

Variability in the Interpretation of Elbow Fractures in Children

Liliya Kraynov MS4¹, Timothy Zebulon MD², Blake Bulloch MD²

¹University of Arizona College of Medicine-Phoenix, ²Phoenix Children's Hospital

Abstract

The emergency medicine (EM) physician is usually the first physician to encounter a child with an elbow fracture, necessitating a great responsibility for an accurate diagnosis. This study aims to survey EM physicians and determine if certain elbow fractures are diagnosed inaccurately more frequently and if some physician characteristics share a relationship with the accuracy of diagnosis of pediatric fractures. This 18-question multiple-choice paper survey found that lateral epicondyle fractures were the most likely fractures to be misdiagnosed (22.1%), while type 3 supracondylar fractures were the most likely to be accurately diagnosed (95.5%). There was no significant difference in accuracy of diagnosis based on physicians working either in an academic department, non-academic department, or both. Those physicians who were board certified or board eligible in two or more specialties had a higher mean percent correct, as well as those who worked in pediatric emergency medicine. While this study served to start clarifying the most frequently misdiagnosed pediatric fractures and whether physicians with particular characteristics were more likely to diagnose fractures accurately, further study is necessary to draw a definitive conclusion. This is an area where additional education about elbow fractures in the developing pediatric elbow may be needed.

Introduction

Elbow fractures account for 10-12% of all fractures seen in children. The elbow's anatomy and radiographic features of the growing elbow increase the difficulty in determining an accurate diagnosis and proper treatment. Often, the burden of an accurate diagnosis falls on the EM physician, especially when orthopedic consultation may not be available. The diagnosis determines appropriate treatment, decreases complication risks, and decreases unnecessary medical costs. This study aims to assess how well physicians diagnose fractures and how their accuracy changes with level of training, focus of training, and fracture type; research in these specific topics is scarce but relevant for maximizing patient outcome. These groups of physicians include general emergency medicine (EM) physicians and pediatric EM physicians. ED annual volume, working in an academic versus non-academic ED were also surveyed to determine if these variables have an effect on accuracy of diagnosis. We anticipate those physicians with more training, those who treat more children, work in academic

departments, and work in high volume EDs will provide accurate diagnoses more frequently. Fractures easily differentiated on radiograph and commonly seen in the field will be accurately diagnosed more frequently.

Methods

A paper survey was constructed that included 18 multiple-choice questions of 2-3 radiographs of a fracture or normal elbow; the fractures included type 1 supracondylar, type 2 supracondylar, type 3 supracondylar, olecranon, medial epicondyle, lateral epicondyle, and Monteggia. 2 questions were dedicated to each type of fracture, as well as 2 questions for not fractured elbows. Each radiograph contained only one fracture type; elbows with multiple types of fractures were not included in the study to simplify analysis. Each radiograph had only one correct answer choice. As such, if a respondent chose the incorrect answer or chose multiple answers, that response was tabulated as incorrect. The gold standard used for "correct" was radiologist interpretation of the radiograph at the time of patient presentation.

The survey also determined the following demographics of physician respondents: board certification, years of training, working in an academic versus non-academic ED, and annual ED volume.

Surveys were distributed to residents, fellows, and physicians working in an academic adult emergency department (Maricopa Integrated Health System), academic pediatric emergency departments (Phoenix Children's Hospital and Dell Children's Medical Center), a non-academic adult emergency department (Banner Thunderbird), and a non-academic pediatric emergency department (Banner Thunderbird). The mean percent correct and standard deviation of each fracture were calculated. The mean percent correct and standard deviation were also found for each characteristic. P-values were calculated using Kruskal Wallis to determine significance of results within each characteristic, with $P \leq 0.05$ indicating significance.

Results

114 physicians completed the surveys; one survey was removed from analysis due to ambiguous answers that made it difficult to determine which final answer the responder selected. Further analysis was performed on 113 surveys.

Characteristics	N (%)
Work Status	
Academic	87 (76.9)
Non-Academic	23 (20.4)
Both	3 (2.7)
Board Certification	
EM	34 (30.1)
Peds EM	17 (15.0)
Peds	5 (4.4)
Peds EM Fellow	6 (5.3)
EM Resident	30 (26.6)
≥ 2 Certifications	21 (18.6)
Years Post Residency	
0-2	21 (18.8)
3-5	15 (13.4)
6-10	19 (16.9)
11+	27 (24.1)
Current Resident	30 (26.8)
Annual ED Volume	
20,000-40,000	2 (1.8)
40,000-60,000	14 (12.4)
>60,000	97 (85.9)

Table 1: Characteristics of Physicians in Study

Type of Fracture	Mean % Correct (SD)	P-value ¹
Normal	50.9 (37.8)	0.046
Type 1 Supracondylar	35.8 (33.7)	
Type 2 Supracondylar	52.2 (38.6)	
Type 3 Supracondylar	95.5 (17.1)	
Olecranon	76.5 (31.4)	
Medial Epicondyle	49.6 (41.4)	
Lateral Epicondyle	22.1 (32.6)	
Work	Mean % Correct	P-value¹
Academic	53.0 (18.1)	0.19
Non-Academic	60.6 (16.4)	
Both	57.14%	
Board Certification	Mean % Correct	P-value¹
EM	55.9 (17.2)	<0.001
Peds EM	60.9 (13.4)	
Peds	45.7 (15.6)	
Peds EM Fellow	58.3 (11.4)	
EM Resident	41.6 (14.6)	
≥2 Certifications	67.3 (16.3)	
Years Post Residency	Mean % Correct	P-value¹
0-2	51.7 (20.4)	<0.001
3-5	60.0 (14.7)	
6-10	64.3 (14.1)	
11+	61.1 (14.6)	
Current Resident	41.7 (14.6)	
Annual Volume	Mean % Correct	P-value¹
20,000-40,000	60.7 (25.3)	0.006
40,000-60,000	40.3 (15.4)	
>60,000	56.7 (17.2)	

Table 2: Relationship between Physician Characteristics and Percentage of Correct Answers. ¹P-values calculated using Kruskal Wallis

Discussion and Conclusions

The two most commonly misdiagnosed fractures were the lateral epicondyle fracture and type 1 supracondylar fracture. There was no statistically significant difference in diagnosis of fractures based on work environment. Those with six to ten years post-training diagnosed fractures accurately more frequently than the other groups; accuracy seems to peak at this timeframe. The mean % correct started to decline at 11 years, however, a trend cannot be determined since we did not further divide that timeframe into smaller increments. Those board certified or board eligible in 2 or more specialties performed better on the survey; this is expected as physicians with more intensive training should have more experience with these cases. A focus in pediatric emergency medicine, as opposed to only adult emergency medicine, improved the likelihood of correct diagnosis. Mean percent correct based on annual ED volume seems to nadir in the range of 40,000 to 60,000.

Obtaining a larger sample size, as well as adding additional sites, would help determine if a relationship exists with annual ED patient volume. It would also allow to further breakdown the time post-residency training into smaller increments.

Including additional fracture types and a greater number of each type would also help clarify which fractures are the most and least likely to be misdiagnosed. Ideally, age groups would consistently be represented in all of the fractures.

We chose fractures from different age groups; this means that different fractures from children of various ages were being compared to each other.

Ideally, future studies would incorporate the technology physicians use daily in the ED, instead of using paper surveys. Further expanding the study to evaluate how well physicians can determine whether a fracture is an operable emergency would add additional value to the results and make the survey more clinically applicable. Another area of expansion is the distribution of this survey to rural emergency medicine departments.

This is an area of further improvement that may include the creation of educational resources.

Acknowledgements

I wish to thank my mentors, Dr. Blake Bulloch and Dr. Timothy Zebulon.