



MRI contribution in minimally displaced lateral humerus condylar fractures in children

Fracture du condyle latéral du coude chez l'enfant : Apport de l'IRM

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ABSTRACT

Introduction: Diagnosis and treatment of displaced humerus lateral condylar fracture is well codified with open reduction and pinning. For non-displaced or minimally displaced lateral condylar (NMDLC) fractures, diagnosis can be challenging because of cartilaginous structures none visualized on radiographs.

Aim: To determine the usefulness of MRI in evaluating articular extension of NMDLC fracture.

Methods: We reviewed consecutive NMDLC fractures during 6 years including children younger than 15 years old with displacement lesser than 2 mm (Rigault type I) at initial radiographs divided in two groups: only line fracture was viewed (R1a), displacement gap lesser than 2 mm (R1b). After elbow cast immobilization, children have got MRI. Surgery was performed in complete articular fractures. All children were seen after 1 month then at 6 month for elbow evaluation.

Results: Thirty-one fracture, including twenty-two (70.97%) boys. Average age was 6.24 years (3 to 11). Fifteen fractures was classified R1a and sixteen R1b. According to MRI, seven fractures (22,6%) were metaphyseal Gp1, eleven (35,5%) were metaphyso-epiphyseal with an intact hinge cartilage Gp2, nine (29%) were complete Salter IV Gp3 and MRI reveals a supracondylar fractures in four cases. Fracture was metaphyseal more often in R1a group (40,0%) compared to R1b (6,3%). Gp3 group was significantly higher in R1b (50,0%) compared to R1a group (6,7%)

For the sixteen R1b cases, 8 presented articular cartilage involvement on MRI (Gp3) with concordant operative findings.

Conclusion: MRI is effective in assessing epiphyseal extension fracture providing accurate information for appropriate treatment.

Key words: lateral condyle, elbow, fracture, children, MRI

RÉSUMÉ

Introduction : Le traitement des fractures déplacées du condyle latéral du coude est codifié avec une réduction chirurgicale. Pour les fractures peu déplacées, le traitement est controversé vu la non visualisation complète du trait au niveau de la maquette cartilagineuse.

Objectif : Déterminer l'intérêt de l'IRM dans l'évaluation de l'extension articulaire.

Méthodes : Nous avons étudié de façon consécutive les fractures peu déplacées du condyle latéral (FPDCL) du coude sur une période de 6 ans. Nous avons inclus les enfants de moins de 15 ans présentant un déplacement inférieur à 2 mm (Rigault type I) que nous avons divisé en deux groupes : seul le trait de fracture était visible (R1a), déplacement inférieur à 2 mm (R1b). Les enfants ont bénéficié d'une IRM après immobilisation plâtrée. Le traitement chirurgical a été réalisé pour les fractures articulaires avec un suivi à 1 mois puis à 6 mois.

Résultats : Trente et une fractures ont été colligées avec un âge moyen de 6,24 ans (3 à 11 ans) et une prédominance masculine (70,97%). A l'IRM, sept fractures (22,6%) étaient métaphysaires Gp1, onze (35,5%) étaient métaphysaires-épiphyseaires avec un cartilage de charnière intact Gp2, neuf (29%) étaient des Salter IV Gp3 et dans quatre cas il s'agissait d'une fracture supra condylienne. Le trait était métaphysaire plus fréquemment dans le groupe R1a (40,0%) comparé au R1b (6,3%). Pour le groupe R1b, 8 fractures étaient articulaire (Gp3) avec des constatations opératoires concordantes.

Conclusion : L'IRM permet d'évaluer l'extension articulaire des FPDCL du coude et fournit des informations indispensables pour un traitement adéquat.

Mots clés: fracture, condyle latéral, enfant, IRM

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INTRODUCTION

Humerus lateral condylar fracture is the second most common elbow fracture in children (1,2), reported to represent 12-20% of pediatric elbow trauma (3,4,5). Diagnosis and treatment of displaced fracture is well codified with an open reduction and internal fixation (6,7,3,8). For non-displaced or minimally displaced (NMDLC) fractures diagnosis, usually based on plain radiograph, can be challenging because of late ossification centers appearing and complex cartilaginous structures none well visualized on such exam. We believe that determination of articular displacement magnitude and epiphyseal line fracture extension is mandatory for treatment management.

Somme authors have suggested ultrasound, arthrography, multidirected computed radiography, oblique incidence and magnetic resonance (MRI) to help for therapeutic decision (9,10,11,12,13) with interesting findings but not clearly practice guideline.

The purpose of this study was to determine the usefulness of MRI in (NMDCL) fracture objecting clearly articular epiphyseal displacement, identifying remaining hinge cartilage (2,10) and guiding therapeutic management.

METHODS

We studied thirty-one consecutive NMDLC fractures during 6 years. We include prospectively children younger than 15 years seen at the emergency room where diagnosis was made on anteroposterior and lateral radiograph. Only fracture classified Rigault type I were included and divided in two groups according to displacement lesser than 2 mm in all cases. Groupe 1: only line fracture was viewed (R1a), group 2 fracture with a gap of displacement lesser than 2 mm (R1b). (Maximum displacement measured on both incidence lateral and posterior cortex) (Figure 1).

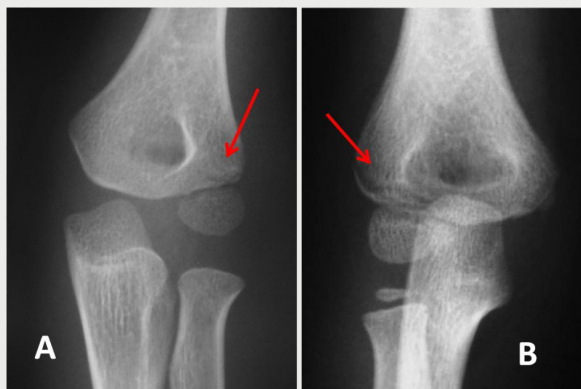


Figure1. Anteroposterior elbow x ray
(A) only line fracture seen (R1a), (B) Gap fracture lesser than 2 mm (R1b)

After elbow cast immobilization, children have got MRI lesser than 48 hours following trauma. MRI was performed with pre-established procedure and without any sedation (T1 weighted, Proton Density and fat suppression sequence in sagittal coronal and transverse view). MRI were read by same both radiologist and pediatric orthopedics (MB-KK). We identified three groups on MRI findings: Gp1: fracture line through only metaphysis, Gp2: line cross epiphyseal with an intact hinge cartilage ("incomplete" Salter IV), Gp3: complete line fracture salter IV. (Figure 2-3). Open reduction was indicated only in Gp3 with complete epiphyseal fracture. Operative findings were noted and compared to MRI images.



Figure 2. line fracture through only metaphysis

(A) Lower intense line in coronal view in T1 weighted sequences
(B) Hyper intense line in coronal view in proton density without fat suppression signal
(C) Fracture lesser than 2 mm on A/P x ray (R1b)

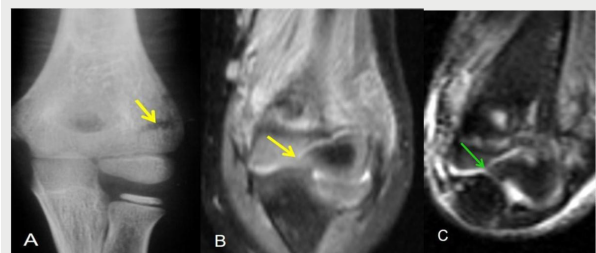


Figure 3. line fracture through epiphysis with intact hinge cartilage

(A) A/P x ray showing only line fracture (R1a)
(B) T2 weighted in coronal with fat suppression showing line fracture through trochlea with intact hinge cartilage (Gp2)
(C) T1 weighted in coronal sequences

All children were followed at outpatient department for cast release at one month with pin removal if surgery was done and at 3 and 6 months. The following up included a comparative physical elbows examination (elbow mobility, frontal deviation).

For our statistical analysis we used SPSS 22. Quantitative variable were expressed as mean with minimal and maximal value, and qualitative variables in percentages. Group comparative used Fisher exact tests.

RESULTS

We reviewed a total of 31 fractures, including twenty two (70.97%) boys and nine (29.03%) girls. The average age at the time of fracture was 6.24 years (range from 3 to 11). Twelve fractures involve the right elbow (38.7%). According to X-rays, only line fracture was viewed (R1a) (48,4%) in fifteen cases and fracture with a gap of displacement lesser than 2 mm (R1b) in sixteen cases. According to MRI, seven fractures were metaphyseal (22,6%), eleven were metaphyso-epiphyseal with an intact hinge cartilage ("incomplete Salter IV" fracture)(35,5%), nine were complete Salter IV(29%) and four supracondylar fracture with bicortical interruption not initially seen in plain radiographs(12,9%). (Table 1)

MRI results differs significantly according to radiographs groups. In fact MRI Gp1 was significantly higher in the R1a group (40.0%) compared to R1b (6.3%).

Gp3 MRI was significantly lower in the R1a group (6.7%) compared to R1b radiographic group (50.0%).

For the sixteen fracture with gap lesser than 2 mm on x-ray (R1b), 8 presented articular cartilage involvement on MRI (Gp3) and 8 remains extra articular (Gp1, Gp2, supracondylar). For the fifteen R1a cases, only one presented articular cartilage involvement on MRI (GP3) with statically difference (P=0.02).

Table 1. Correlation between MRI findings and initial radiographs

| X-ray | MRI | | | | | | | |
|--|----------------------------|------|--------------------------------------|------|------------------------------------|------|-----------------------------|------|
| | Gp1 : metaphyseal fracture | | Gp2 : epiphysio metaphyseal fracture | | Gp3 : articular fracture Salter IV | | SC : supracondylar fracture | |
| | n | % | n | % | n | % | n | % |
| R1a: only the fracture line is visible | 6 | 40,0 | 6 | 40,0 | 1 | 6,7 | 2 | 13,3 |
| R1b: displacement<2mm | 1 | 6,3 | 5 | 31,3 | 8 | 50,0 | 2 | 12,5 |
| Total | 7 | 22,6 | 11 | 35,5 | 9 | 29,0 | 4 | 12,9 |
| P (Fisher test) | 0.02 | | | | | | | |

Only Gp3 and one children from Gp2 had surgery (32,26%) due to a doubt of articular infraction on MRI which was not confirmed (false positive case) (Gp2).(Figure 4)

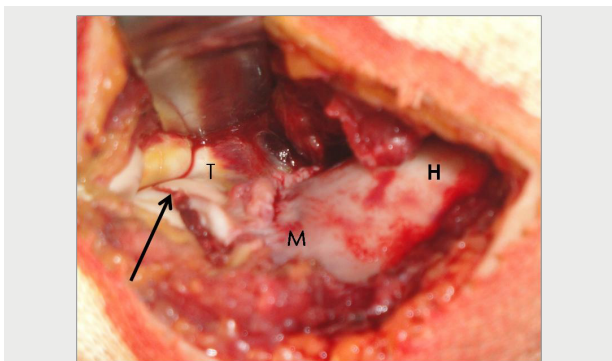


Figure 4. Operative view showing line fracture through trochlea with intact hinge cartilage
M: metaphysic, T: trochlea, H: humerus

For the other patients (Gp1, Gp2 and supracondylar fracture,) orthopedic treatment was conducted with long arm cast for 1 month (67, 74%).

At follow-up all children recover a full range of motion with bone healing for each group.

DISCUSSION

Lateral condylar fracture diagnosis, still based on biplanar radiographs is usually made in emergency room by primary care physician or orthopedic surgeon. Displaced fractures were often easily diagnosis. Open reduction and pin fixation is well codified procedure to avoid nonunion and stiffness. For MNDLC fracture, radiographs provide incomplete information of real epiphyseal gap displacement and treatment is still controversial. This articular displacement could be missed and conservative treatment could be incorrectly indicated.

Radiological criteria have been widely used to evaluate lateral condylar fractures (14) with instability criteria reported for displacement further than 2 mm (10,12,3,15). In our study even in displacement lesser than 2 mm we noted 29% of articular involvement confirming the fact that x-ray can hardly predict articular displacement even if some authors suggested oblique x-ray incidence (16). Fracture topography and displacement could be clearly identified only by exam able to show articular cartilage such as ultrasound or MRI (13).

Mintzer et al. (17) recommend arthrography preceding percutaneous pinning for displaced condylar fracture more than 2mm and Knutsen A et al. showed that the real fracture displacement were larger than radiographic displacement measurement (18). Even if MRI is still expensive and not always available, it remains a non

radiation sensitive exam in pediatric elbow injury diagnosis (19) and could be the appropriate imaging to establish clearly line fracture, displacement guiding therapeutic management. The second point to evaluate is fracture stability, Finnbogason et al. reported that even in NMDLC fractures, further displacement may occur after conservative treatment (long arm cast immobilization) (20) this is due to the underestimation of articular fracture involvement in radiographs.. Jakob et al.(2) by studying fracture mechanism using cadaver elbow, demonstrate that the fracture line does not cross the epiphyseal cartilage in all cases and remaining hinge cartilage stabilize fracture. This hinge cartilage has been clearly identified by MRI with this "incomplete Salter IV" fracture reported by our Gp2. Elbow MRI in NMDLC fracture could be the gold standard to visualize reality of articular involvement. Conservative treatment could then be indicated without any doubt in extraarticular fracture where line passes thought only metaphysic or "incomplete Salter IV" fracture with intact hinge cartilage assuring stability.

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