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CLINICAL CASE

Ultrasonography: An alternative imaging modality in diagnosing greenstick fractures. Early experience in a county hospital

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ABSTRACT

Aim: In this case series clinical protocol, comparison of X-ray examination vs ultrasonography in detecting minimally displaced distal radius fractures in children is presented.
Patients and Methods: In twenty four children, 2 to 14- year old, with a suspected fracture of the distal radius ultrasound of the wrist was applied prior to X-ray. Tenderness on palpation and the point of maximal tenderness was located and marked. This was the place where the probe was first placed. The bone was examined circumferentially. In cases where the children could not cooperate, the examination began at the wrist area and the probe was moved proximally.
Results: In all greenstick fractures pain on palpation was present. Whenever there was a fracture diagnosis with the X-rays, the ultrasound was also positive for fracture.
Conclusion: From the data of the above study, it seems that ultrasound, is at least as sensitive as radiography in detecting greenstick fractures. Therefore it is an alternative, low-cost, safe, effective and sensitive bedside test in order to reveal minimally displaced fractures in children.

KEY WORDS: torus fractures; greenstick fractures; distal radius fracture; ultrasonography

1. Introduction

Children have a thick periosteum that protects the bony cortex which is softer than in adults. This is the reason that some types of fractures such as greenstick, buckle or torus, long bone bowing, are seen only in children. A torus fracture is a bulging of the bony cortex and happens when compressive forces act on the bony metaphysis. In a greenstick fracture there is a clear break of the convex surface and bending of the concave one and happens by more severe forces [1]. Since the distinction between these two types of fractures might be confusing, and the treatment is more or less the same, from

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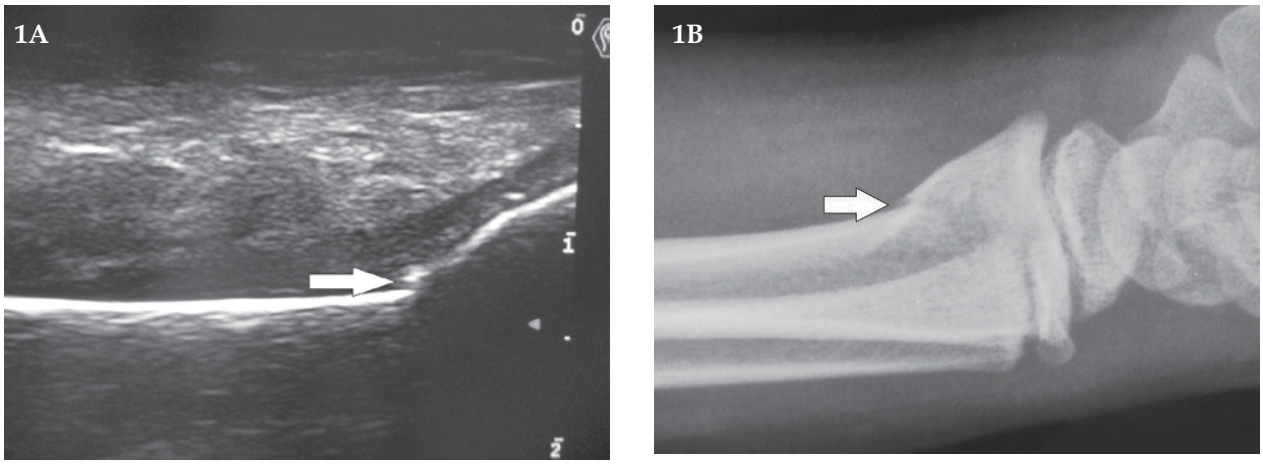

Fig. 1. *The arrow in both figures (ultrasound 1a and x-rays 1b), shows a green stick fracture*

now on they will be referred as minimally displaced distal radial fractures. The diagnosis of minimally displaced fractures of the distal radius in children can be established by history, physical examination and plain X-rays. The latter is still the gold standard amongst the imaging modalities to detect these fractures. However, there are concerns regarding radiation exposure and an alternative imaging tool for the diagnosis of these common fractures in children remains unsolved. Musculoskeletal ultrasonography was first used in rheumatic diseases in the 80's. Since then it has been used in several specialties including Orthopedics. Musculoskeletal ultrasound has been recently used in Orthopedics and there are still a lot to be done in that area [2].

This study aimed to investigate if the ultrasound can add to the diagnosis of minimally displaced fracture of distal radius or even replace the gold standard of plain X-rays investigation.

2. Patients and Methods

Children up to14 years old complaining of wrist pain after a fall were included. On physical examination there was tenderness on palpation over the distal radius. However, no obvious deformity of the wrist or forearm was noticed.

All patients had an ultrasound scan of the injured limb at the time of presentation in A&E using an Esaote My lab 70 X-vision and a linear probe (13 MHz). The bone was examined circumferentially, to avoid false negative results. After the ultrasound investigation, they had an X-ray of the wrist area (postero-anterior and lateral views) and the films were interpreted by a radiologist and compared to ultrasonography results. The X-rays diagnosis was performed by a specialist radiologist and it was then compared to the ultrasound diagnosis made by the authors.

3. Results

Twenty four patients presented in A&E Department met the inclusion criteria. There were ten females and fourteen males with a mean age of 8 years (2 to 14). The presentation time after the injury ranged from hours to three days. The point of maximal tenderness on palpation was marked. This was the site where the probe was first applied. The bone was examined circumferentially. In cases where the child could not cooperate, the examination started at the wrist area and the probe moved proximally.

The parents were informed about the study and a verbal consent was obtained. All parents, consent to have their kids an ultrasound examination and all children relaxed quite soon after the application of the probe onto their wrist when realized it was not painful.

The area where the fractures occurred is shown in **figure 1** (arrow) In some cases the fracture side was also examined using Doppler trying to allocate the epiphyseal nutrient vessel (**Fig. 2**) All fractures were within the criteria set for the minimally displaced distal radial fracture (**Fig. 2 and Fig. 3**).

In all cases there was a fracture diagnosis with the use of X-ray, the ultrasound was also positive for such a fracture.

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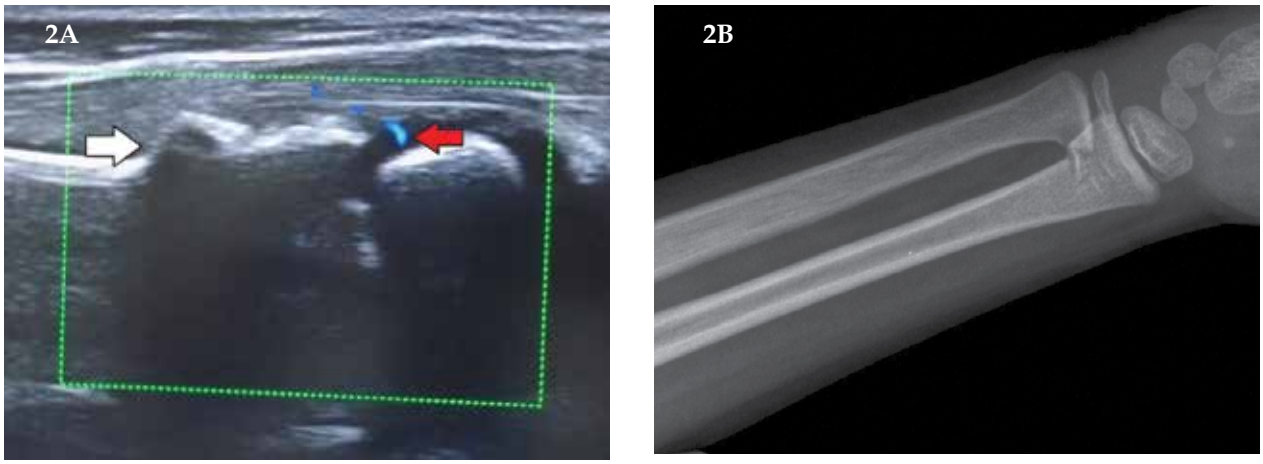

Fig. 2a. *Ultrasound picture of a buckle fracture (white arrow) and the nutrient vessel (red arrow).* ***2b****. X-Rays of the above mentioned fracture*

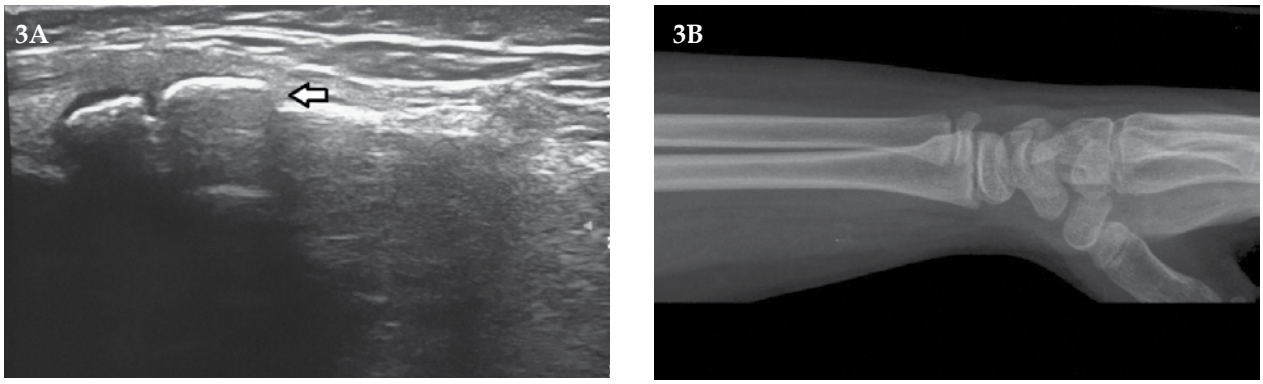

Fig. 3. *A buckle type fracture*

4. Discussion

Minimally displaced distal radius fractures in children counts for a significant portion of the distal forearm fractures [3].

To the author's knowledge the true annual incidence of such fractures is not known in Greece, however in the United Kingdom, 900,000 children attend A&E Department suffering of a distal forearm fracture [4, 5].

According the literature the sensitivity of ultrasound in detecting the minimally displaced distal forearm fractures is quite high [6] even higher than x-rays [5]. The results from the above study showed that ultrasound demonstrated the same sensitivity with X-rays. The ultrasonography can be also used to asses callus formation and fracture healing [5].

Ultrasonography is operator dependent, but detecting a fracture has a lower learning curve when compared to other more complicated soft tissue pathology. Additionally, the cost of an ultrasound is low and comparable to that of an X-ray. Finally, the use of ultrasound for the diagnosis of such a common but occult fracture saves children from radiation exposure.

The clinical implication of this study could be the use of a portable ultrasound device by the caring physician, in a primary care center could lead to a further cutdown of the direct cost of expensive X-rays equipment and staff. Furthermore, the indirect cost from waiting time at the A&E department, travelling from a primary care center to a referral hospital, lost working hours form accompanying persons, is also reduced. Conclusively, the application for ultrasonography could substantially contribute to the reduction of the direct and indirect health costs in fractures diagnosis.

5. Conclusions

The results showing that ultrasound can be safely

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used in diagnosis of minimally displaced distal radius fracture in children. It is a valuable bedside test, a low cost, safe and effective diagnostic tool and as sensitive as X-rays for the diagnosis of minimally displaced distal radius fractures in children.

Conflict of interest:
The authors declared no conflicts of interest.

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ΠΕΡΙΛΗΨΗ

Σκοπός: Ο σκοπός της παρούσας μελέτης, είναι η σύγκριση του ακτινολογικού με τον υπερηχογραφικό έλεγχο στη διάγνωση των ελάχιστα παρεκτοπισμένων καταγμάτων του κάτω πέρατος κερκίδας στα παιδιά. Παρουσιάζονται τα πρώιμα αποτελέσματα σε ένα επαρχιακό νοσοκομείο

Ασθενείς και Μέθοδος: Είκοσι τέσσερα παιδιά ηλικίας δύο έως δέκα τεσσάρων ετών, με κλινικά πιθανό κάταγμα κάτω πέρατος κερκίδος, υποβλήθηκαν σε υπερηχογραφικό έλεγχο. Ο ηχοβολέας τοποθετείτο αρχικά στην περιοχή της μέγιστης ευαισθησίας στην ψηλάφηση και ακολούθως η εξέταση επεκτείνετο κυκλοτερώς του οστού.

Αποτελέσματα: Σε όλες τις περιπτώσεις καταγμάτων υπήρχε ευαισθησία στην ψηλάφηση, ενώ όπου ετίθετο διάγνωση κατάγματος από τον ακτινολογικό έλεγχο, συμφωνούσε και η υπερηχογραφική διάγνωση.

Συμπεράσματα: Από την παραπάνω μελέτη, φαίνεται ότι ο υπέρηχος έχει τουλάχιστον την ίδια διαγνωστική αξία με τον ακτινολογικό έλεγχο, στα ελάχιστα παρεκτοπισμένα κατάγματα του κάτω πέρατος της κερκίδας στα παιδιά. Με την απλή και οικονομική αυτή απεικονιστική μέθοδο αποφεύγεται η έκθεση σε ακτινοβολία των νεαρών ασθενών.

ΛΕΞΕΙΣ ΚΛΕΙΔΙΑ: κατάγματα περιφερικής κερκίδας, παιδιά, υπέρηχος