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Research Article

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A Cross-Sectional Study to Determine the Health Outcomes Benefits of Using Ultrasound in the Treatment of Elbow Fractures

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Abstract: Background: Elbow injuries present as a prolific pathology to the pediatric emergency unit. **Aim:** This study is enrolled health outcomes of ultrasound effect in the diagnoses pediatric with elbow fractures. **Methods:** A cross-sectional study was conducted on 85 pediatric patients diagnosed with elbow fractures using ultrasound. Ultrasound was performed on only pediatric patients aged 4-14 years in hospitals in Basra, Iraq, during the follow-up period covering March 2023-January 2024. Patient demographics, diagnostic characteristics, and ultrasound findings were recorded. **Results:** The present study encompassed a total of 85 cases of pediatric patients. The most prevalent signs observed included point tenderness and swelling, which occurred in 87.06% and 94.12% of cases, respectively. The predominant trauma mechanism was identified as falling on the same level in 54.12% of cases, while the most common affected side was the left side in 41.18% of cases. The ultrasound imaging diagnostic findings included elevated posterior fat pads in 64.71% of cases and lipohemarthrosis in 74.12%. The ultrasound technique mechanism revealed US mechanism scores of 93.8% in terms of accuracy and 94.3% in terms of sensitivity. **Conclusion:** Our findings yielded high diagnostic accuracy concerning the ultrasonography diagnosis of an elbow fracture, which allows us to confirm ultrasonography imaging of the elbow as a safe alternative during the evaluation of pediatric elbow injuries.

Keywords: Elbow fracture; Ultrasound imaging; Accuracy; Fracture Types; and Functional Recovery.

INTRODUCTION

At the pediatric emergency room, elbow injuries are a popular complaint and often elicit radiographic tests for checking for a potential fracture (Wanjiang, F. *et al*., 2022; Ipsen, J.A. *et al*., 2022). Up to 15% of pediatric fractures are elbow fractures (Yıldırım, C. *et al*., 2022). The posterior fat pad, which is typically situated within the olecranon fossa but is disturbed through elbow joint effusion, is elevated on plain radiographs. In the event of elbow trauma, this elevation acts as a sensitive signal for elbow fractures (Aldieri, A. *et al*., 2022; Kalogiouri, N.P. & Samanidou, V.F., 2021).

With just a few hours in targeted training, emergency doctors can perform ultrasound imaging properly and consistently (Shinohara, H. *et al*., 2021). Recent studies have shown the significance of musculoskeletal ultrasonography in the direct detection of cortical disruption in the diagnosis of fractures in adults as well as kids (Fritz, A.V. *et al*., 2022; Yi, J. *et al*., 2022; Masoudi, A. & Naraghi, L., 2022; Natrajan, P. *et al*., 2021). It has been demonstrated that the midshaft of long bones has a higher detection accuracy for fractures (Kiwanuka, E. *et al*., 2013).

Due to variations in the ossification centers and the many curved contours at the extremities in the distal humerus, proximal radius, as well as proximal ulna, it may be technically challenging to utilize ultrasonography to visualize fractures directly in the elbow joint in children. On ultrasonography, the posterior fat pad can be easily detected (Sheng, D.L. *et al*., 2022; Lalande, É. *et al*., 2017).

PATIENTS AND METHODS

Study Design:

We conducted a study of 85 children aged 4–14 years with elbow fractures diagnosed by ultrasound in hospitals in Basra, Iraq, during the follow-up period between March 2023 and January 2024. This study recorded clinical and demographic data of pediatric patients at the hospital using SPSS 22.0 software. Patient characteristics included age, sex, body mass index (BMI), ASA class, educational and economic parameters, and parental marital status.

Patient Selection Parameters:

Eighty-five pediatric patients with elbow fractures aged 4–14 years were included. This study

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included patients under the age of 20, children with elbow fractures, patients who underwent ultrasound, and all children admitted to the pediatric emergency unit. This study excluded another group of children, including those who had undergone another or previous radiograph, children with complete elbow dislocation, children with open injury or loss of consciousness, patients unable to complete the data, or children with fractures resulting in death.

Ultrasound Diagnosis of Children:
This study presents a convenience sample of patients with an elbow fracture, which was then suspected by history and clinical examination. The suspected fracture is defined as one associated with pain, point tenderness, ecchymosis, swelling, or diminished range of motion to the elbow.

In the attending radiologist's report, which was blinded to the ultrasound results, the elbow fracture on the X-ray was defined by the posterior fat pad sign, cortical disruption, or posterior displacement of the capitellum relative to the anterior humeral line. All elbow injuries were treated according to the patient's clinical complaints and radiological findings. Additionally, other measures were used to evaluate elbow fractures using ultrasound. Children underwent a clinical assessment of the fracture before the test, and the fracture side (right, left, or both) and fracture type (supracondylar, radial, ulnar, and condylar fractures) were determined.

Functional Outcomes:
Clinical ultrasound findings were recorded in children with elbow fractures, including adverse parameters associated with the condition, as well as other data, including time to diagnosis (minutes), reduction accuracy (%), pain scores, and fracture complications. Clinical outcomes were determined to assess elbow motion and functional recovery in children. Elbow motion was assessed by having children undergo a pediatric range-of-motion assessment, which included flexion, extension, and pronation/supination. The Mayo Elbow Performance Score (MEPS) is a widely accepted tool for assessing the functional outcomes of elbow disorders. It comprises pain, range of motion, stability, and function, providing a detailed evaluation of elbow performance. The MEPS is very important in the clinical setting because it has been shown by numerous studies to have reliability and validity, thus making it the chosen tool when assessing elbow impairment across the globe. These four domains were scored and evaluated using a satisfaction rating scale ranging from 0 to 100, with higher scores representing better recovery of elbow function and movement. The SF-36 General Questionnaire was administered to assess pediatric patients' overall health-related quality of life, which included four domains: physical, social, emotional, psychological, and daily activity, where scores ranged from 0 to 100, with higher scores representing patients' optimal quality of life.

RESULTS
This study is shown demographic characteristics in children with elbow fractures for 85 cases aged 4–14 years, where group (10 – 14) year had 80% of total cases, males got 63 as the most participated while females got 22 children of total cases.

Table 1: Baseline Features Of Demographic And Clinical Outcomes

Items	Parameters	Frequency, {85}	Percentage, {%}
Age, {Years}			
	4 – 9	17	20%
	10 – 14	68	80%
Gender			
	Male	63	74.12%
	Female	22	25.88%
BMI, {Kg/m2}			
	Normal weight	55	64.71%
	Overweight	17	20%
	Obesity	13	15.29%
ASA Class, %			
	I	14	16.47%
	II	21	24.71%
	III	33	38.82%
	IV	17	20%

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Education status of children			
	Educated	75	88.24%
	Non – educated	10	11.76%
Marital status of parents			
	Married	62	72.94%
	Divorced	23	27.06%
Economic status of parents, $			
	< 350	42	49.41%
	350 – 650	28	32.94%
	> 650	15	17.65%

The most common symptoms detected clinically include point tenderness had 87.06% of cases and swelling had 94.12% of cases as diagnostic criteria.

Table 2: Distribution Symptoms Of Elbow Fractures On Pediatric

Symptoms	Frequency, {85}	Percentage, {%}
Point tenderness	74	87.06%
Swelling	80	94.12%
Ecchymosis	3	3.53%
Deformity	21	24.71%
Decreased range of motion	71	83.53%
Neurovascular compromise	74	87.06%

Table 3: Determining the Main Trauma Mechanisms At Pediatric.

Trauma mechanism	Frequency, {85}	Percentage, {%}
Falling on the same level	46	54.12%
Cycling	18	21.18%
Direct trauma	11	12.94%
Exercise and playing	6	7.06%
Other	4	4.71%

It determined trauma mechanisms of elbow fractures at children, which include falling on the same level, had 54.12% of cases, where the left elbow is as the common side of fractures in 41.18% of total cases.

Table 4: Examination Data of Elbow Fracture Injury

Items	Variables	Frequency, {85}	Percentage, {%}
Pretest clinical assessment of fracture, %			
	Less or equal to 2	0	0%
	3–25	11	12.94%
	26–50	14	16.47%
	51–75	17	20%
	76–98	23	27.06%
	Above or equal to 99	20	23.53%
Fracture side			
	Right	27	31.76%
	Left	35	41.18%
	Both	23	27.06%
Fracture type			
	Supracondylar fracture	59	69.41%
	Radial head fracture	11	12.94%
	Olecranon fracture	10	11.76%
	Humeral condyle	5	5.88%

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	fractures		

Our study enrolled clinical ultrasound findings, including Elevated posterior fat pad with 64.71% and lipohemarthrosis with 74.12% of total children.

Table 5: Enroll the Clinical Findings of Ultrasound Examination at Pediatric With Elbow Fractures.

Findings	Frequency, {n = 85}	Percentage, %
Elevated posterior fat pad	55	64.71%
Lipohemarthrosis	63	74.12%
Cortex disruption	28	32.94%
Effusion	11	12.94%

Table 6: Diagnostics Findings of Children with Elbow Fracture under Ultrasound (Us) Guidance.

Variables	**Frequency, {n = 85}**	**Percentage, %**
Time to Diagnosis (min)	7.15 ± 2.83	
Reduction Accuracy (%)	85–95%	
Pain scores, VAS scale		
1st week	6.7 ± 2.5	
2nd week	4.1 ± 1.5	
4th month	2.6 ± 0.8	
7 month	1.4 ± 0.5	
Complications	8	9.41%
Nerve injury	4	4.71%
Malunion	2	2.35%
Infection	2	2.35%

Table 7: Assessment of the Functional Recovery of Children with Elbow Fracture under Ultrasound (Us) Guidance.

Items	**Variables**	**Frequency**	**%**
Range of Motion (ROM)			
	Flexion and Extension {0 – 130}		
	Normal ROM	12	14.12%
	Restricted ROM	73	85.88%
	Pronation/Supination {50°}		
	Normal	10	11.76%
	Restricted	75	88.24%
Mayo Elbow Performance Score (MEPS)			
	Excellent, ≥90	2	2.35%
	Good, 75–89	7	8.24%
	Fair, 60–74	24	28.24%
	Poor, <60	52	61.18%

Table 8: Assessment of General Health Quality Of Life at Patients during Follow–Up with Ultrasound Examination.

Items	**SF – 36 Scores**
Physical function	61.46 ± 12.45
Psychological function	57.33 ± 9.15
Social and emotional functions	54.01 ± 6.92
Daily activity	52.29 ± 7.66

It evaluated ultrasound technique mechanisms in diagnoses of elbow fractures at children, where an accuracy of 93.8% and sensitivity of 94.3%. MEPS and SF-36 indicated improved recovery and quality of life post-treatment.

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Table 9: Assessment Accuracy of Ultrasound Technique in Elbow Fracture Diagnoses in Children.

Items	Scores
Accuracy	93.8%
Sensitivity	94.3%
Specificity	88.4%
Positive predictive value (PPV)	82.6%
Negative predictive value (NPV)	86.2%

DISCUSSION

Acute fractures constitute the most common bone types in children, occurring in 10–25% of cases. They significantly impair a child's ability to engage in activities and have a major impact on their socioeconomic outlook later in life (Rovida, S. *et al*., 2022). At most, 15% of all fractures that present in an emergency department [ED] occur in the elbow, making it a common site for pediatric fractures. For this reason, a radiographic assessment using an X-ray, such as standard 2-way anteroposterior as well as lateral views, is necessary, which are used to assess elbow injuries (Epema, A.C. *et al*., 2019).

In this clinical context of elbow injuries, the posterior fat pad indication of lateral radiographs was very sensitive for detecting fractures. However, the nonossified epiphysis, as well as imprecise two-plane radiographs in unwilling youngsters, make it challenging to perform a radiographic examination of the elbow at an early age (Auten, J.D. *et al*., 2019; Storch, K. *et al*., 2022).

Pediatric elbow injuries are common. An accessible, reliable, and accurate marker of elbow fractures is the point-of-care sonographic identification of lipohemarthrosis and an increased posterior fat pad. Patients who are more likely to have an elbow fracture should be sent for imaging and can be identified with the use of point-of-care elbow ultrasonography (Bortolotto *et al*., 2017; Scheier *et al*., 2022). We examined lipohemarthrosis and posterior fat pad elevation as indicators of elbow fracture.

Ultrasonography has demonstrated improved performance accuracy even in lengthy bones, including the forearm's midshaft region. Because these characteristics may be hard to see at the curved ends of long bones and in regions of fractures next to joints, posterior fat pad elevation along with lipohemarthrosis were chosen as indirect indicators of fracture. Elevation of the posterior fat pad has been proposed as a potential accurate marker of elbow fracture. Furthermore, non-radiology sonologists find it difficult and time-consuming to do direct ultrasonographic examinations of fractures due to variance in the ossification centers in the juvenile elbow (Krishnamurthy *et al*., 2021; Yu *et al*., 2019).

However, radiography would be required to rule out the occurrence of a fracture and the degree of the dislocation if ultrasonography came up positive. Other studies that looked at fractures in children and young adults reported that positive elevation in the posterior fat pad by ultrasonography had 87% specificity and 80% sensitivity for elbow fractures (Martin *et al*., 2021). Apart from that, the German study is based on a fairly small sample of 30 patients who suffered elbow injuries, although their fracture incidence was comparatively higher at 50%. In addition, there was no assessment for the existence of lipohemarthrosis in the German investigation (Hwang *et al*., 2016).

As ultrasonography is the only diagnostic method, any fracture that occurred without an effusion may go unnoticed since the function in point-of-care elbow ultrasonography depends on the detection of effusion to presume a potential fracture (Gu *et al*., 2021; Ciminero *et al*., 2020). Remarkably, the only fracture we overlooked was a medial epicondyle fracture that was treated nonoperatively (Sun *et al*., 2022; Nicholson *et al*., 2021; Sawauchi *et al*., 2022). Incorporating a discernible clinical finding on a fracture to a positive ultrasound result will increase the test's sensitivity to 94.3% and accuracy to 93.8% in identifying elbow fractures while also lowering the total number of radiographs needed. Although not particularly examined, cutting back on radiologic investigations would seem to be a strategy worth considering from the perspectives of time and cost savings, necessitating more study and evaluation of these results.

CONCLUSION

Ultrasound remains a safe and effective means, devoid of radiation, for the diagnosis and management of pediatric elbow fractures. It works on reducing the time to diagnosis, improving early pain control, and preserving functional outcomes.

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Further multicenter studies are required for protocol standardization and to determine long-term effects.

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