Is the fat pad sign as reliable as we think for diagnosing occult pediatric elbow fractures?

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INTRODUCTION: Elbow fractures are the most common type of fracture in the pediatric population, accounting for approximately 15% of all pediatric fractures. While x-rays are highly effective for diagnosing large and grossly displaced fractures, up to 45% of pediatric elbow fractures are radiographically occult on initial imaging. In cases of suspected radiographically occult fractures, the fat pad sign (FPS) is frequently used to assist with diagnosis. While this finding is frequently used, its predictive value for ruling fracture in or out has not been fully characterized. Our study evaluated the sensitivity, specificity, and predictive values of the FPS in diagnosing occult elbow fractures in children.

METHODS: We identified all patients aged 2-21 years old who received an x-ray for elbow pain at a single, tertiary academic medical center between 2013-2023 (n=752). We reviewed a random sample of these cases (n=46) to estimate the prevalence of fracture, which was determined to be 60%. We then performed an *a priori* power calculation using this prevalence rate of 60%, a sensitivity of 80%, and a specificity of 80%, which revealed that to obtain a power of 0.8, we would need to include n=33 cases of which at least n=20 would have a fracture. Because we were interested in looking at the specific fracture subtypes of ulna/radius and humerus, we aimed to obtain at least 20 cases of each of these two fracture types. Since fracture type was not available until the chart was reviewed, the remaining 706 were reviewed in randomized order until at least 20 fractures of the ulna or radius and 20 humerus fracture cases were identified. We identified the anterior FPS (AFPS), posterior FPS (PFPS), presence of fracture, and fracture type on initial and follow-up x-rays. For occult fractures initially classified as a clinical diagnosis, bony healing on follow-up x-ray was used for confirmation of elbow fracture.

RESULTS: We reviewed a total of n=198 cases, of which n=154 cases were in the analysis, while n=44 cases were excluded based on loss-to-follow-up, nonapplicable indication for x-rays, or lack of mention of a fat pad. Of the 154 cases included in the final analysis, 88 patients (57.1%) had an elbow fracture. Ninety-nine patients (64.3%) had a positive FPS. The sensitivity of a positive FPS was 94.3% (95% confidence interval (CI), 87.2% to 98.1%) with a specificity of 75.8% (95% CI, 63.6% 85.5%) and a negative predictive value (NPV) of 91% (95% CI, 80.9% to 96%). The sensitivity of an AFPS was 83.9% (95% CI, 74.5% to 90.9%) with a specificity of 84.8% (95% CI, 73.9% to 92.5%) and an NPV of 80% (95% CI, 71% to 86.7%). The sensitivity of a PFPS was 62.1% (95% CI, 51.0% to 72.3%) with a specificity of 89.4% (95% CI, 79.4% to 95.6%), and a NPV of 64.1% (95% CI, 57.4% to 70.3%). There was no association between AFPS or PFPS and fracture location.

DISCUSSION: This study confirms the clinical intuition that the presence of an AFPS on an elbow x-ray is a strong predictor of occult elbow fracture. The presence of a PFPS is less reliable, but its absence may help rule out an occult fracture. When combined, they are even more predictive of fracture. The location of fracture cannot be distinguished based on the FPS. Therefore, clinicians should continue to rely on the history and physical exam to determine the location of an occult fracture.

SIGNIFICANCE: Our study presents a novel contribution to the literature on the use of the FPS in diagnosing pediatric occult elbow fractures. Our findings support the value of the AFPS, and that the presence of the FPS does not correlate with elbow fracture location.