

Retrograde Intramedullary Nailing for Proximal Monteggia Fractures in Children

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Research

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Abstract

Introduction

Monteggia fractures are defined as fractures of the ulna's proximal third with associated dislocation of the radial head and were further described and classified by Bado. They are very rare in adults and even rare in children reaching an incidence of 1.5 - 3% of all pediatric forearm fractures. The treatment's primary goal is the anatomical reduction of the ulnar fracture, and with that, the following indirect anatomic reduction of the radial head. Different modalities for the treatment of Monteggia fractures in children are reported.

We present possible closed reduction techniques and internal fixation based on the type of Bado classification in pediatric patients. We illustrate these techniques as a case series discussing the strengths, risks, and pitfalls of the ulna's retrograde nailing.

Materials and Methods

For this case series, we included all pediatric patients who got surgical treatment at our institution for a Monteggia lesion from November 2000 to August 2019. Preoperative imaging consisted of conventional radiographs of the elbow and the forearm in two planes.

Results

This case series reports about six pediatric cases (age two to six years, two girls and four boys). They all had a proximal Monteggia fracture. In all cases, closed indirect reduction of the ulnar fracture and reposition of the radial head was achieved utilizing retrograde nailing of the ulna employing an intramedullary nail or Kirschner-Wire according to the instructions. No infection, vascular or nerve injuries, or other complications occurred. All were pain-free and regained full range of motion compared to the contralateral side.

Conclusion

Indirect reduction and intramedullary retrograde nailing are minimally invasive techniques that do not harm the blood supply to the bone and soft tissues. It may be a safe and effective procedure.

Introduction

Monteggia fractures[1] are defined as fractures of the ulna's proximal third with associated dislocation of the radial head and were further described and classified by Bado[2]. They are very rare in adults and even rare in children reaching an incidence of 1.5–3% of all pediatric forearm fractures[3].

The treatment's primary goal is the anatomical reduction of the ulnar fracture, and with that, the following indirect anatomic reduction of the radial head. Different modalities for treating Monteggia fractures in

children are reported[4]. The most frequent one is non-operative and consists of a manual reduction of the elbow's ulnar deformity and immobilization in flexion and supination in a long-arm cast[5]. However, due to the often-occurring plastic deformation and shortening of the proximal ulnar fracture, anatomical reduction and retention may be challenging to achieve by closed manipulation. Consequently, a residual malalignment, a subluxation of the radial head can persist. This is a major complication of these fractures and can lead to a mechanical impingement with reduced pro-supination or flexion, deformity and instability, and tardive ulnar and/or radial nerve palsy. Therefore, close follow-up with a conventional radiogram is needed [6] and in doubt, operative treatment is indicated.

Lim and Huntley[7] described the use of anterograde intra-medullary stacked nailing to reduce proximal plastic deformity in a pediatric Monteggia fracture. Rockwood et al.[4] and Dietz et al.[8] mentioned the option of retrograde nailing to treat this type of fracture.

Schmittenebecher[9] published a brief instruction on performing closed reduction and internal fixation using an intramedullary nail (IMN).

However, there is no step-by-step instruction on how to reduce and stabilize pediatric Monteggia fractures of the proximal third using a retrograde nailing technique.

Aim

We want to present our adapted technique of closed reduction and internal fixation based on the type of Bado classification[2] in pediatric patients with a proximal fracture pattern.

Materials And Methods

For this case series, we included all pediatric patients who got surgical treatment at our institution for a Monteggia lesion from November 2000 to August 2019. Preoperative imaging consisted of conventional radiographs of the elbow and the forearm in two planes. We performed in all cases a closed reduction and internal fixation using retrograde ulnar nailing. Informed consent was obtained from the parents of the patients. The local ethical committee approved this study (CER-VD-2019-01816).

Surgical technique

The surgical procedures were performed under general anesthesia. All patients were in a supine position with an arm-table. The whole upper extremity was disinfected and sterile draped. Administration of weight-adapted single-dose antibiotic prophylaxis of Cefuroxime was 30 minutes before surgery.

The entry point in the distal third of the ulna was localized using fluoroscopy. The surgeon made a 10-20 mm long skin incision slightly distally of the ulna's distal third's desired bony entry point. After blunt dissection of the subcutaneous tissue, avoiding the superficial ulnar nerve or basilica vein, the periosteum was sharply incised, and the ulnar cortex perforated obliquely using a 2.5 mm drill bit or an awl.

An appropriate size of IMN (one-third of the intramedullary canal) - alternately a Kirschner-wire (K-wire) (Fig. 17 + 18) – was chosen and slightly bent (Fig. 1) to allow exerting corrective forces at the fracture site and thus, indirectly reduce the ulnar fracture and relocate the radial head correctly. The nail was manually introduced under fluoroscopic control just to the level of the ulnar fracture. Then, depending on the specific fracture displacement, a manual force was exerted at the level of the ulnar fracture, the nail ultimately brought into contact with the dens cancellous bone of the ulnar metaphysis, and by turning the nail, definitive reduction and simultaneous fixation accomplished. The surgeon achieved reduction and fixation accordingly to the Bado classification, as explained below. After the fixation, the correct anatomical reduction of the ulna and the radial head's central position was checked using fluoroscopy in the two planes with the forearm in pronation and supination.

Then, the IMN was bent and shortened distally, the skin sutured, and the arm immobilized with a plaster cast for four weeks. Clinical and radiographic controls were at week four, eight, and ten after surgery. Removal of the IMN was done after radiological healing.

Bado I –

is defined as an ulnar fracture displacement in extension with ventral dislocation of the radial head.

1. Insert the nail to the level of the ulnar fracture with its tip pointing toward the dorsal side
2. Put the elbow in flexion, with one hand hold the distal humerus and with the other hold the forearm in supination and apply traction (Fig. 2)
3. Keep the elbow in flexion, advance the IMN to the proximal fragment cortex, apply manual pressure on the radial head from the volar side and simultaneously reduce the ulnar fracture and the radial head with an additional flexion maneuver (Fig.3)
4. Turn the IMN 180 degrees to stabilize the fracture and overcome displacement forces (Fig.4)

Bado II –

is defined as an ulnar fracture displacement in flexion with dorsal subluxation of the radial head

1. Insert the nail to the level of the ulnar fracture with its tip pointing toward the volar side
2. Hold the forearm in supination and the elbow in extension. Hold with one hand the distal humerus and with the other one apply traction on the forearm (Fig. 5)
3. Advance the IMN, put the elbow in extension, apply an extension stress with one hand on the forearm and simultaneously with the other hand apply manual force on the radial head from dorsal to reduce it (Fig. 6)
4. Turn the IMN 180 degrees until its tip points dorsally to finalize the reduction and retention (Fig. 7)

Bado III –

is defined as an ulnar fracture displacement and impaction in varus with lateral dislocation of the radial head

1. Insert the nail to the level of the ulnar fracture with its tip pointing toward the volar side
2. Put the elbow in extension, hold the forearm in pronation with one hand and with the other hand the distal humerus, and apply traction on the forearm (Fig. 8)
3. Keep the elbow in extension, advance the IMN, apply valgus stress with one hand on the forearm and simultaneously with the other hand applying manual pressure from lateral on the radial head to reduce it (Fig. 9)
4. If necessary, turn the IMN about 90 degrees until its tip points laterally to finalize the reduction and retention (Fig. 10)

Results

This case series reports about six pediatric cases (age two to six years, two girls and four boys). Table 1 shows the epidemiologic and treatment details. They all had a proximal Monteggia fracture. Three presented a type I and three a type III lesion. In five cases, closed indirect reduction of the ulnar fracture and reposition of the radial head was achieved utilizing retrograde nailing of the ulna employing an IMN or K-Wire according to the instructions. One case needed revision surgery due to wrong positioning of an unbent nail, insufficient fracture reduction and persistent subluxation of the radial head. After removing the nail, closed reduction with internal fixation by nail repeating the described technique could be achieved (Fig. 19 – 22). The follow up was uneventful.

Within twenty-four hours after admission, the surgeon on duty performed the surgery. The mean operation time for the initial fracture surgery was 50 minutes (range 40 to 62 minutes).

No infection, vascular or nerve injuries, or other complications occurred.

All fractures united in correct alignment, and implant removal was performed at ten to twenty weeks after the initial procedure. Recorded operation time for removal of the implant was 17 minutes (6 to 36 minutes). At the last follow-up, all children were pain-free and regained full mobility of the elbow joint for flexion and extension and pro- and supination compared to the contralateral side.

Illustrative cases

Case 1

It is a six-year-old boy after falling with a direct impact on his left upper extremity. He described local pain with no vascular or nervous injury. (Fig. 11-16)

Discussion

Bado type lesions of the forearm are rare injuries[10]. To reduce the dislocated radial head properly, anatomic reduction and retention of the ulnar fracture are mandatory[11]. Closed reduction can be difficult in case of severe impaction or soft tissue interposition. Residual malalignment or/and radial head subluxation should not be tolerated[11,12]. If malalignment of the radiocapitellar joint is suspected, operative treatment is advised. Improper bending or positioning of the IMN or a soft tissue interposition can cause this. If interposition is suspected, an open reduction should be considered[13].

Nevertheless, to respect bone and soft tissue vascularity and vitality, a closed indirect reduction technique and stabilization of the ulnar fracture through the intramedullary implant is preferable.

Because the ulnar fracture is localized in the forearm's proximal third, a retrograde nailing technique should be used according to the known Küntscher's [14] principle.

Our study presents six cases treated with this technique. In one case, secondary displacement occurred due to insufficient surgery. Using the described method, we did the revision surgery successfully. Later healing was uneventful.

As illustrated in case 1, it appears bending has not been applied as proposed. It's debatable if bending in narrow intramedullary canal is necessary. However, reduction and retention were achieved by rotating the elastic nail tip as described and remains a key element. Nevertheless, if the IMN cannot bridge the fracture, bending can help guiding the nail properly.

Other possible surgical procedures have essential drawbacks. Percutaneous pinning or stacked nailing[7] implicates postoperative wound treatment and, therefore, repetitive opening or removal of the cast. Antegrade nailing with the introduction of a nail through the olecranon apophysis may create later growth disturbances. Yuan et al. [12] showed better results using closed reduction and intramedullary nailing than external fixation in terms of residual pain and clinical appearance.

We think that open reduction and internal fixation using plating as a primary treatment option is reserved for specific cases, e.g., in highly comminuted fracture patterns, due to the invasive type of procedure[12]. Literature lack showing if nailing is superior to plating.

Immobilization after internal fixation is not necessary. However, postoperative pain is better tolerated by our patients than without. Therefore, we use an open removable cast with an antalgic purpose for a short duration.

There are several limitations to this study. It's a retrospective case series and has no control group. The outcome was, therefore, dependant on the radiographic and surgeon-reported outcomes. A surgical technique for Bado type II has been described, but at this moment lack of evidence. Further studies need to be done comparing this procedure to other treatment modalities with a more significant case number.

Conclusion

A reduction and internal fixation algorithm is illustrated using an elastic nail to treat a Monteggia fracture with a proximal fracture pattern in children. Indirect reduction and intramedullary retrograde nailing are minimally invasive techniques that do not harm the blood supply to the bone and soft tissues. It may be a safe and effective procedure for these kinds of fractures.

Abbreviations

IMN intramedullary nail

K-Wire Kirschner-Wire

OP operation

Declarations

Ethics approval:

Each author certifies that his institution has approved the reporting of this case series, that all investigations were conducted in accordance with the Declaration of Helsinki and Guidelines for Good Clinical Practice. The study was approved by the Ethics Cantonal Committee (CER-VD-2019-01816).

Consent for publication:

Not applicable.

Availability of data and material:

Authors do not wish to share their data as it was not stated in the ethics approval.

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Competing interests:

The authors declare that they have no competing interests.

Author's contributions:

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Thürig Grégoire, Ines Raabe and Maniglio Mauro. The first draft of the manuscript was written by Thürig Grégoire and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Tables

Table 1 IMN=intramedullary nail, OP 1 = first index surgery, OP 2 = Surgery for implant removal

Cases	Age	Sex	Bado type	Op 1	Implant	Revision	Hospitalization (n = nights)	Op 2
1	4y	m	I	45'	IMN 2mm	-	2n	6'
2	6y	m	III	50'	IMN 2mm	-	1n	14'
3	6y	f	III	62'	IMN 2mm	-	1n	11'
4	4y	m	III	51'	IMN 2,5mm	48'; IMN 2mm	1n	14'
5	4y	m	I	40'	IMN 2mm	-	2n	36'
6	2y	f	I	52'	K-Wire 1,6mm	-	1n	24'

Figures

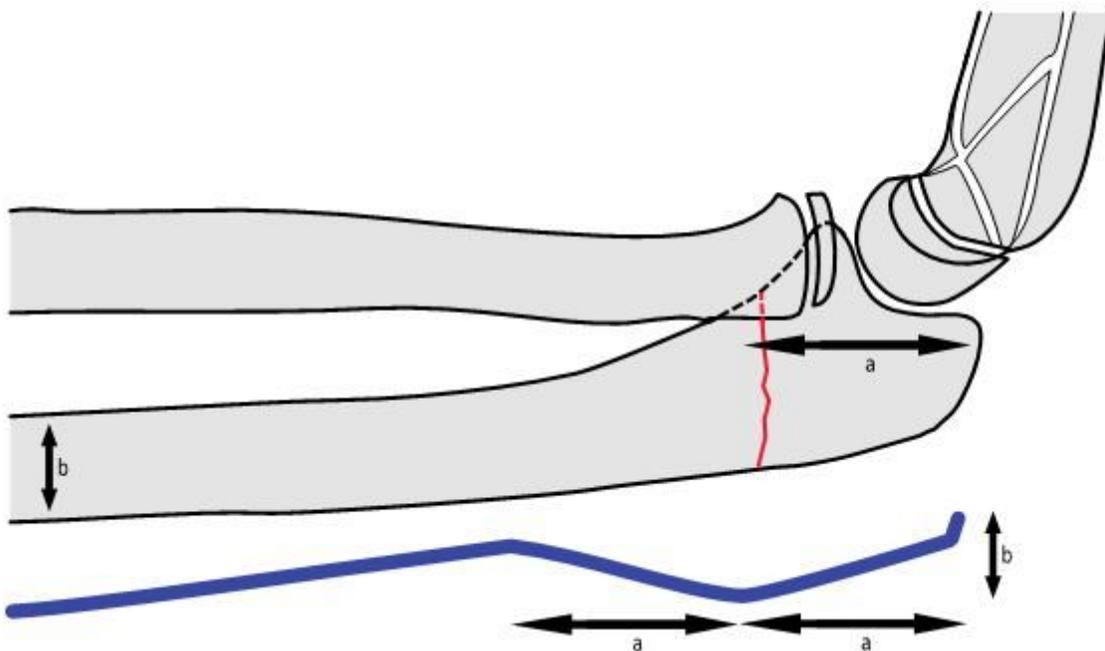


Figure 1

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Supination

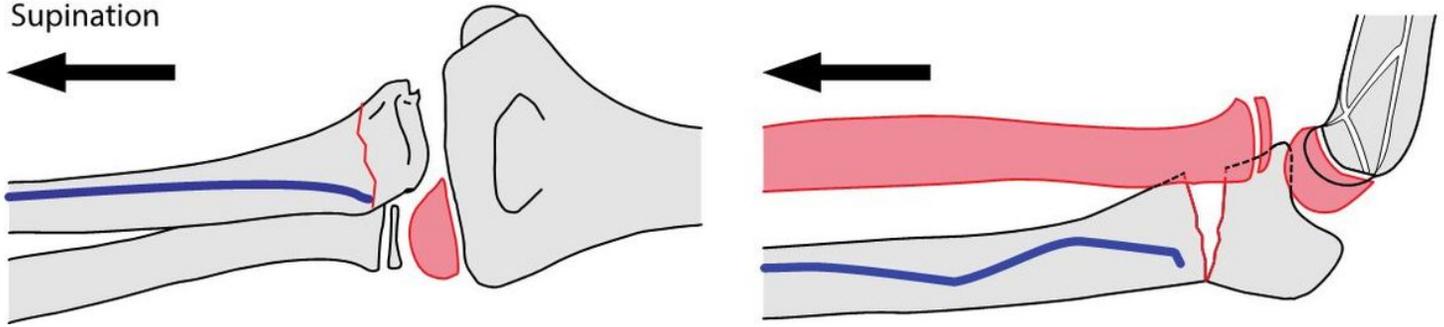


Figure 2

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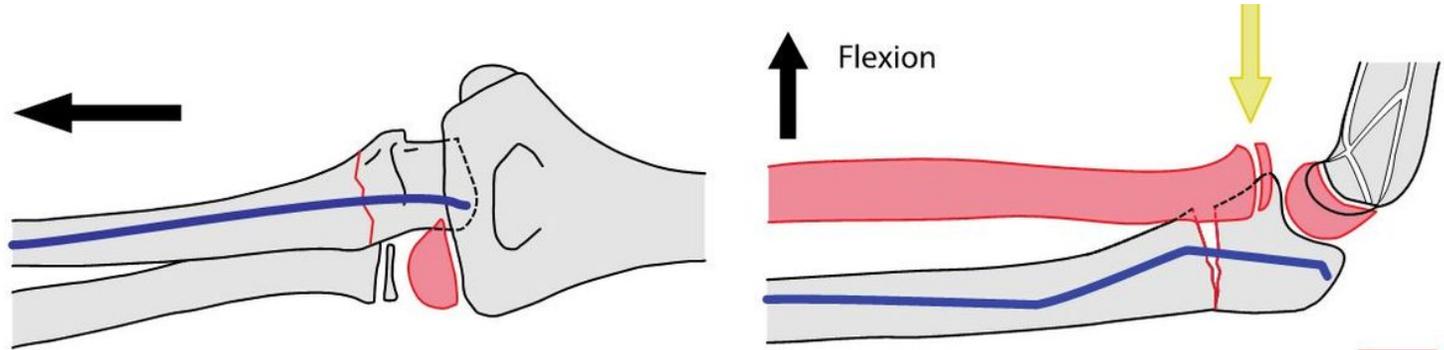


Figure 3

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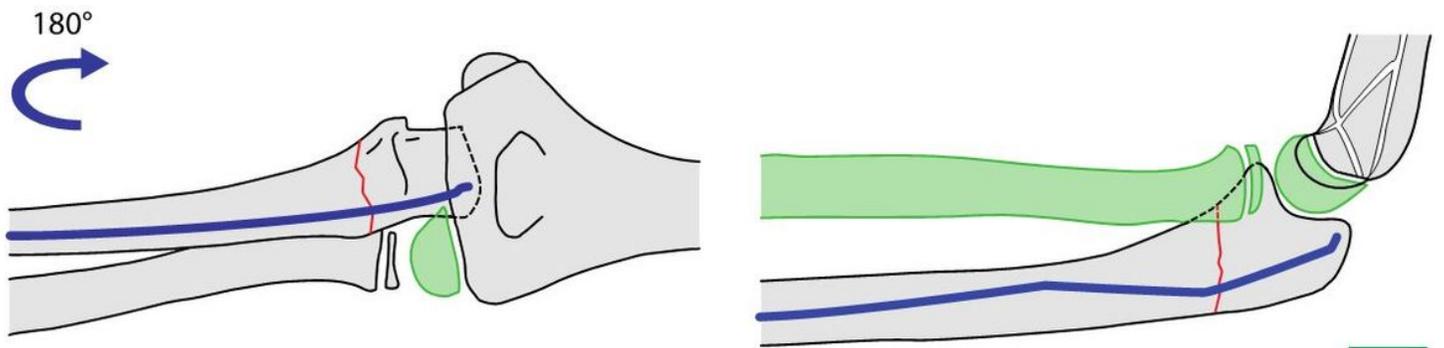


Figure 4

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Supination

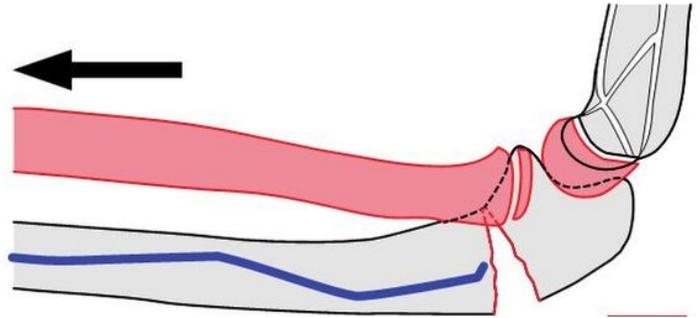
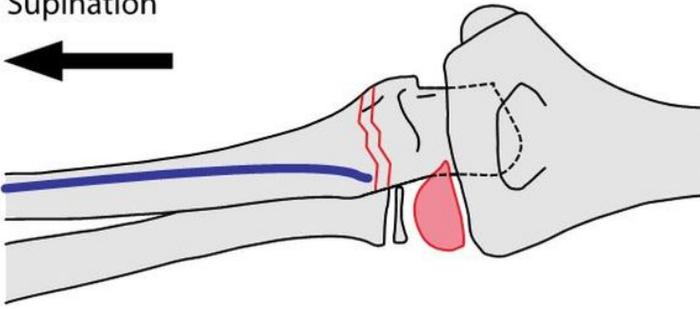


Figure 5

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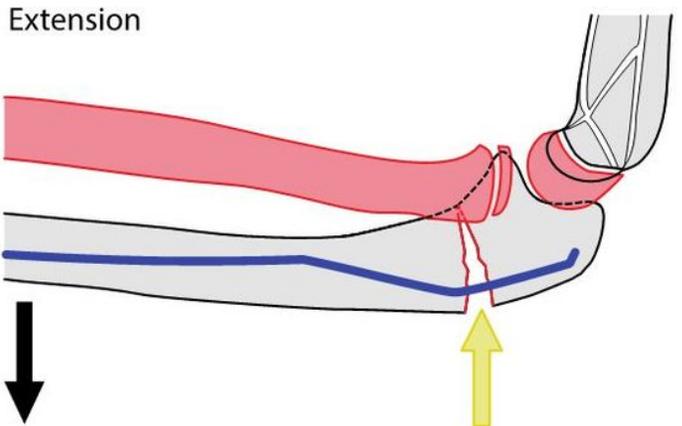
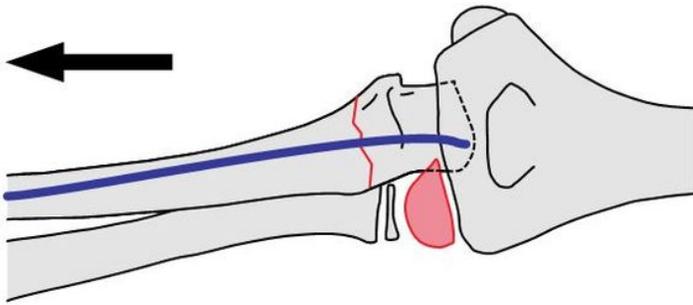


Figure 6

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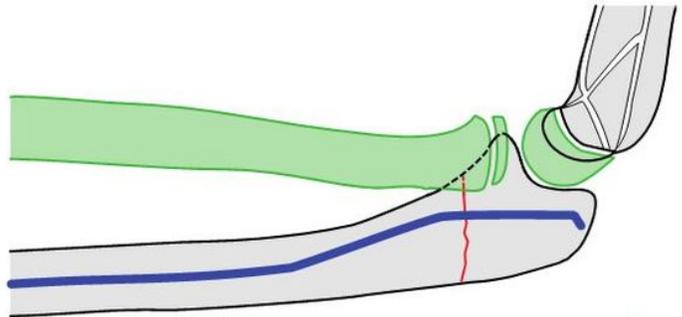
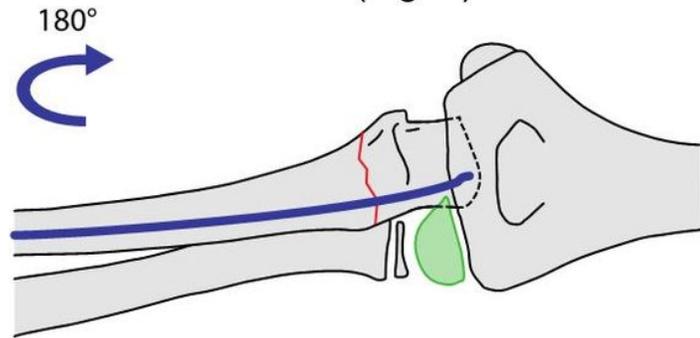


Figure 7

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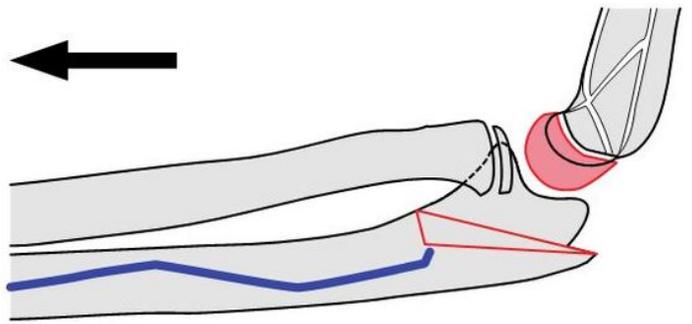
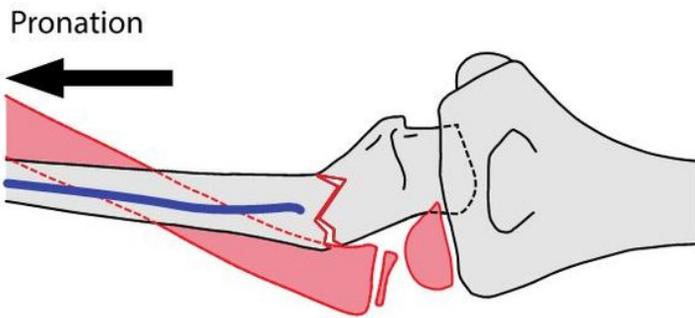


Figure 8

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Valgus

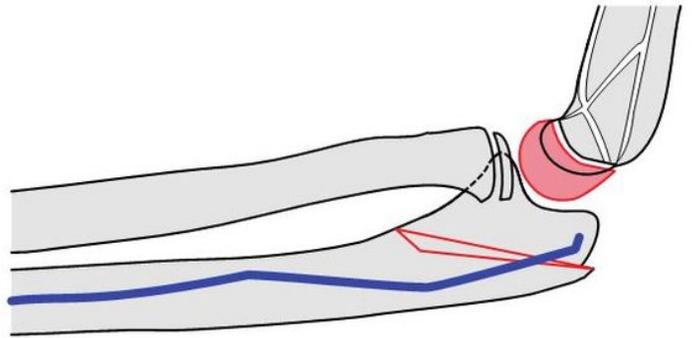
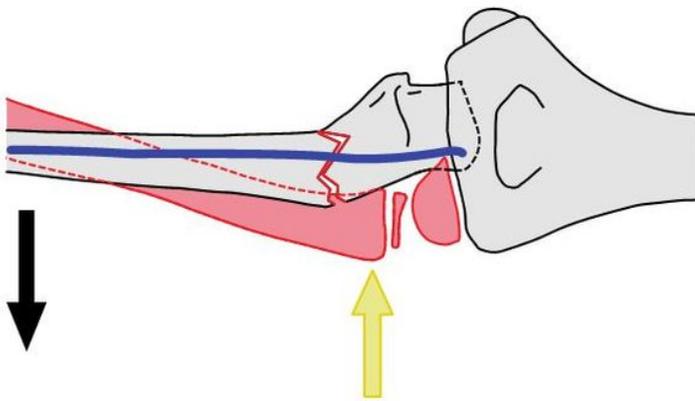


Figure 9

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90°

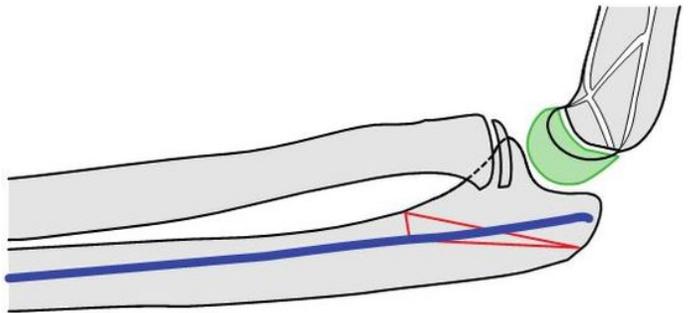
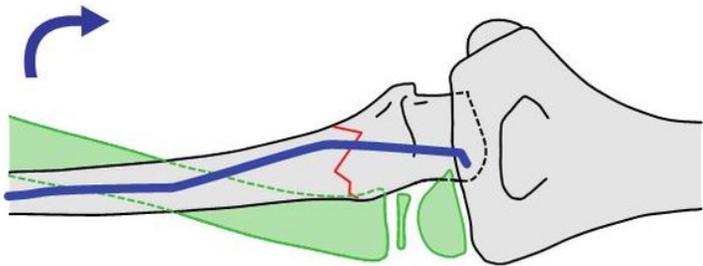


Figure 10

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Figure 11

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Figure 12

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Figure 13

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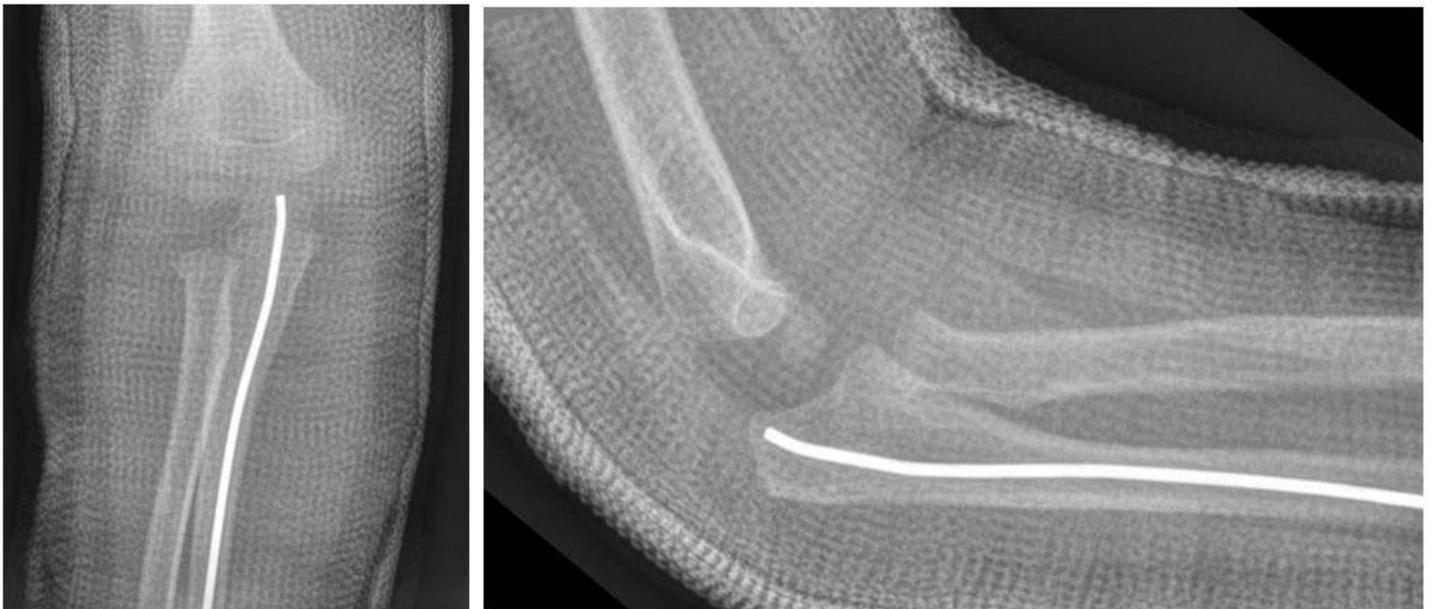


Figure 14

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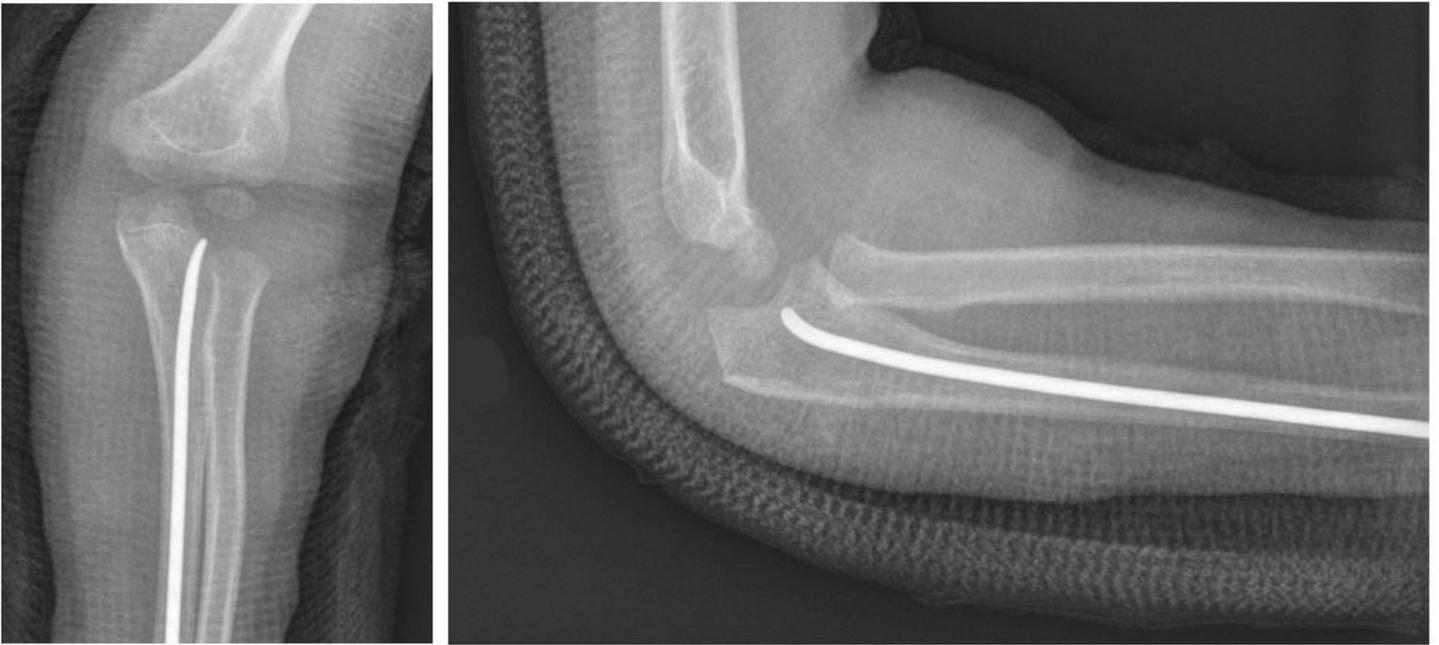


Figure 15

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Figure 16

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