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Original article

## Diagnostic value of ultrasonography in elbow trauma in children: Prospective study of 34 cases

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### ABSTRACT

**Introduction:** Among the various elbow injuries in children that initially have normal radiographs, a certain number of occult fractures are only diagnosed correctly after the fact, during a follow-up visit.

**Purpose:** This study evaluated the diagnostic contribution of ultrasonography in the treatment of acute elbow injuries in children and the strategic and economic impact of using this tool alongside radiography.

**Materials and methods:** During this prospective study performed between January 1 and April 1 2014, elbow ultrasonography was performed within 6 days in all children under 15 years of age with a suspected occult fracture. The ultrasonography exam looked for lipohemarthrosis, the posterior fat pad sign and cortical disruption. If no fracture was visible on ultrasonography, a removable splint was given to the patient to relieve pain, and no radiological or clinical follow-up was scheduled. The patients were contacted again at least 15 days later to determine whether an undetected fracture was present. Lastly, we evaluated the cost of treatment with and without ultrasonography in the cases where no fracture was diagnosed.

**Results:** In 13 cases, ultrasonography revealed lipohemarthrosis and a fat pad sign, with cortical disruption also present in 11 of these cases. In two cases, the diagnosis was made based solely on the presence of lipohemarthrosis and a fat pad sign. There were seven lateral condyle fractures, two medial epicondyle fractures and two supracondylar fractures. Among the 21 patients with normal ultrasonography, no fracture was diagnosed later on. In patients without a fracture, using ultrasonography resulted in a cost savings of €29.10 per patient versus not using it.

**Conclusion:** In our study, ultrasonography is a sensitive examination for the diagnosis of occult elbow fractures in children. When the radiography and ultrasonography are both normal, the possibility of fracture can be ruled out definitively, which reduces the need for immobilization, follow-up and treatment costs. The findings of this preliminary study should be validated with a larger prospective study.

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### 1. Introduction

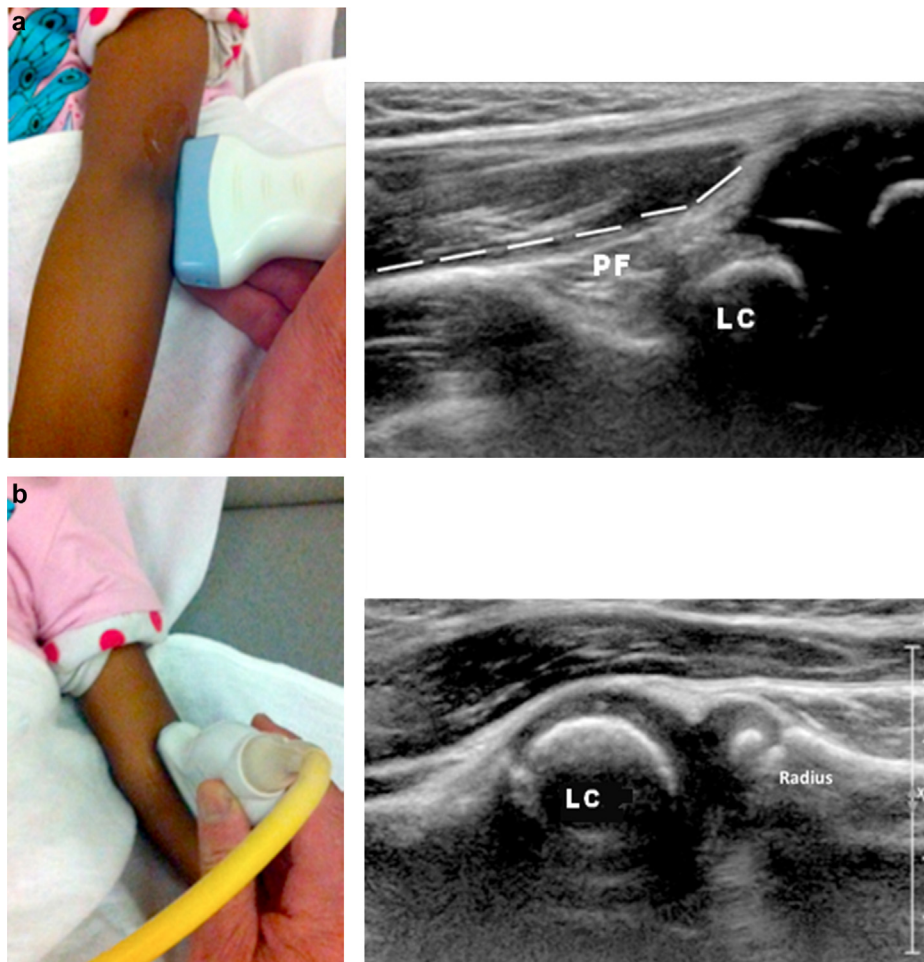
Arm injuries are a common reason for children to visit to the emergency room. Among the various elbow injuries in children that initially have normal radiographs, a certain number of occult fractures are only diagnosed correctly after the fact, during a follow-up visit. Based on various studies, occult fractures make up 2–18% of fractures in children [1,2]. But the radiographic fat pad sign can be

difficult to interpret and if an occult fracture cannot be ruled out, cast immobilization is often preferred.

Recent studies have shown the benefits of musculoskeletal ultrasonography for the diagnosis of fractures in adults [3] and children [4,5] by identifying cortical disruption, even when it can be difficult to directly see the fracture line. The presence of indirect signs such as lipohemarthrosis [6] and the posterior fat pad sign (also called sail sign) makes it possible to diagnose the fracture [7,8]. For this reason, ultrasonography is the ideal diagnostic examination in children.

This study evaluated the diagnostic contribution of ultrasonography in the treatment of acute elbow injuries in children and the strategic and economic impact of using this tool alongside radiography for the management of suspected occult fractures.

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**Fig. 1.** Ultrasonography of a normal left elbow. (a) Longitudinal posterior slice: absence of posterior fat pad sign, i.e. No fat visible behind the distal line of the humerus (dotted line). PF: Posterior fat LC: Lateral condyle. (b) Longitudinal anterolateral slice: absence of joint effusion. LC: Lateral condyle.

## 2. Materials and methods

This prospective study was carried out between January 1 and April 1 2014 in all children less than 15 years of age who came to the surgical emergency room of the Lyon pediatric hospital with a suspected occult fracture, in the context of an acute injury. These patients had a functional disability with elbow or forearm pain requiring immobilization for which no bone damage was found on radiography.

Excluded were patients with bone damage diagnosed on the initial radiographs or with arm deformity, painful pronation, musculoskeletal infection and patients with no suspicion of occult fracture after the initial clinical and radiographic assessment.

All of the included patients had their elbow immobilized with an elbow to body splint until ultrasonography (standard Philips IU 22 unit with 12.5 MHz probe) was performed on the injured and contralateral elbows within 6 days.

The elbow was placed in 90° flexion when possible. The probe was placed on the posterior and then the anterior portion of the distal humerus. The following views were generated with the ultrasonography: transverse posterior of humerus, longitudinal posterior internal and external of humerus, longitudinal lateral centered over humeroradial joint (Fig. 1), then medial centered over humeroulnar joint, and lastly, transverse anterior of humeroulnar joint. If necessary, the longitudinal views were also done with the elbow extended to look for the posterior fat pad sign.

The ultrasonographer looked for indirect signs of fracture such as lipohemarthrosis and the ultrasonographic fat pad sign (Fig. 2). Lipohemarthrosis corresponds to a hyperechogenic intramedullary fat released into the joint cavity and suspended above the hypoechogenic hemorrhagic joint fluid (Fig. 2b). The fat pad sign is defined as the presence of fat above the distal line of the humerus in a longitudinal posterior view or a line joining the two edges of the olecranon fossa on the transverse view. Lastly, the exam sought to find direct signs of fracture such as cortical disruption. The diagnosis of fracture was made when there was cortical disruption, lipohemarthrosis or fat pad sign. The relevant ultrasonographic images were saved.

The initial radiographs were read again independently and in a blinded manner by three senior pediatric orthopedic surgeons. They looked for the radiographic fat pad sign (anterior or posterior) and cortical disruption.

If no fracture was diagnosed based on ultrasonography (No fracture group), the patients were immobilized with an elbow to body splint to provide pain relief for 15 days without radiological or clinical follow-up. If a fracture was diagnosed based on ultrasonography (Fracture group), the diagnosis of occult fracture was made; standard treatment consisted of immobilization with a long-arm cast and a radiological and clinical follow-up after 15 days. At this point, the radiographs were read to look for a bone callus confirming the presence of a fracture.

The patients who were not diagnosed as having a fracture on radiographs or ultrasonography were given a removable splint. No

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