was 4 (0-100). Thus, compared to the literature, the final pain levels reported in this study are quite low. This may be due to the present study's long duration of follow-up and the fact that appropriate closed reduction was achieved in all cases.

In the literature review conducted by Gianakos et al., it was stated that DASH scores were reported in 22% of the evaluated studies on the treatment of interphalangeal joint fracture dislocations, and the mean DASH score of patients in studies using dynamic external fixators was 9.2 (22). In the present study, the median DASH score was found to be 4.16. The lower DASH scores obtained in this study compared to the literature, reflecting a lower level of disability, may be attributed to the fact that most patients in this study had injuries of the fourth or fifth finger. These fingers have a relatively limited impact on overall DASH function scores.

Considering the frequency of postsurgical infections among patients treated with dynamic external fixators, Elatta et al. reported the occurrence of 5 superficial infections among a total of 36 patients, and those infections were treated with oral antibiotics without removal of the traction systems (23). In the study conducted by Agarwal et al., pin site infections were observed in 7 cases (28%) and were again treated with antibiotics without removal of the systems (19). Debus et

al. detected superficial infections in 3 patients who were accordingly treated with oral antibiotics, while one patient underwent surgical curettage due to osteomyelitis (18). In the study conducted by Kiral et al., no signs of infection were found in any patient (24). Infection at the pin site was observed in three patients in the present study. They were treated with oral antibiotics and removal of the pin-and-rubber system was not necessary. No patients developed osteomyelitis.

Regarding the possible complications of finger joint injuries treated with dynamic external fixators, nonunion, osteoarthritis, osteomyelitis, coronal and sagittal plane deformity, and osteolysis have been reported in the literature (16,19,20,25,26). In contrast, in the present study, only condylar fractures due to falls were encountered as complications in two cases, with one occurring in the middle phalanx and the other in the proximal phalanx. This finding may be attributed to the occurrence of osteolysis in bone area through which K-wires pass, with fractures due to trauma occurring more easily in those areas due to the effect of active movement.

The present study has several limitations that should be acknowledged. First, retrospective nature of the study may cause bias. Second, lack of control group prevents to compare the presented data with other treatment options. Third, relatively shorter follow up time may cause underestimating some complications that can present in long term such as osteoarthtiris. Also patient populations is not enough to demonstrate risk factors for complications.

CONCLUSION

In conclusion, good functional results can be achieved with the pin-and-rubber method in selected cases of interphalangeal joint injuries, as this method allows for early movement and does not disrupt the fracture biology. Although the complication rates of this method are relatively low, it should be kept in mind that condylar fractures may occur, especially due to osteolysis.

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Ethical approval: *This study was designed as a retrospective case series. Approval was obtained from the Erciyes University Clinical Research Ethics Committee, (2018/516, 17.10.2018) before the research began.*

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