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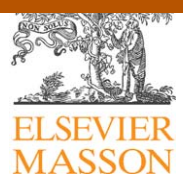

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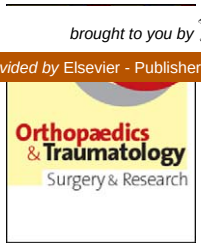

TECHNICAL NOTE

Posteromedial elastic stable intra-medullary nailing (ESIN) in volarly displaced metaphyso-diaphyseal distal radius fractures in child

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KEYWORDS
Forearm fracture;
Volar angulation;
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ESIN

Summary
Introduction: The distal metaphyso-diaphyseal fractures of the radius with volar angulation are generally considered unstable. Too distal to be treated with classic elastic stable intramedullary nailing (ESIN) via a laterodistal approach and too proximal to be stabilized with simple conservative treatment, they are sometimes treated by plating.
Patients and methods: To avoid the disadvantages of the open exposure necessary for this latter fixation and to prevent volar angulation while respecting the curvature of the radius, radial elastic nailing with posteromedial distal entry was used in 16 patients. These patients were reviewed with an average follow-up of 4.5 months.
Results: Six patients presented a mean volar angulation of 7°, eight a mean posterior angulation of 5.5°, and two were aligned at 0°. On the AP view, seven patients presented a mean residual varus of 6.5°, four a mean residual valgus of 5°, and five were at 0°. The pronating curvature of the radius and the radioulnar index remained intact in all cases. One case of extensor digitorum tenosynovitis was observed and disappeared after wire removal.
Discussion: For the unstable fractures of the distal third of the radius, certain authors propose systematic classic ESIN, but the lateral point of entry inevitably entails a varus misalignment, which is no longer the case if the entry is medial.
Level of evidence: Level 4. Retrospective Study.

Introduction

Fractures of the distal third of the radius with volar angulation are located in a border zone that is difficult to classify, because they are too distal to be part of the middle-third fractures and too proximal to come within

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Figure 1 Treatment with posteromedial ESIN.

the fractures of the distal quarter of the radius (Smith-type fractures) [1]. This type of fracture involves the diaphyseal—metaphyseal junction (Fig. 1). They can be isolated or associated with radioulnar dislocation (Galeazzi) [2] or with distal epiphyseal fracture or detachment of the ulna (equivalent Galeazzi) [3]. These fractures, reputed to be unstable, sometimes warrant open osteosynthesis with an anterior plate. A few centimeters above the diaphyseal—metaphyseal junction, the fractures of the middle third of the radius respond to orthopaedic treatment (reduction followed by brachial-antebrachial-palmar immobilization) or classic elastic stable intramedullary nailing (ESIN) [4—6] (ascending curved nail inserted via the laterodistal percutaneous approach) [7,8].

In an attempt to adapt to these borderline forms, in 1999 we proposed a posteromedial ESIN reduction and stabilization technique for fractures of the radius [9] (Fig. 1). This article reports the results of a retrospective series of 16 cases.

Patients and methods

Sixteen children (Table 1) presenting a fracture of the distal third of the radius with volar angulation, whether or not associated with an ulnar fracture, treated with posteromedial ESIN, were analyzed clinically and radiologically at presentation and on the 8th and 45th days. The last radiological and clinical evaluation took place on day 8 after the osteosynthesis material was removed. No examination after the last follow-up visit was considered useful, since clinical recuperation was complete in 100% of the cases. Clinically, flexion-extension mobility and pronosupination were compared to the healthy side.

In the radiological assessment, plain x-rays of the supra- and subjacent joints were taken in the AP and lateral position. The AP image was taken with the hand in supination on the plate. If this position was difficult to achieve, the Hastings position [10] was used in which the subject is placed in the lateral decubitus position on the side to be x-rayed. The lateral view was taken with the ulnar edge on the plate, the wrist straightened with a few degrees of supination. The usual radiological landmarks in adults could not be applied in young children because of the partial radiotransparency of the bony epiphyses. Also, so as to study the modifications of the front and sagittal tilt and to be able to compare them, particular landmarks were used (Fig. 2): the diaphyseal—metaphyseal M-axis, drawn on the last few centimeters of the radial shaft based on the overall curvilinear aspect of the bone, makes a 90° angle in both AP and lateral images, whatever the child's age may be. These landmarks lose their value in cases of epiphysiodesis, of course.

Surgical technique

Surgery was performed under general anesthesia with the patient in the dorsal decubitus position, the upper limb on the operating table with arm rests. Nailing was carried out with image intensifier guidance. The entry point of the nail, whose caliber was chosen beforehand in accordance with the smallest diameter of the diaphyseal shaft, was identified, located at the limit of the distal metaphysis, keeping the growth plate intact, on the posterior side and the medial edge of the radius. A 1-cm incision was made in the skin, the soft tissues were then dissociated using Halstead forceps with a hole drilled through its jaw using a square nail, oriented in as ascending a fashion as possible (Fig. 3). An ESIN was performed with reduction using external maneuvers, with the concavity of the nail oriented inward so as to reconstitute the pronating curve of the radius, and backward to prevent recurrence of displacement. In cases of associated fracture of the ulna, this bone was not nailed systematically if the reduction obtained was satisfactory. Immobilization was provided by a below-elbow cast with a window on the approach. The patient was seen again for

Table 1 Table describing the series with time to union and time to osteosynthesis material removal.

	Sex	Age	Closed (F) or open (O) fracture	Side	Fracture	Number of nails	Time to union (months)	Time to material removal
1	M	12 years 1 month	C	L	R	1	2	4 years
2	M	7 years 6 months	C	L	R + U	1	2	9 months
3	M	13 years	C	R	R + U	2	1.5	4 months
4	F	10 years 6 months	C	R	R + U	1	2.5	5 months
5	M	12 years 2 months	C	R	R	1	2	5 months
6	M	13 years 4 months	C	L	R + U	2	1.5	3 months
7	M	13 years 6 months	O (Cx.2)	R	R + U	2	1.5	5 months
8	F	10 years 2 months	O (Cx.2)	L	R + U	2	2	4 months
9	M	11 years 7 months	0 (Cx.2)	R	R + U	2	2	5 months
10	M	8 years 10 months	C	R	R + U	1	2	3 months
11	M	11 years 9 months	O (Cx.1)	L	R + U	2	2.5	3 months
12	M	14 years 8 months	C	L	R	1	2	2.5 months
13	M	14 years 9 months	O (Cx.1)	R	R + U	2	4	5 months
14	M	12 years	C	L	R + U	1	4	6 months
15	M	12 years 7 months	C	L	R + U	2	4	7 months
16	M	10 years	C	L	R + U	1	3	4 months

Cx: Cauchoix; R: radial; U: ulnar.

radiological and clinical follow-up on day 7, then on day 45, when the cast was taken off and self-rehabilitation was started. Removal of the material was proposed between the 4th and 6th months.

Results

The files of 14 boys and two girls were analyzed. The mean age at the time of fracture was 10 years and 11 months (range, 7—14 years). The radial fracture was associated with an ulnar fracture in 13 cases (81%) and treated with a second nail in eight cases. Five fractures were open (31%) with two Cauchoix 1 fractures and three Cauchoix 2 fractures. The fracture line was transversal in 10 cases and oblique short in the six others. On the sagittal plane, eight patients had an overlapping fracture and eight presented a mean volar angulation measured at 25° (range, 15°—37°). On the frontal plane, eight fractures were overlapping, two

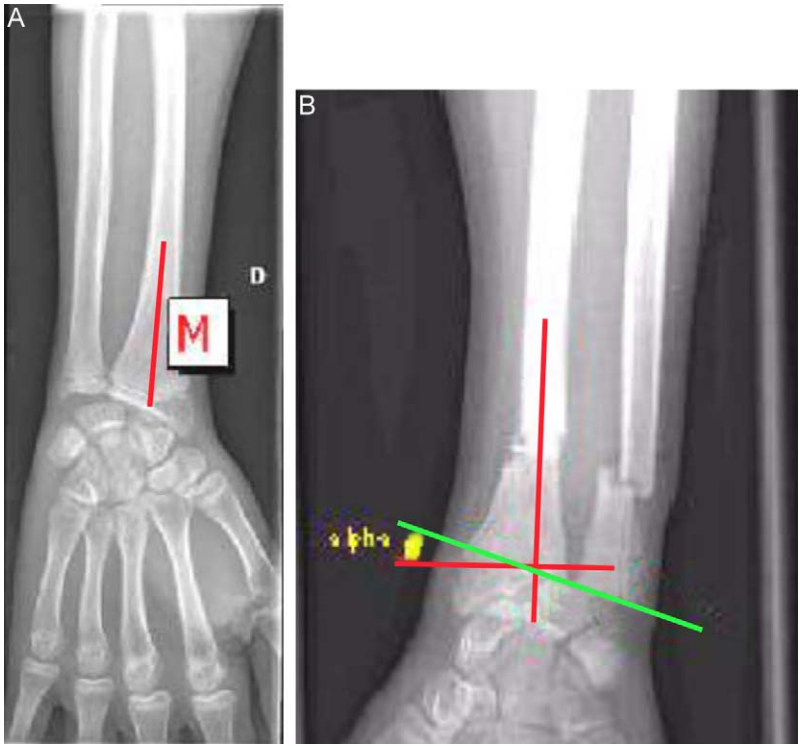

Figure 2 X-ray landmarks. A. Diaphyseal—metaphyseal M axis. B. Angulation angle alpha.

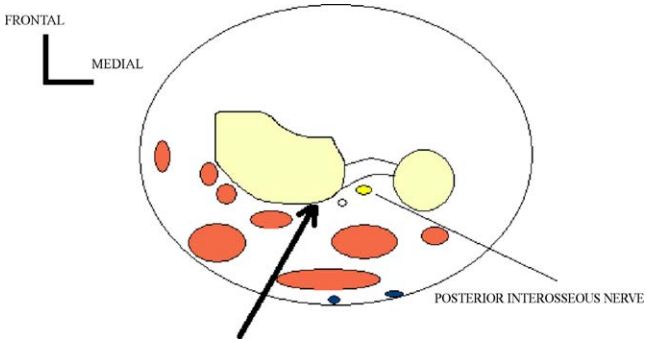

Figure 3 Anatomic slice of the forearm, distal quarter: posteromedial approach.

Figure 4 Aspect of the insertion site of the radial wire 4 months later, in a 13-year-old boy (picture taken on the wire removal day)

fractures were aligned, four were a mean 15° valgus (range, 4°—30°), and two were a mean 20° varus (range, 18°—23). The mean follow-up was 4.5 months (range, 2.5—9 months), corresponding to the last follow-up visit 8 days after the material was removed (one case was lost to follow-up for 4 years and was referred to us again for removal of the material).

Clinical results

Reduction was always satisfactory. The mean time to union was 2.5 months (range, 1.5—4 months), with no secondary displacement. The mean time to osteosynthesis material removal was 4.5 months after the intervention. No difference was found between the fractures involving the two bones in relation to placing one or two nails.

Of the 16 patients, one presented tenosynovitis of the extensor digitorum communis, which resolved after removal of the radial nail. All patients recuperated complete flexion-extension as well as pronosupination. Since the technique was percutaneous, the resulting scarring was minimal (Fig. 4).

Radiological results

The correction as demonstrated on the x-rays was satisfactory in all 16 cases.

On the sagittal plane, at the last follow-up (bone union acquired), six patients preserved a mean 7° anterior angulation of the radius (range, 3°—18°), eight patients a mean 5.5° posterior angulation (range, 2°—10°), and in two cases, the radius remained aligned at 0°.

On the frontal plain, seven patients presented a mean 6.5° residual varus (range, 4°—12°), four a mean 5° valgus (range, 2°—7°), and in five cases the radius remained at 0°. No physeal lesions were observed. The pronating curve remained intact in all cases, as well as the radioulnar index (mean, 1.4 mm, range, 0—2.2.).

Discussion

The instability of this type of fracture has been attributed to brachioradialis, extensor pollicis longus, and abductor pollicis longus traction [3]. If, after reduction, the stability of the site is not sufficient [11] for treatment with immobilization placing a short-arm cast with extension of the wrist,

Figure 5 A 13-year-old boy, forearm fracture (volar angulation). A. D0. B. D1. C. D + 3 months.

osteosynthesis must be discussed [12,13]. Osteosynthesis can also be proposed in secondary therapy after failure of orthopaedic treatment with closed site reduction and cast immobilization [14] or in cases or repeated fracture (Fig. 5). Placing an anterior plate requires opening the fracture site, which can cause lesions to the growth plate and the plate must be removed later through the same approach. Ascending elastic nailing with a posteromedial entry point does not present the same risks as the lateral approach [15,16] and can lead to impingement with the extensor digitorum communis. Descending radial elastic nailing, mechanically logical, is dangerous in its approach: two cases of radial paralysis, regressing spontaneously, were noted after radial nailing via the superior approach [17].

Ascending posteromedial nailing is mechanically warranted if the fracture is not excessively distal, because the elastic force of the nail works against anterior displacement given its posterior entry point on the distal radius. If a forceps discission cautiously separates the extensor tendons, their transfixion is prevented. No permanent tendon lesion was observed in our 16 cases and no difference was found between orthopaedic treatment and nailing of the ulnar fracture when it was associated.

For unstable fractures of the distal third of the forearm, some authors systematically propose classical ESIN associated with cast immobilization [18,19], but the lateral distal entry point inevitably leads to varus at the fracture site, which is no longer the case if the entry point is medial.

Conclusion

Posteromedial elastic intramedullary nailing improves the results of the treatment of fractures of the distal third of the radius with volar angulation, when, depending on the patient's age, the angulation and instability of the fracture require it. The advantage is above all biomechanical in that the pronating curve of the radius remains intact. This technique can be proposed as primary or secondary treatment, in cases where conservative treatment has failed or there is reiterative fracture.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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