Percutaneous flexible double pinning (Py–Desmanet’s procedure) for pediatric distal radius fractures

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Abstract

Purpose The purpose of this study is to report the results of percutaneous flexible double pinning for pediatric distal radius fractures.

Methods Thirteen unstable fractures (three physeal and ten metaphyseal) of the distal radius in which the physeal plate could be still identified were treated with percutaneous flexible double pinning between 2008 and 2011. The average age of these cases was 9.8 years (range, 2–16 years). According as Py–Desmanet’s original technique, the fracture was fixed with two percutaneous transepiphyseal intramedullary wires. Kirschner wires or c-wires of 1.4–1.6 mm in diameter were used in each case depending on age. Operative and short follow-up outcomes were assessed.

Results The average operative duration was 23 min (range, 5–45 min). Comorbid distal ulnar fractures were further stabilized by intramedullary pinning. Additional external splintage was administered in all cases for 6 weeks postoperatively. Wires were removed after an average of 7.2 weeks (range, 4–10 weeks). Bone union was achieved in all cases. Neither malunion nor early epiphyseal closure of the distal radius was identified at mean follow-up of 12 months (range, 3–51 months).

Discussion Flexible double pinning has been successfully used for distal radius fractures in adults. Since this technique is minimally invasive, quick, and technically easy, it is also a good treatment option for unstable distal radius fractures in children.

Level of clinical evidence: Therapeutic Level IV

Keywords Pediatric fracture · Diametaphysis · Distal radius fracture · Percutaneous pinning

Introduction

Flexible double pinning was first described by Claude Py in 1969 and updated by Desmanet [3–6, 12]. The principle of this method is to reduce the distal radius fracture and maintain the reduction with two flexible K-wires. Due to the funnel-like shape of the distal radial epiphysis, intramedullary K-wires inserted at the distal-most point of the epiphysis are distorted and a spring effect is obtained. This leverage effect (F), consisting of a compression component (f1) and a traction component (f2), counteracts the postero-lateral displacing force of the fragment (Fig. 1). Although a limited number of reports have examined this method in adult cases from Romania and Japan [1, 9, 13], this is the first report of its kind that addresses pediatric treatment.

Materials and Methods

From April 2008 to December 2011, there were 13 consecutive cases (1 girl and 12 boys) of unstable distal radius fractures in which the physeal plate was still identified (Table 1). After receiving approval from our institutional review board, all 13 patients and their parent(s) were informed and consented verbally that data concerning their injuries, treatments, and prognoses would be submitted for publication. The average age of these patients was 9.8 years (range, 2–16 years). There were three Salter-Harris type II physeal fractures and ten metaphyseal fractures. Comorbid fractures consisted of four distal ulnar metaphyseal fractures accompanying metaphyseal radial fractures and two ipsilateral humeral supracondylar fractures accompanying the physeal fractures. Surgical intervention was indicated in all cases in which the distal radius was completely displaced and/or closed reduction alone could not achieve stable retention.

Although Kirschner wires of 1.8–2.0 mm were used in the original technique described by Py and Desmanet [3, 4, 6, 12], 1.4-mm wires were used in patients younger than 10 years old,

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Fig. 1 **a** Percutaneous wires are inserted through the radial styloid and the postero-medial end of the distal epiphysis. **b** These wires reach the dorsal and volar cortex, respectively. Since shape of the distal radial epiphysis is like a funnel, K-wires intramedullary inserted at the distal-most points of the epiphysis are distorted and a spring effect is obtained as a result. The leverage effect (F), consists of a compression component ($f1$) and a traction component ($f2$), counteracts the postero-lateral displacing force of the fragment

and 1.6-mm wires were used otherwise. Kirshner wires or c-wires (a shorter length wire with a trocar tip) were chosen depending on the patient's physical size. In cases where closed reduction was difficult, limited open reduction with an elevator was administered prior to insertion of the wires. Accurate

reduction was not necessary at this point because a spring effect obtained after insertion of intramedullary K-wires reduced the distal fragment toward more accurate position. Percutaneous wires were inserted transepiphyseally into the medullary canal of the radius through the radial styloid process and the postero-medial end of the distal epiphysis (Fig. 2). Good reduction and stability were confirmed by fluoroscopy. The distal ends of the wires were cut to the proper length and bent to expose the distal tips safely on the skin. All patients were immobilized in an above-the-elbow splint for 6 weeks, and then in a below-the-elbow splint for an additional 2 weeks in unusual cases of bone healing. The mean follow-up period was 12 months (range, 3–51 months). Postoperative clinical and radiographic results, including the duration until hardware removal, complications, the course of bone healing, and effect on the physal plate, were documented independently by one of co-authors (TH) to avoid interobserver error.

Results

The operation was performed under axillary block in six cases and under general anesthesia in seven cases. The average operative duration was 23 min (range, 5–45 min). The comorbid distal ulna fractures and humeral supracondylar fractures were stabilized by simultaneous intramedullary pinning and

Table 1 Patient summary

Case no.	Age (years)	Sex	F/u (months)	Type of fracture	Comorbid fracture	Waiting days till operation	Anesthesia	Operation time (minutes)	Wire diameter (mm)	Metal removal (weeks)	Complications
1	13	F	51	Metaphysis	n	0	Axilla/block	15	16	8	n
2	10	M	5	Metaphysis	Ulna ^a	0	General	43	16	8	n
3	7	M	3	Metaphysis	Ulna ^a	0	Axilla/block	20	14	8	Subcutaneous wire migration
4	12	M	3	Metaphysis	N	1	Axilla/block	5	16	7	n
5	12	M	3	Metaphysis	Ulna ^a	0	Axilla/block	25	16	8	n
6	16	M	3	Metaphysis	N	9	Axilla/block	45	16	10	n
7	9	M	43	Metaphysis	n	5	Axilla/block	20	16	8	Subcutaneous wire migration
8	12	M	4	Metaphysis	Ulna ^a	2	General	8	16	10	n
9	9	M	11	Metaphysis	N	0	General	40	16	6	n
10	8	M	15	Physis ^b	N	2	General	20	14	7	n
11	12	M	12	Metaphysis	n	0	General	18	16	6	n
12	6	M	9	Physis ^b	Humeral supracondylar ^c	1	General	25 ^d	14	6	n
13	2	M	5	Physis ^b	Humeral supracondylar ^c	0	General	15 ^d	14	4	n

^a Ulnar metaphyseal fracture

^b Salter-Harris type II

^c Ipsilateral fracture

^d Operation time for supracondylar fracture was excluded

Fig. 2 Schema of percutaneous flexible double pinning (Py-Desmanet's procedure). Percutaneous wire through the radial styloid process is inserted first, and then the second wire is inserted through the postero-medial end of the distal epiphysis. As a result, a spring effect obtained by intramedullary K-wires reduced the distal fragment toward more accurate position

cross pinning, respectively. Wires were removed after 7.2-weeks on average (range, 4–10 weeks). Two cases in which the distal end of one wire migrated underneath the skin required local anesthesia for wire removal. Bone union was achieved in all cases. No postoperative complications, such as refracture, malunion, functional deficit, or early epiphyseal closure of the distal radius, were identified at the final follow-up (Figs. 3 and 4).

Discussion

Fractures of the distal radius in children are classified as either physeal or metaphyseal fractures. Physeal fractures are generally Salter-Harris type II, while metaphyseal fractures often occur at a more proximal level, near the diaphysis.

Although fractures of the distal radius in children have been traditionally treated by closed reduction and immobilization in a plaster cast, percutaneous pinning are recommended for severely and completely displaced fractures [2, 11]. For physeal fractures, intrafocal (Kapandji) pinning seems to be a useful option to protect the growth plate from iatrogenic damage [8], but this uncontrolled approach may put adjacent vessels, tendons, and nerves at risk [10]. When stabilizing diaphyseal fractures, classic K-wire fixation inserted through the radial styloid is difficult. Ensuring sufficient fixation of the K-wire in the opposite cortical bone is technically demanding because of the long distance and steep angle of the implant [10]. Cross pinning without piercing the physeal plate and intrafocal (Kapandji) pinning are other options for metaphyseal fractures, but both present the same difficulty of penetrating the opposite cortex at a certain distance from the fracture line to achieve adequate stability. Elastic stable intramedullary nailing (ESIN) constitutes a well-established procedure for forearm fractures in children and is mainly used to stabilize unstable diaphyseal and special proximal metaphyseal fractures without the need for casting. However, sufficient three-point support cannot be achieved in the distal metaphyseal zone because of the short distal fragment [7, 10]. Flexible double pinning (Py-Desmanet's procedure) could be successfully applied to both fracture types in children.

Although any kind of special device is not necessary for this technique, a few pointers may help prevent penetration of the opposite cortical bone at the diaphysis instead of slipping on the medial cortex. Intramedullary wire should be pushed with a low drill speed when the tip approaches the opposite medial cortex. In addition, a trocar tip K-wire is more convenient than the more commonly used diamond-shaped tip which is easy to scrape the opposite cortex. The tip of the inserted wire should contact the radial head or the proximal radial epiphysis to achieve adequate stabilization. Intramedullary insertion of the wire tips just beyond the narrowest area of the diaphysis ensures that reliable stabilization of the wires can be achieved in children without neither nonunion or wire loosening due to unstable fixation. Subcutaneous migration of the distal end of the wire was identified in two cases as a minor complication. This was due to postoperative soft tissue edema, not to intramedullary migration of the unstable wires.

Like EESIN, this technique has the advantage of producing micromotion at the fracture site, which stimulates the formation of bridging callus [4, 10]. No cases of injury to the physis or growth disturbance after transepiphyseal wire insertion have occurred so far in our series. Although the postoperative follow-up of our cases is relatively short, recent reports have identified a low risk of premature physeal closure after percutaneous transepiphyseal Kirschner wiring for pediatric forearm fractures [2, 10, 14].

The technical ease of this procedure also avoids the risk of iatrogenic damage to the epiphysis due to multiple insertions

Fig. 3 *A, A'* Case 2, a 10-year-old boy incurred a distal metaphyseal fracture in the left forearm. *B, B'* The radius fracture was fixed by flexible double pinning. The ulnar fracture was also fixed by retrograde pinning because of dirty abraded wound around the olecranon. *C, C'* complete bone union was achieved without malunion nor early physal plate closure at the final follow-up

Fig. 4 *A, A'* Case 10, an 8-year-old boy incurred a physal fracture of the left distal radius. *B, B'* After flexible double pinning. *C, C'* Unfavorable early physal plate closure was not identified at the final follow-up

encountered in more complicated technique. Despite its limited results, our study suggests that flexible double pinning (Py–Desmanet’s procedure) is a good option for treatment of pediatric distal radius fractures.

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A Statement of Human and Animal Rights This article does not contain any studies with animal subjects. The study was approved by an institutional review committee.

A Statement of Informed Consent Informed consent was obtained from all patients included in this study.

Conflict of Interest K S declares that he has no conflict of interest. T H declares that he has no conflict of interest. K K declares that he has no conflict of interest. S O declares that he has no conflict of interest.

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