Treatment of delayed proximal interphalangeal joint fractures with a handmade dynamic external fixator

Ali Gulec, Harun Kutahya, Recip Gani Goncu, Yunus Kirac, Mehmet Ali Acar

ABSTRACT

**Objectives:** Although several methods are used in the treatment of intra-articular proximal interphalangeal (PIP) joint fractures, there is no universally accepted ideal method, and joint stiffness, deformity and degenerative osteoarthritis remain as significant complications. The aim of this study was to examine the results of patients treated with a handmade dynamic external fixator for PIP fractures delayed for at least 10 days and to investigate whether or not these patients had adequate finger movement.

**Methods:** A retrospective study was conducted in patients treated with a handmade dynamic external fixator for PIP joint fractures in the Orthopaedic Department at the Selçuk University Medical Faculty Hospital. The results of 12 cases were examined in which treatment had been neglected for various reasons, with at least 10 days passing since the injury occurred.

**Results:** The cases included 1 female and 11 males with a mean age of 25.9 years. The mean time from injury to operation was 12.1 days. The device was left in the finger for a mean of 32.9 days. At the final follow-up examination, 7 patients had full range of motion (ROM), while 4 patients had full extension, but flexion was restricted, ranging from 5° to 15°, and in 1 case both extension and flexion restriction were 15°. The mean follow-up period was 13.7 months, during which no patient reported any pain, nor were there any findings of osteomyelitis, as determined radiologically or clinically.

**Conclusion:** Treatment with an external fixator is a method that is quick, inexpensive and easy to apply. Fixation using a handmade dynamic external fixator for the treatment of PIP fractures is safe and technically simple. Additional extensive studies are required on this subject.

**Key words:** Dynamic external fixator, proximal interphalangeal joint fractures, k-wire

Introduction

Proximal interphalangeal (PIP) joint fractures are not uncommon and are generally complex injuries [1]. In addition to a lengthy treatment time, high sequelae rates of approximately 8% in these injuries increase the socio-economic burden on the patient [2]. Several methods are used in the treatment of intra-articular PIP fractures, such as dynamic splinting, transarticular Kirschner (K)-wires preventing extension, static or dynamic external fixators and volar plate arthroplasty. However, despite all of these methods, there is no universally accepted ideal method for treating PIP fractures and joint stiffness, deformity and degenerative osteoarthritis remain as the most important complications [3]. To prevent these complications, it is important to start the appropriate treatment at an early stage and to have early mobilisation after achieving anatomic reduction of the fracture [4, 5]. Therefore, the time of...
starting treatment is significant in defining the effectiveness of the treatment and in reducing morbidity.

The use of an external fixator in the treatment of difficult PIP fractures was first suggested in 1946 [6]. Later in 1986, Schenk et al. again proposed the dynamic external fixation method for the treatment of PIP fractures [7]. It has been demonstrated that this method can correct subluxation and it allows movement in the early stages of healing. Particularly successful results were obtained with respect to movement. Different dynamic external fixators have been developed since that time and this method now plays a significant role in the treatment of PIP fractures. The most important advantage of these dynamic fixators is that multiple tissues are considered in the lesions being treated. In PIP fractures, the phalanx epiphysis, the capsulo-ligamentous structures, the joint capsule and the collateral ligaments are affected and dynamic external fixators provide stabilisation of all these structures in the early postoperative period [8].

The aim of this study was to examine the results of patients treated with dynamic external fixators for PIP fractures delayed for at least 10 days and to investigate whether or not these patients had adequate finger movement.

Materials and Methods

A retrospective study was conducted on patients treated with dynamic external fixators for PIP joint fractures in the Orthopaedic Department at the Selçuk University Medical Faculty Hospital. The results of 12 cases were examined in which treatment had been neglected for various reasons, with at least 10 days passing since the injury. All the fractures, which occurred between November 2010 and September 2012, were treated with dynamic external fixators. The patient data was accessed from hospital records. Following treatment, the active range of motion (ROM) of the PIP joint was measured with a standard goniometer.

Statistical analyses were made using the Statistical Package for Social Sciences software (SPSS for Win-
Surgical Technique

The operation was performed under local anaesthesia in all patients. Closed reduction was applied first, then a 1.1 mm K-wire was placed percutaneously vertical to the long axis of the phalanx and moved towards the head of the proximal phalanx, taking care not to damage the joint capsule. A longer second K-wire was placed more distally and again was moved towards the head of the middle phalanx, without damaging the joint capsule. Both wires were used to manipulate the fracture. A hook was passed approximately 5 mm from the skin at the proximal K-wire. The distal K-wire was bent into the shape of a parabolic curve running parallel to the long axis of the phalanx and was joined with the proximal wire. In this way, traction was applied to the finger (Figures 1a, b, c and d). For 3 days postoperatively, rest and elevation were recommended, then on the 3rd day, a mild movement program was started. A regular physiotherapy program containing active and passive movements was started on the 7th day and was continued for 2-3 months.

Results

While there was a single finger injury in 12 cases, one case involved 2 finger injuries, one on each hand (Figures 2 and 3). The cases included 1 female and 11 males with a mean age of 25.9 years (range of 16-34 years). The general data of the patients is summarised in Table 1.

The mean time from injury to operation was 12.1 days (range of 12-19 days). The device was left on the finger for a mean of 32.9 days (range of 23-38 days). At the final follow-up examination, 7 patients had full ROM, 4 patients had full extension but flexion was restricted, ranging from 5° to 15°, and in 1 case both extension and flexion restriction were limited to 15°. No postoperative complications developed in 10 of the pa-
Table 1. General characteristics of the cases included in the study.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age / gender</th>
<th>Mechanism of injury</th>
<th>Finger</th>
<th>Time to surgery (days)</th>
<th>Duration of fixator (days)</th>
<th>Follow-up (months)</th>
<th>Complication</th>
<th>ROM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28 M</td>
<td>Sports injury</td>
<td>Left 5</td>
<td>14</td>
<td>36</td>
<td>20</td>
<td>None</td>
<td>Full</td>
</tr>
<tr>
<td>2</td>
<td>25 M</td>
<td>Fall</td>
<td>Left 3</td>
<td>11</td>
<td>32</td>
<td>11</td>
<td>None</td>
<td>Full</td>
</tr>
<tr>
<td>3</td>
<td>22 M</td>
<td>Fall</td>
<td>Left 5</td>
<td>11</td>
<td>36</td>
<td>10</td>
<td>None</td>
<td>Full Extension/ flexion restriction (10°)</td>
</tr>
<tr>
<td>4</td>
<td>25 M</td>
<td>Fall</td>
<td>Right 4</td>
<td>13</td>
<td>31</td>
<td>10</td>
<td>None</td>
<td>Full</td>
</tr>
<tr>
<td>5</td>
<td>18 M</td>
<td>Fall</td>
<td>Left 4</td>
<td>16</td>
<td>38</td>
<td>17</td>
<td>None</td>
<td>Full Extension/ flexion restriction (5°)</td>
</tr>
<tr>
<td>6</td>
<td>16 F</td>
<td>Sports injury</td>
<td>Left 4</td>
<td>12</td>
<td>23</td>
<td>18</td>
<td>Pin tract infection</td>
<td>Full</td>
</tr>
<tr>
<td>7</td>
<td>33 M</td>
<td>Traffic accident</td>
<td>Left 3</td>
<td>19</td>
<td>34</td>
<td>12</td>
<td>None</td>
<td>Full Extension/ flexion restriction (15° in 3rd and 10° in 4th fingers)</td>
</tr>
<tr>
<td>8</td>
<td>28 M</td>
<td>Sports injury</td>
<td>Left 5</td>
<td>11</td>
<td>28</td>
<td>7</td>
<td>None</td>
<td>Full</td>
</tr>
<tr>
<td>9</td>
<td>30 M</td>
<td>Fall</td>
<td>Left 3</td>
<td>10</td>
<td>38</td>
<td>7</td>
<td>None</td>
<td>Full Extension/ flexion restriction (10°)</td>
</tr>
<tr>
<td>10</td>
<td>32 M</td>
<td>Fall</td>
<td>Left 5</td>
<td>12</td>
<td>35</td>
<td>6</td>
<td>None</td>
<td>Full</td>
</tr>
<tr>
<td>11</td>
<td>20 M</td>
<td>Fall</td>
<td>Right 1</td>
<td>15</td>
<td>36</td>
<td>28</td>
<td>Pin tract infection</td>
<td>Full</td>
</tr>
<tr>
<td>12</td>
<td>34 M</td>
<td>Fall</td>
<td>Left 5</td>
<td>14</td>
<td>28</td>
<td>18</td>
<td>None</td>
<td>Extension/ flexion restriction (15°)</td>
</tr>
</tbody>
</table>

Discussion

This study investigated the results of the use of a handmade dynamic external fixator in the delayed treatment of PIP fractures. Successful results were obtained from a mean follow-up period of 13.7 months. Following treatment, 7 patients had full ROM, 4 patients had full extension but flexion was restricted, ranging from 5° to 15°, and 1 patient had both extension and flexion restricted to 15°. In 2 patients (16.7%), pin tract infections developed, and these complications were successfully treated with oral antibiotics.

Fractures of the PIP joint remain a difficult problem to treat. As the bone is immediately adjacent to the soft tissue, all types of injury to the bone also affect the surrounding soft tissue. Lengthy immobilisation of the finger causes not only scar tissue to form in the injured area, but also causes the adhesion of tendons and ligaments to the joint capsule and the adjacent bone tissue, respectively. As a result, stiffness develops in the finger joint [9, 10].

The best treatment method for PIP joint fractures achieves a well-aligned, stable reduction without surgical intervention and early mobilisation of the associated muscle, tendon and joints [11]. The primary aims of treatment are to reduce oedema, prevent tendon adhesion and start rehabilitation at an early stage, thereby preventing stiffness of the joint. When these aims are taken into consideration, the use of a dynamic external fixator in the treatment of PIP fractures seems to be one of the best methods. This method has attracted much attention, as it is inexpensive, simple to apply and does...
not require major surgery.

Closed reduction can generally provide a successful joint reduction, but for PIP fractures which are dynamically unstable, external fixation is suitable. Fractures in which more than 30% of the joint surface is affected are generally unstable and if more than 50% of the joint surface is affected, the fracture is evaluated as definitely unstable [12].

The application of an external fixator to interphalangeal joint fracture dislocations was first described in the literature in 1946 by Robertson, Cawley and Faris [6]. Later, Schenk et al. used a wide fixator which allowed passive finger movement [7]. Then Suzuki et al. described a different dynamic external fixator using elastic bands [13]. However, the use of elastic bands during the operation and adjusting the elasticity is difficult. Therefore, this method has been modified by different researchers [14]. Subsequently, simple dynamic external fixators using K-wires have been described [15, 16].

In a study by Badia et al., 6 patients with PIP joint fractures were treated with dynamic external fixators and following treatment, ROM values were determined as between 5° and 89° (range of 0-100°). Of those patients, pin tract infections were successfully treated with oral antibiotics in 2 cases. The mean time from injury to surgery in that study was 6 days (range of 1-14 days). The fixator was removed within 3-4 weeks and early active flexion was allowed [17]. Ruland et al. treated PIP joint fractures in 26 patients with dynamic external fixators and as a result all the patients returned to their pre-injury work and activities. In the follow-up period, the mean ROM value was determined as 88°. An interesting point of this study is that 3 of the cases were chronic fractures in which a dynamic external fixator was applied at a mean of 6 weeks after the injury. Patients in those cases returned to their previous occupations after treatment [18].

In another study, 8 patients were treated with dynamic external fixators and after a 26-month follow-up
period, the PIP ROM in flexion was found to range from 1°-89°. Grip strength was calculated as 92% of the unaffected side, but in addition to these positive results, early arthritis was reported in 2 patients [19]. In another study, after the use of dynamic external fixators in the treatment of complex PIP fractures, the mean ROM value was found to be 79° and patient satisfaction was reported to be high [20].

In another study of 11 cases of PIP fractures treated with dynamic external fixators, the mean ROM value after treatment was determined as 64°. A different study reported lower ROM values, which were associated with a short follow-up period of 6 months. The mean time from injury to surgery was 8 days (range of 2-14 days) and the fixator was removed at the end of a mean of 4 weeks. In that study, a negative, but not statistically significant correlation was determined between delayed surgery and grip strength. However, no relationship was determined between delayed surgery and the ROM value of the PIP joint [21]. In this study, which had a mean period of 16.4 weeks, early return to work, successful pain control and high patient satisfaction were reported after employing this method.

Between 1995 and 2001, Richter et al. treated 13 PIP fracture dislocations with the Suzuki external fixator method and reported long-term results. The mean ROM value was determined as 85° (range of 0-100°) at the final follow-up examination from a mean follow-up period of 8 years (range of 5-11 years). This study is important with respect to the evaluation of long-term results, with the results obtained in the long-term found to be better than those of the short-term [22].

There are some limitations to the current study, the most important of which is the low number of patients. It is not possible to generalise from the 12 cases reported here, but the data of this current study can be considered important in terms of providing guidance for future studies and as an example for surgeons faced with delayed PIP joint fracture treatment. Another limitation is that the follow-up period was not very long (mean of only 13.7 months). Longer term data may show even more successful results.

In conclusion, the use of a handmade dynamic external fixator provides a quick, easy and technically simple to apply method which can be performed under local anaesthesia. To the best of our knowledge, this study is the first to report successful results obtained in the treatment of delayed PIP fractures with the use of a dynamic external fixator. However, additional extensive studies on this subject are warranted.

References
12. Kiefhaber TR, Stern PJ. Fracture dislocations of
the proximal interphalangeal joint. J Hand Surg Am 1998;23;368-80.


