Gradual joint distraction of post-traumatic flexion contracture of the proximal interphalangeal joint by a mini-external fixator

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We present the outcome of the treatment of chronic post-traumatic contractures of the proximal interphalangeal joint by gradual distraction correction using an external fixator. A total of 30 consecutive patients with a mean age of 34 years (17 to 54) had distraction for a mean of 16 days (10 to 22). The fixator was removed after a mean of 29 days (16 to 40). Assessment at a mean of 34 months (18 to 54) after completion of treatment showed that the mean active range of movement had significantly increased by 63° (30° to 90°; $p < 0.001$). The mean active extension gained was 47° (30° to 75°).

Patients aged less than 40 years fared slightly better with a mean gain in active range of movement of 65° (30° to 90°) compared with those aged more than 40 years, who had a mean gain in active range of movement of 55° (30° to 70°) but the difference was not statistically significant ($p = 0.148$).

The use of joint distraction to correct chronic flexion contracture of the proximal interphalangeal joint is a minimally-invasive and effective method of treatment.

Post-traumatic flexion contracture of the proximal interphalangeal joint (PIPJ) is a common clinical problem and can lead to substantial functional deficit especially when it is severe or affects many fingers.^{1,2} Surgical treatment is demanding and the results are unpredictable.²⁻⁵ However, recently, a minimally-invasive technique using the principle of distraction histogenesis with external fixation has been reported with good short-term results.^{6,7}

Our aim was to evaluate the clinical outcome of gradual distraction correction using a monolateral external fixator in a consecutive series of patients with chronic post-traumatic flexion contracture of the PIPJ.

Patients and Methods

Between September 2001 and September 2004, 32 patients with post-traumatic chronic flexion contracture of the PIPJ were included in the study. Two were subsequently lost to follow-up and the remaining 30 were available for assessment at one, three, six, and 12 months and at latest follow-up. The mean follow-up was 34 months (18 to 54).

There were 24 males and six females with a mean age of 34 years (17 to 54). The index finger was involved in five, the middle in two, the ring in seven and the little finger in 16. The mean time from injury to operation was 20 months (6 to 84).

All had chronic flexion contractures either because of dislocation or fracture-dislocation involving the PIPJ (Fig. 1). Of the 30 patients, 19 (63%) had a posterior PIPJ fracture-dislocation with fractures of the volar lip, seven (23%) had volar dislocation with a dorsal avulsion fracture and the remaining four (14%) had a pure PIPJ dislocation without a fracture. All the intra-articular fractures, when present, involved less than a third of the articular surface, as assessed on the lateral radiographs.

All the patients had initial treatment for their fracture-dislocation in the form of a closed reduction and either neighbour strapping or a plaster of paris back slab. The patients were skeletally mature and none had previously undergone operative treatment, although all had received hand therapy with dynamic extension splints for a minimum of three months. Patients with contractures because of a burn or crush injury, or associated with a tendon laceration or chronic regional pain, were excluded from the study. Before surgery, the mean range of movement (ROM) of the PIPJ was 19° (0° to 50°).

Operative technique. Under local or regional anaesthesia a unilateral dynamic mini Orthofix (Orthofix, Guildford, United Kingdom) external fixation device was positioned using image-

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©2007 British Editorial Society of Bone and Joint Surgery
doi:10.1302/0301-620X.89B2.18448 \$2.00

J Bone Joint Surg [Br]
2007;89-B:206-9.
Received 24 July 2006;
Accepted after revision 13 October 2006

Fig. 1

Radiograph and photograph showing fixed-flexion deformity with contracture of the proximal interphalangeal joint of the index finger.

Table I. Post-operative mean (°; range) active range of movement

	Mean	
At end of treatment	19.33	(0 to 50)
At 1 month	64.33	(40 to 90)
At 3 months	82.00	(50 to 100)
At 6 months	82.00	(50 to 100)
At final follow-up	82.00	(50 to 100)

intensifier guidance (Fig. 2). The proximal and distal block fixations were attached to the proximal and middle phalanges respectively, using a single 2 mm threaded pin in each phalanx. The pins were placed parallel to each other and equidistant from the joint. The block and lengthening bar were placed on the volar aspect to provide both distraction and extension.

The fixator was positioned far enough away from the skin to accommodate swelling. The distraction nut was turned each day by a quarter turn (one full turn gave a joint distraction of 1 mm) starting on the first day after surgery.

The patients were trained to do the distraction themselves at home and were reviewed weekly. The joint was distracted by a mean of 4 mm (3 to 5), as seen on lateral radiographs. When full extension was obtained (Figs 3 to 5) distraction was then maintained for a mean of 29 days (16 to 40).

The device was removed without anaesthesia in the outpatient clinic. No patient received prophylactic antibiotics. Hand therapy was undertaken for four weeks after removal of the fixator.

Fig. 2

Photograph showing the mini external fixator *in situ*.

During distraction, the neurovascular status of the finger was carefully monitored, especially when longer distraction was required for straightening of the PIPJ. The skin on the volar aspect of the joint was checked for pallor, and pain was also monitored during distraction. Many patients experienced some pain for a few minutes immediately after the distraction which then settled without the need for analgesia.

Statistical analysis. The statistical software packages SPSS 11.00 (SPSS Inc., Chicago, Illinois) and Systat 8.0 (Systat Software Inc., Richmond, California) were used for analysis of the data. Student's *t*-test (paired) was performed in order to determine significance in the improvement of the ROM. A *p*-value of ≤ 0.05 was considered to be significant.

Results

The mean distraction time was 16 days (10 to 22) and the fixator was removed after a mean of 29 days (16 to 40). The wide range of distraction times reflects the difference in severity of the initial contracture and its duration before surgery. These two factors also influenced the duration for which the fixator was left *in situ* after full correction.

The mean active ROM gained by the procedure was 63° (30° to 90°); Student's *t*-test, $p < 0.001$; Table I. The mean active extension gained was 47° (30° to 75°).

Patients aged less than 40 years fared slightly better with a mean gain in active ROM of 65° (30° to 70°) compared with those aged more than 40 years, who had a mean gain in active ROM of 55° (30 to 70), but the difference was not statistically significant ($p = 0.148$).

At the final follow-up there were no recurrences and no loss of ROM. All patients were free from pain and were satisfied with the functional and cosmetic results (Fig. 6).

Complications included superficial pin-track infection in five patients (17%) which settled within seven days with oral antibiotics and local wound care. Nine patients

Fig. 3

Radiograph showing a lateral view of the index finger with 2 mm joint distraction four days after application.

Fig. 4

Radiograph showing an anteroposterior view of the index finger with 5 mm joint distraction ten days after application.

Fig. 5

Radiograph showing a lateral view of the index finger with 5 mm of joint distraction 12 days after application.

(30%) had slight pain at the beginning of distraction, but all could tolerate the procedure well without interruption of the treatment.

We did encounter a temporary flexion deformity of the distal interphalangeal joint after distraction probably because of tension of the flexor tendon. This resolved after hand therapy following removal of the fixator.

Fig. 6

Photographs showing flexion and extension of the proximal interphalangeal joint at follow-up at one year.

Discussion

The standard treatment for chronic post-traumatic flexion contracture of the PIPJ which is resistant to conservative management has been open surgery. Curtis^{8,9} described sequential capsular release and subsequently several other surgeons have reported alternative open techniques with variable rates of success. Sprague³ reported a gain of only 13° in the arc of movement after capsular release which subsequently deteriorated and became worse than the pre-operative value at follow-up at one year. In 1977 Harrison¹⁰ proposed a modification of Curtis' method by preserving the collateral ligaments and reported a gain in the arc of movement of 24°.

Gould and Nicholson¹¹ reported improvement of 12° to 13° after volar capsulectomy. Mansat and Delprat¹² used arthrolysis for release of flexion contracture and noted an improvement of 18° while Bruser et al¹ reported improvement of 30° to 50°.

Ghidella et al² presented the long-term results using Curtis' technique and reported a mean gain of 8°. However, 31% of their patients required further surgery and they concluded that patients should be carefully evaluated before surgery and a strict selection policy applied.

Although the principle of distraction histogenesis is well established, its application in correcting flexion contracture of the PIPJ by external fixation has only recently been documented in the literature.^{6,7,13,14} In 1986, Schenck¹⁵ was probably the first to use external fixation and early passive mobilisation for fracture and dislocation around the PIPJ.

Hastings and Carrol,¹⁶ Inanami et al,¹⁷ Patel and Joshi¹⁸ and Fahmy¹⁹ have also reported the use of distraction with subsequent mobilisation in the management of chronically dislocated PIPJs. Richtir and Rysavy^{20,21} used the Volkov-Oganesjan distraction-reposition apparatus in six patients with flexion-contracture of the PIPJ. An improvement in the ROM of 48° was obtained at a follow-up of three months. Hodgkinson²² described the use of skeletal traction before definitive surgery to correct contracture in patients with advanced Dupuytren's disease and Bain et al²³ used a compass-hinge fixator for flexion-contracture, reporting a good result in two cases. Kasabian, McCarthy and Karp²⁴ in 1998 described the use of a multiplanar distractor in a single patient with a PIPJ contracture after replantation. Houshian, Gynning and Schroeder²⁵ used a similar compass hinge for dynamic extension correction in 27 patients, and reported a mean extension gain of 38° with a mean arc of movement of 42° (0° to 80°). Da Silva et al²⁶ reported distraction correction of a long-standing (20 years) flexion contracture, using a lengthening device, with a good result.

In theory, distraction correction differs from extension correction using the compass hinge, in that the soft-tissue contractures have an increased chance of correction when the joint is subjected to gradual distraction. We have previously reported good short-term results using a monolateral Orthofix frame for distraction in ten patients with a mean gain in ROM of 54° at six months.⁶ Ravishankar⁷ used a bilateral frame (Joshi's fixator) for correcting post-burn contracture of the PIPJ.

Loss of movement over time after the procedure has been a problem in previous studies.³ Ghidella et al² stated that there was probably little difference in the expected outcome after 24 months. In our series there was little difference between the result at six months and that at the last follow-up and there were no recurrences.

Ghidella et al² discouraged attempts at correction of the contracture of the PIPJ in patients over 43 years of age. Their ideal patient was 28 years of age and had a maximum flexion contracture of 43°. The mean age of our patients was 34 years (17 to 54) and nine patients were more than 40 years of age. We found no difference in outcome for patients aged over and under 40 years.

We had no serious complications, although pin-track infection occurred in five patients.

There are two areas which require further investigation. The first is the amount of distraction required and the stage at which permanent damage¹ occurs. Patel and Joshi¹⁸ reported joint distraction of 5 mm for optimum reduction of the dorsal dislocation. We have not had any adverse effects from distraction of 5 mm, perhaps because the distraction is applied gradually. In addition, we did not encounter any lateral instability of the PIPJ. The second point is the timing of removal of the fixator. We left it *in situ* for a mean of 29 days (16 to 40) after full correction of the

deformity. This allowed the stretched tissues to mature in their new position and inflammation to subside.

In summary, joint distraction using a monolateral external fixator for correction of flexion contracture of the PIPJ offers an effective method of treatment, but we suggest that randomised, controlled studies are now required.

Supplementary Material

A table showing the clinical details of the patients in this study is available with the electronic version of this article on our website at www.jbjs.org.uk

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

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