Dorsal fracture-dislocations of the proximal interphalangeal joint: evaluation of closed reduction and percutaneous Kirschner wire pinning

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Abstract

Background The purpose of this study is to evaluate the outcome of closed reduction and percutaneous Kirschner wire pinning in acute dorsal fracture-dislocations of the proximal interphalangeal (PIP) joint.

Methods Eight men and one woman were treated with closed reduction and percutaneous Kirschner wire pinning by one orthopaedic surgeon. The ring finger was injured in six patients, the small finger in two patients and the middle finger in one patient. The mean joint surface involvement was 36 % (range, 26–49 %). The Kirschner wires were removed after an average of 28 days (range, 24–37 days).

Results All patients demonstrated a painless, but fusiform, swollen PIP joint after a mean follow-up of 6.5 months. The average flexion of the PIP joint was 106° (range, 80–110), and the average extension of the PIP joint was 4° short of full extension (range, 10 hyperextension–15 flexion contracture). All patients had a concentrically reduced PIP joint with a healed fracture on radiographs. Two patients had radiographic evidence of degenerative changes, but were asymptomatic. One patient developed a superficial pin track infection, which quickly resolved with a short course of antibiotics, and avascular necrosis affecting one of the condyles of the proximal phalanx.

Conclusions In agreement with previous studies, closed reduction and percutaneous Kirschner wire pinning in dorsal

fracture-dislocations of the PIP joint is a minimally invasive and simple technique which appears to give satisfactory outcomes in the short to intermediate term.

Keywords Dorsal fracture-dislocations · PIP joint · Closed reduction · Kirschner wire fixation

Introduction

Unstable fracture-dislocations of the proximal interphalangeal (PIP) joint have an estimated incidence of 9 per 100,000 per year [34]. They remain a challenging problem for the hand surgeon since inadequate treatment can result in joint stiffness, pain, degenerative arthritis and residual deformities. Surgical treatment is often required in the presence of unstable fracture-dislocations. Many surgical treatments have been described, including open reduction and internal fixation (ORIF) of the fracture [2, 7, 15, 16, 20, 25], closed reduction and extension block pinning [21, 32], use of a dynamic external fixation device [3, 6, 10, 13, 24, 27, 29], palmar plate arthroplasty [8, 9, 11] and hemi-hamate arthroplasty [1, 5, 23, 35, 37]. The combination of anatomic reduction and stable fixation of the fracture fragments, followed by early mobilization to prevent joint stiffness, is considered the ideal treatment. There is little evidence to guide the clinician in choosing the appropriate procedure from among the numerous surgical alternatives, although there is general agreement that restoration of the normal gliding motion of the base of the middle phalanx about the head of the proximal phalanx is required for a successful outcome [19, 22]. A simple treatment option is to maintain the reduction of the PIP joint with a Kirschner wire, which is inserted percutaneously across the PIP joint. Three studies have been done previously using this technique [4, 26, 33].

The aims of this study were to retrospectively assess the early- to intermediate-term outcome of closed reduction and

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percutaneous Kirschner wire pinning for the treatment of unstable dorsal fracture-dislocations of the PIP joint and to confirm the results of previous studies.

Material and Methods

Nine consecutive patients, who sustained a dorsal fracture-dislocation of the PIP joint, were treated with closed reduction and percutaneous Kirschner wire pinning by one surgeon between May 2005 and January 2009 (Table 1). No exclusion criteria were applied.

After obtaining necessary approval from our Institutional Review Board, demographic data and the treatment course of the patients were determined by review of office notes, pre- and postoperative radiographs, as well as operative reports. All fractures involved the volar aspect of the middle phalanx, leading to dorsal subluxation of the middle phalanx with respect to the proximal phalanx. Except in one patient, who also had a mallet finger, no other joints were injured in the affected hand. All fractures were closed and no patient had any neurovascular compromise. Fracture-dislocations were either caused by falls or occurred during sports and, in one case, were due to physical assault. None of the patients had any prior injuries to the affected digit or any previous surgeries performed on their injured finger.

Injury radiographs were reviewed to measure the fracture size (damaged joint surface) as a percentage of the whole articular joint of the base of the middle phalanx, using institutionally provided Amicas digital software (Amicas

Incorporated, Brighton, MA, USA) (Fig. 1). All fractures were considered unstable based on the percentage of involvement of the articular surface in conjunction with the inability to maintain a concentric reduction of the PIP joint despite adequate flexion.

The entire procedure was carried out using fluoroscopic guidance. Reduction was achieved through traction, if necessary with manipulation. In all cases, a concentric and congruous reduction was achieved and confirmed with fluoroscopy. The PIP joint was then stabilized in 30–60° of flexion with a 0.045 in./1.14 mm Kirschner wire which was introduced on the dorsum of the base of the middle phalanx, just distal to the insertion of the central extensor slip through the triangular ligament, which was then passed proximally across the PIP joint and into the head or medullary canal of the proximal phalanx. In two patients, two wires were used: one patient had two wires placed retrograde similar to the other patients in this series while the other patient had them placed antegrade from the head of the proximal phalanx across the PIP into the shaft of the middle phalanx.

Postoperative radiographs were obtained to confirm congruous concentric reduction of the PIP joint, and patients were splinted with a removable volar gutter PIP orthoplast splint. Gentle active motion of the metacarpophalangeal and distal interphalangeal joint was encouraged. The Kirschner wires were removed after an average of 28 days (range, 24–37 days). Active and active-assisted range of motion of the PIP joint were commenced after wire removal, and the splints were

Table 1 Patient details and outcome

Age (years)	Sex	Affected finger	Joint surface involvement	Time to surgery (days)	Pin removal (days)	Follow-up (days)	Complications	Flexion	Extension
23	F	Right small finger	38 %	14	26	73		110	–10
39	M	Right ring finger	41 %	6	37	45		80	–15
29	M	Left ring finger	26 %	7	31	90		110	10
15	M	Right middle finger	34 %	27	24	599	Infection, AVN, degenerative changes	110	10
23	M	Left ring finger	28 %	6	28	41		110	10
45	M	Left small finger	33 %	9	27	27 ^a			
44	M	Left ring finger	29 %	13	24	317	Degenerative changes	110	10
24	M	Left ring finger	49 %	12	26	403		110	10
16	M	Left ring finger	44 %	9	27	45		110	10
Ø 29			Ø 36 %	Ø 11	Ø 28	Ø 179		Ø 106	Ø 4

Ø mean, AVN avascular necrosis, F female, M male

^a Lost to follow-up

Fig. 1 The fracture size (damaged joint surface) was measured as a percentage of the whole articular joint of the base of the middle phalanx

gradually discarded over the ensuing 2 weeks. Strengthening was commenced 3 to 4 weeks after wire removal. Patients had twice a week visits with a hand therapist. Flexion and extension were measured with a goniometer by the senior author.

Results

All patients demonstrated a fusiform swelling of the PIP joint at the time of their last clinical assessment (Table 1). None of the patients had any pain at final follow-up. Earlier pin removal was not associated with a better range of motion ($r = -0.48$, $p = 0.28$). Radiographic evaluation demonstrated in all patients a concentrically reduced PIP joint with a healed fracture (Fig. 2). Two patients had radiographic evidence of degenerative changes, but were asymptomatic. Nonetheless, the joint position was found to be very well maintained. None of the patients required additional procedures.

One patient developed a superficial pin track infection, which resolved after a short course of oral antibiotics. The patient developed a minimal degree of subluxation of the PIP joint compared to previous radiographs as well as some radiographic avascular necrosis affecting one of the condyles of the proximal phalanx but appeared to have moulded well to this (Fig. 3). We have to presume that a low-grade chronic infection may have led to avascular necrosis. However, in the absence of any symptoms after 20 months, no further intervention was contemplated.

Discussion

Inadequately treated PIP joint fracture-dislocations may result in permanent and severe disability, and the optimal treatment remains controversial [28]. Multiple surgical treatments exist, but adequate evidence to assess the ultimate outcome of one treatment or compare the outcome of different methods is lacking. Establishment of joint congruity remains the key to treat these fractures [7, 9, 11, 14, 15, 17, 19, 36]. We present our results of dorsal fracture-dislocations of the proximal interphalangeal joint treated with closed reduction and percutaneous Kirschner wire fixation with adequate retention of the closed reduction and good functional outcome. Our results confirmed the good results of using this technique in selected dorsal PIP fracture-dislocations, as noted by other authors [4, 26, 33].

We utilized the same technique as that of Newington et al. [26]. Our study outcomes with a mean range of motion of 106° , which is slightly greater than the motion achieved with extension block pinning, appears to be at least comparable if not slightly better. Newington et al. [26] suggested that, in many instances, accurate anatomical reduction of the fracture itself is not required and that satisfactory results can be obtained by closed reduction and percutaneous Kirschner wire fixation of the subluxated joint, provided a congruous and concentric reduction is obtained, as also seen in our cohort. The same authors suggested that this technique appears to be satisfactory for fractures involving 25–50 % of the joint surface. In the current study, an average of 36 % of the articular surface was fractured. We therefore support Newington's statement that using this surgical technique can lead to a satisfactory outcome, at least in the short to intermediate follow-up. This also seems consistent with the current classification of stable (<30 % articular surface involvement), tenuous (30–50 %) and unstable (>50 %) dorsal fracture-dislocations, with the threshold for stability being about 40 % involvement of the articular surface of the base of the middle phalanx [12, 18, 31].

Deitch et al. [7] stated that, if reduction is maintained, patients may expect few functional deficits despite radiographic degenerative changes and loss of mobility. In our study, although achieving concentric and congruous joint stabilization was considered the main goal of our treatment, achieving an anatomically perfect fracture reduction was considered less important. Follow-up radiographs indicated that two of our patients had secondary degenerative changes. On the last follow-up visit, these patients had excellent motion. This supports the outcome of various studies, which reported that an anatomically imperfectly restored joint surface, regardless of treatment, is sometimes associated with degenerative changes seen on radiographs but with a good clinical outcome. In addition, this does not always seem to affect range of motion adversely, nor do the results in these joints seem to deteriorate over time in all patients [8, 10, 26].

Fig 2 (a–c) Preoperative, early and late postoperative follow-up radiographs of a 44-year-old patient with a dorsal fracture-dislocation of the proximal interphalangeal joint of the left ring finger, treated with closed reduction and percutaneous Kirschner wire pinning

It has been suggested that early motion was an important determinant of successful outcome, not only in combating stiffness but also in promoting cartilage healing [15, 17, 19, 29]. In our study, the patients were immobilized preoperatively for an average of 11 days and pinned for an average of

28 days, and the pinned digit was also splinted for that duration. For the short term, we can conclude that good results can be obtained, even after more than 1 month of immobilization. The duration of immobilization has to be carefully weighed against the data which suggests that shorter periods of Kirschner wire fixation increase the risk of recurrent subluxation of the PIP joint due to inadequate union of the fracture [2].

McAuliffe [22] stated that recurrent subluxation or the need for revision surgery is considerably similar in the majority of reported series. In this current study, one patient revealed subluxation postoperatively, but the patient remained asymptomatic and had no functional deficit. Neither Newington et al. [26] nor Twyman et al. [30] encountered cases of recurrent dislocation in the long term. On the other hand, Aladin et al. [2] did encounter recurrent subluxation in 4 of 19 cases. This might be due to the fact that, unlike Aladin et al., Newington et al. protected the injured finger with the PIP joint in flexion for a few weeks to allow firmer fracture union.

In some series, satisfactory outcomes have been reported despite PIP joints displaying slight dorsal subluxation [2, 8, 11, 34]. The key feature in these patients appeared to be that, on the lateral radiograph, the middle phalanx fracture healed in a position that restored the concavity of the phalangeal base. However, it is not uncommon in this subset of patients to find that the postero-anterior radiograph can reveal a flaring or deepening of the articular surface of the base of the middle phalanx. It appears that restoration of the palmar buttress of

Fig. 3 Late postoperative follow-up radiographs of a 15-year-old patient with some degree of subluxation of the PIP joint, radiographic avascular necrosis affecting the lateral condyle of the proximal phalanx and a retained broken Kirschner wire

the base of the middle phalanx, along with palmar fragment consolidation, allows for restoration of the normal gliding motion of the joint, producing a successful result. However, if the palmar buttress of the middle phalanx is not restored, the PIP joint will hinge in flexion, resulting in treatment failure [7, 9, 19]. The patient in our series who developed the subluxation after wire removal did not have anatomic union of his palmar fracture fragment.

This study has several weaknesses including the retrospective data collection, observer bias, small patient cohort and the short length of follow-up.

In summary, percutaneous Kirschner wire fixation, after obtaining a congruous and concentric closed reduction of the joint, appears to give satisfactory outcomes in the short to intermediate term. It avoids the soft tissue trauma associated with all open surgical techniques. Future studies should prospectively compare the results of different operative methods to define more clearly their indications and effectiveness in preventing early postoperative dislocation.

Conflict of Interest Kristin B. de Haseth declares that she has no conflict of interest.

Valentin Neuhaus declares that he has no conflict of interest.

Chaitanya S. Mudgal declares that he has no conflict of interest.

Statement of Human and Animal Rights All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008. The authors adhere to the ethical standards described by the Committee on Publication Ethics and the International Committee of Medical Journal Editors. The study was completed under an IRB-approved protocol (Partners Human Research Committee Protocol No. 2009P001019).

Statement of Informed Consent Informed consent was obtained from all patients for being included in the study.

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