

## Original Research Article

# Middle phalanx base fractures managed with Suzuki frame: a series of 23 patients

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## ABSTRACT

**Background:** Intra-articular fractures of the base of middle phalanx are difficult to manage. With many known methods of treatment available, the authors present their experience of managing these injuries by Suzuki's pin and rubber traction method.

**Methods:** A prospective study of five years duration which included 23 patients. All the patients were managed with Suzuki's pin and rubber traction system. The primary outcome variable was ROM at the PIP joint. The secondary outcome variable was the complication profile.

**Results:** The mean ROM at the PIP joint at the final follow-up was 80±12.2 (range: 50-100) degrees. The mean flexion at PIP joint at the final follow-up was 82.72±10.5 degrees and the mean extension at PIP joint was -2.7±4.5 degrees. No case of non-union was observed in the present study. Pin tract infection occurred in 17.39% of cases and was the commonest complication observed. Two patients needed realignment of K-wires for pin displacement. One patient developed osteomyelitis of middle phalanx at three weeks and needed early removal of hardware. The same patient also developed complex regional pain syndrome (CRPS) at two months. One patient developed painful arthritis of PIP joint.

**Conclusions:** Suzuki's pin and rubber traction method is an effective modality of treatment for intra-articular fractures of the base of proximal phalanx of fingers of hand. Although, not free of complications the final results in most patients are good. However, the authors recommend large randomized control trials to be held for these injuries to compare various modalities of treatment.

**Keywords:** Phalanx fracture, Suzuki frame, Pin and rubber traction

## INTRODUCTION

Middle phalanx base fractures are difficult to manage, because these are mostly intra-articular.<sup>1</sup> Three patterns of these fractures are usually encountered. The commonest pattern is a volar lip fracture of the base of middle phalanx. Dorsal lip fractures and the pilon fractures are the other patterns. All the three patterns are commonly associated with joint subluxations.<sup>2,3</sup> The management of these injuries has always been a debate. Although open reduction and internal fixation is possible after meticulous

dissection, but fixation of the small bony fragments using pins needs immobilization for variable duration of time which leads to joint stiffness. The pin and rubber traction system for these injuries was first described by Suzuki et al.<sup>4</sup> This is a dynamic method for fixation of such injuries with the advantage that early range of motion can be started and ligamentotaxis may be used for close reduction of the fractures.<sup>5-8</sup> The present study aimed at studying the functional outcome of fractures of base of middle phalanx of hand using Suzuki frame.

## METHODS

The present study was a prospective study of 5 years duration (August, 2017 to September, 2022), which was conducted in the department of orthopaedics, government medical college, Anantnag and included 26 patients with intra-articular fractures of base of middle phalanx of hand who were managed with Suzuki pin and traction frame. One patient died due to COVID-19 complications and two patients were lost to follow-up. The 3 patients excluded from the study and final study sample included 23 patients.

### Inclusion criteria

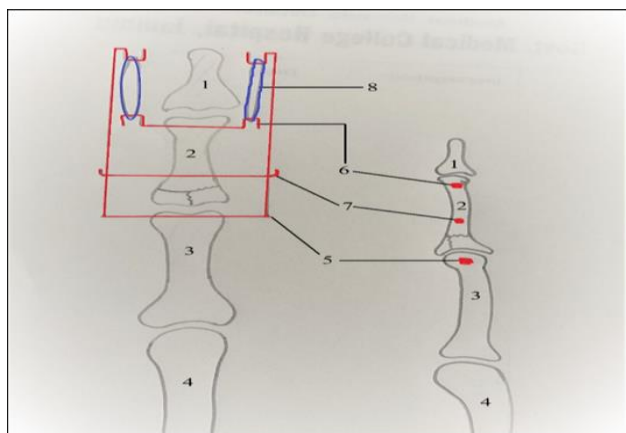
Adults patients with age >18 years, closed injuries, intra-articular fractures of base of middle phalanx of any finger of hand were included in the study.

### Exclusion criteria

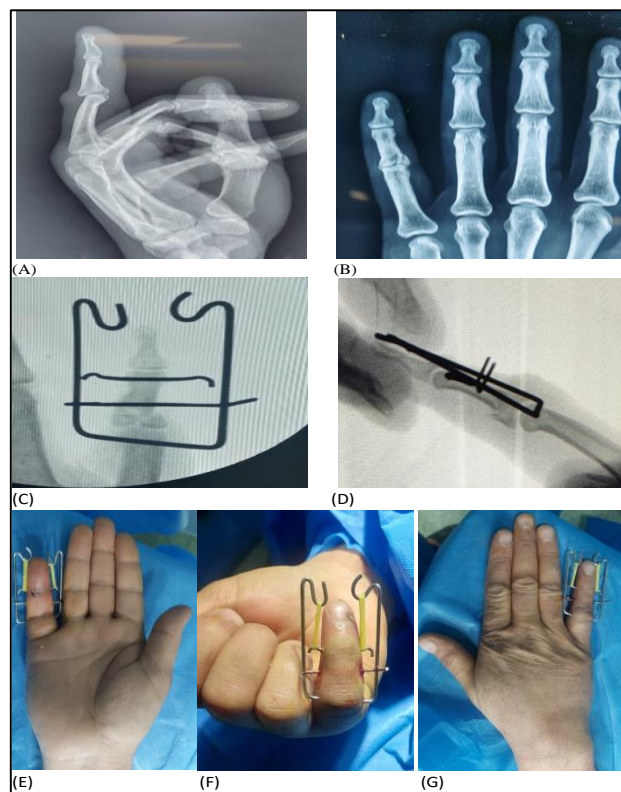
Patients with age <18 years, open injuries, extra-articular fractures and injuries of thumb were excluded from study.

The patients were admitted from orthopaedic emergency and out-patient departments of the hospital. Antero-posterior and lateral radiographs of the involved finger were carried out. Initial management included splintage of the finger, buddy strapping and adequate analgesia. Informed written consent was taken from all the patients and ethical approval was taken from the institutional ethical committee for the study.

All the patients were operated under regional anaesthesia. Injection cefuroxime 1.5 gm was given as prophylactic antibiotic, half an hour prior to surgery. Closed reduction was used in all the cases using the principle of ligamentotaxis. Three long Kirschner wires (K-wires) were used along with rubber bands to create a dynamic frame assembly (Figures 1 and 2).



**Figure 1: Diagram of Suzuki's frame for fracture of base of middle phalanx-(1) distal phalanx, (2) middle phalanx, (3) proximal phalanx, (4) metacarpal bone, (5) axial traction pin, (6) hook pin, (7) reduction pin, (8) rubber band.**



**Figure 2 (A-G): 40-year-old male with fracture base of middle phalanx of little finger. Pre-operative lateral view, pre-operative antero-posterior view, intra-operative AP and lateral radiographs with Suzuki's frame *in situ* and clinical photos of the Suzuki's frame.**

As described Suzuki et al a long 1.2 mm K-wire was passed horizontally into the head of the proximal phalanx just proximal to the proximal interphalangeal (PIP) joint.<sup>4</sup> The K-wire is bent at an angle of 90 degrees on both side and at the distal ends hooks are created for rubber bands. This wire is called the 'axial traction pin'. A second 1.0 mm K-wire, which is called as 'hook pin', was inserted transversely into the head of the middle phalanx and bent to create hooks. A third wire was placed just distal to the fracture, which helps correct any volar or dorsal subluxation at the PIP and hence is called a 'reduction pin'. Rubber bands were inserted into the hooks created in the first two K-wires and the strength was adjusted by increasing the number of rubber bands.

Active range of motion (ROM) was started immediately. The patients were discharged the same day from the hospital and the attached to physiotherapy department on OPD basis. Minimum final follow up for every patient was two years. The primary outcome variable was ROM at the PIP joint. The secondary outcome variable was the complication profile. Mean, percentage and standard deviation were calculated. The statistical analysis of the data was performed using SPSS statistics programme version 20 (IBM, Armonk, NY, USA).

## RESULTS

Observations and demographic details of the study have been listed in Table 1. The mean age of the patients in the present study was  $29.95 \pm 9.07$  years (Range: 18-50 years). The injuries were observed predominantly in males with a male to female ratio of 2.83:1. Sports injuries, while playing cricket and volleyball, were the commonest mechanism of injury observed (39.13%) followed by punching during fighting or assault (34.78%). Dominant hand was involved in 69.56% of patients. Middle finger was most commonly involved (34.78%), while as little finger (13.04%) was the least common. Volar plate avulsion pattern fracture with dorsal subluxation of the PIP joint was observed in 60.86% patients. The mean interval between injury and surgery was  $7.34 \pm 4.2$  (range: 2-16) days and average surgical time was  $31.3 \pm 6.6$  minutes.

**Table 1: Demographic details of study participants.**

Variables	Observation, N (%)
<b>Age of patients (Mean<math>\pm</math>SD) (years)</b>	29.95 $\pm$ 9.07 (Range: 18-50)
<b>Gender</b>	
Male	17 patients (73.9)
Female	06 patients (26.1)
Male: Female	2.83:1
<b>Mechanism of injury</b>	
Sports injury (Cricket and Volleyball)	09 patients (39.13)
Punching (Assault and Fighting)	08 patients (34.78)
Machine injury	06 patients (26.08)
<b>Laterality</b>	
Dominant hand	16 patients (69.56)
Non-dominant hand	07 patients (30.43)
<b>Involved finger</b>	
Middle finger	8 (34.78)
Ring finger	7 (30.43)
Index finger	5 (21.73)
Little finger	3 (13.04)
<b>Fracture pattern</b>	
Volar plate avulsion	14 (60.86)
Dorsal plate avulsion	06 (26.08)
Plafond (comminuted)	03 (13.04)
<b>Mean interval between injury and surgery</b>	7.34 $\pm$ 4.2 days
<b>Mean operative time (min)</b>	31.3 $\pm$ 6.6
<b>Mean flexion at PIP joint (final follow-up)</b>	82.72 $\pm$ 10.5 degrees
<b>Mean extension at PIP joint (final follow-up)</b>	-2.7 $\pm$ 4.5 degrees
<b>Mean ROM at PIP joint (final follow-up)</b>	80 $\pm$ 12.2 degrees

SD=standard deviation, PIP=proximal interphalangeal; ROM=range of motion.

The mean ROM at the PIP joint at the final follow-up was  $80 \pm 12.2$  (range: 50-100) degrees. The mean flexion at PIP

joint at the final follow-up was  $82.72 \pm 10.5$  degrees and the mean extension at PIP joint was  $-2.7 \pm 4.5$  degrees. No case of non-union was observed in the present study. The complication profile and the treatment provided is summarized in Table 2. Pin tract infection occurred in 17.39% of cases and was the commonest complication observed. Two patients needed realignment of K-wires for pin displacement. One patient developed osteomyelitis of middle phalanx at three weeks and needed early removal of hardware. The same patient also developed complex regional pain syndrome (CRPS) at two months and responded well to a stellate ganglion block. One patient developed painful arthritis of the PIP joint at 8 months post-operatively and was managed with arthrodesis of the joint.

**Table 2: Complication profile and treatment provided.**

Complications	Number of patients (%)	Management
<b>Pin site infection</b>	4 (17.39)	Responded well to pin site dressings
<b>Pin displacement</b>	2 (8.69)	Realignment under local anaesthesia
<b>Osteomyelitis</b>	1 (4.34)	Removal of K-wire and antibiotics
<b>CRPS</b>	1 (4.34)	Stellate ganglion block
<b>PIP joint arthritis</b>	1 (4.34)	Arthrodesis of PIP joint

CRPS=complex regional pain syndrome; PIP=proximal interphalangeal.

## DISCUSSION

Mostly young patients were involved in the present study with a mean age of  $29.95 \pm 9.07$  years. Finsen et al and Keramidis et al observed a mean age of 54 years and 30 in their series', respectively.<sup>1,7</sup> These injuries seem to occur in all the age groups but mostly in young and middle age groups. In the present series, the males had a higher involvement which is similar to the observations by previous authors.<sup>1,7,9</sup> Dominant hand was involved in majority of the patients which is expected due to preference of working with dominant hand. Most of the previous researchers also observed the predominant dominant hand involvement.<sup>1,7,9</sup>

Sports injury was the most common cause in the present study, mostly by games like cricket and volleyball which are the commonest sports in this part of the world. Injuries secondary to punching and assault were also observed. Also, machine injury was the cause in few patients. The mechanism of injury is variable in previous literature, depending upon the geographical location. However, in all the previous studies, various sports injuries have been the most commonly observed cause.<sup>1,7,9</sup>

Injury was most common in middle finger in the present series. However, most of the previous researchers have

observed variable involvement of fingers.<sup>10-12</sup> Volar plate avulsion fractures were observed in 60.86% of the patients and was the commonest fracture pattern. This is similar to the findings in existing literature.<sup>13,14</sup>

The mean surgical time was 31.3 minutes in the present study. Though four different surgeons operated all the patients, operative time was almost similar. The existing literature also suggests the procedure to be easy to perform with a brief surgical time.<sup>1,9</sup> In the present study, the mean ROM at the PIP joint at the final follow-up was  $80 \pm 12.2$  degrees. The mean flexion at PIP joint at the final follow-up was  $82.72 \pm 10.5$  degrees and the mean extension at PIP joint was  $-2.7 \pm 4.5$  degrees. The results in the previous studies have been variable. De Soras et al in their series achieved the mean ROM of the 84 degrees as well as the Duteille et al observed that the 85.9 degrees of mean ROM at the final follow-up.<sup>1,5,10</sup> Majumdar et al in their study, observed a final mean ROM of the 74 degrees.<sup>6</sup> The results of the present study seem to be similar to the previous ones in this context.

Pin tract infection was observed in four patients and one patient developed osteomyelitis of the phalanx. Though pin tract infection has been commonly reported in the previous literature by all the researchers, osteomyelitis is rare.<sup>16-18</sup> The same patient needed early implant removal but later developed CRPS and was given a stellate ganglion block, to which the patient responded well. One patient needed arthrodesis of the joint for painful arthritis of PIP joint.<sup>19</sup>

All the patients were able to carry out their daily activities of living, although the final ROM at involved PIP joints was less than normal. This can be explained on the basis of observations by Ellis and Tsai, who state that most of the daily activities do not need more than 50% of maximal joint motion.<sup>20</sup>

The limitation of the present study was a lack of control group and small sample size. Hence, the authors recommend large randomized control trials be held to compare the results of other modalities of treatment for these injuries.

## CONCLUSION

Suzuki's pin and rubber traction method is an effective modality of treatment for intra-articular fractures of the base of proximal phalanx of fingers of hand. Although, not free of complications the final results in most patients are good. However, the authors recommend large randomized control trials to be held for these injuries to compare various modalities of treatment.

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