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Selected Topics: Emergency Radiology

VARIABILITY OF ELBOW RADIOGRAPHY IN THE INJURED CHILD: A POTENTIAL DIAGNOSTIC DILEMMA

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☐ **Abstract—Background: Radiographic imaging is essential in assessing the severity and treatment of injuries. However, when a radiographic series is of poor quality, its diagnostic utility is limited, especially in cases involving pediatric elbow injuries. Objectives: This study aims to investigate the variability of elbow radiographs in the injured child, review parameters used to assess diagnostic quality, and introduce the lateral distal humeral metaphyseal-diaphyseal (LDHMD) ratio as a potential measurement of the quality of a lateral elbow radiograph. Methods: A retrospective review was performed of elbow radiographs of children who presented to our hospital. Demographic data, injury, location where the radiograph was obtained, and presence of immobilization were collected. Radiographs were subjectively classified as optimal, adequate, or suboptimal based on several radiographic parameters, one of which was the LDHMD ratio. Results: There were 286 radiographic series reviewed. Per our assessment of the anteroposterior images, 81% were found to be optimal, 18% adequate, and 1% suboptimal. In contrast, only 24% of the lateral images were deemed optimal, 63% adequate, and 13% suboptimal, therefore making the lateral radiographs the focus of our investigation. The LDHMD ratios of the optimal (n = 21) and suboptimal (n = 11) lateral radiographs without definite fracture were 0.96 and 0.84, respectively (*p* < 0.001). Conclusions: An LDHMD ratio that is approximately 1 and an hourglass sign appearing in the anterior third of the humerus are criteria for determining true pediatric lateral radiograph, and with increased awareness, will lead to improved diagnostic utility of radiographs when assessing the injured child's elbow and determining management.** **© 2019 Published by Elsevier Inc.**

☐ **Keywords—pediatric; orthopedic; elbow; fracture; x-ray**

INTRODUCTION

The quality of images such as electrocardiographic tracings, radiographs, magnetic resonance imaging, and the like can be affected by the experience of the technician, patient position, motion artifact, and equipment quality. This can lead to variable diagnostic utility (1). As in most areas of medicine, the quality of an imaging modality is of utmost importance when deciding on the correct diagnosis and treatment. Accordingly, obtaining a high-quality series of radiographs is essential for proper evaluation and treatment, especially when assessing for fracture in a child's elbow.

In the case of supracondylar humerus fractures in children, a poor radiograph may lead to a false perception of the true nature of the fracture. A suboptimal lateral elbow radiograph of a supracondylar humerus fracture may appear to be displaced and outside of tolerance for the fracture type and falsely positive, indicating operative intervention, but when a more accurate "true" lateral radiograph is obtained of the same elbow, it is apparent

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that the fracture is not as displaced and, in turn, treated nonoperatively (2–12) (Figure 1).

The purpose of this study was to investigate the variability of elbow radiographs in the injured child, review several parameters used to assess diagnostic quality, and introduce the lateral distal humeral metaphyseal-diaphyseal (LDHMD) ratio as a potential measurement of the quality of a lateral elbow radiograph.

MATERIALS AND METHODS

An institutional review board-approved retrospective review of a consecutive series of elbow radiographs of children presenting to our hospital's Emergency Department (ED), outpatient orthopedic clinic, or inpatient ward for evaluation of elbow pain over a 2-month period from January 1, 2015 to February 28, 2015 was performed. Synapse (Fujifilm Medical Systems U.S.A., Inc., Stamford, CT) picture archiving and communication system was accessed to view radiographs. Demographic information and data were collected and included age, sex, mechanism of injury, location in which the radiograph was obtained (ED, clinic, hospital-ward), presence or absence of fracture, whether the radiograph was obtained with the elbow immobilized in a splint or cast, and the identity of the radiology technician. The radiology technicians were then divided into three groups (frequent, occasional, and infrequent) based on how often they obtained elbow radiographs at our institution. If, during the study period, the technician of record obtained 20 or more of the radiographs evaluated, they were classified as frequent, 5–20 as occasional, and < 5 as infrequent.

By way of a thorough literature review and through personal observation, multiple key parameters were identified, to be analyzed for the evaluation of the radiographs. The parameters utilized to evaluate the quality of the radiograph are as follows: the appearance of the ulnohumeral joint, radial head, and coronoid overlap, and elbow position in abduction, adduction, flexion, extension, and rotation. Aspects evaluated specifically on the lateral projection are: the hourglass shape (formed by the olecranon and coronoid fossa), its position and quality, the supracondylar ridge overlap, and ratio of the width of the distal humeral metaphysis and diaphysis, which we termed the LDHMD ratio (13–16).

These parameters were then utilized to eventually define the terms optimal, adequate, and suboptimal, which we utilized to subjectively classify the radiographs reviewed. The absence of any malposition and normalcy of the parameters analyzed led to the definition of an optimal radiograph, which, when evaluating the lateral projection, we consider synonymous to the term "true" lateral elbow radiograph. Any deviation in one of the parameters analyzed was deemed an adequate radiograph. Deviation of more than one of the parameters or gross deviation of one was deemed sub-optimal.

The hourglass was further analyzed on optimal lateral radiographs without fracture using Microsoft software (Microsoft Corporation, Redmond, WA). We fit the distal humerus to a drawn box to obtain a consistent position and size of the humerus. The hourglass was then traced on all images. The images were then directly overlapped to give an idea of what the hourglass looks like from a series of optimal and suboptimal radiographs. The center of all the hourglasses were then lined up to evaluate the shape of the hourglass. The box was then divided into thirds to determine which third of the humerus the hourglass was found in both optimal and suboptimal radiographs (Figures 2 and 3).

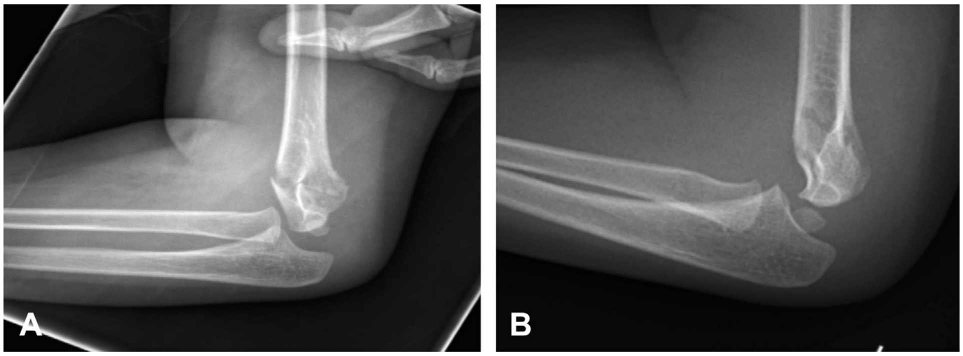

Figure 1. (A) Lateral elbow radiograph taken in an emergency department and found to have a supracondylar humerus fracture. Based on this radiograph, the anterior humeral line does not intersect the capitellum, indicating that the distal fragment is extended, consistent with a Gartland II and may appear to be an operative fracture. However, this was recognized as a poor elbow radiograph and (B) a repeat image was obtained. In this image the anterior humeral line intersects the middle to anterior third of the capitellum, and shows minimal extension of the distal fragment, consistent with a Gartland I. The repeat image made the decision-making process much clearer and the patient was treated nonoperatively and went on to heal without event (2–12).

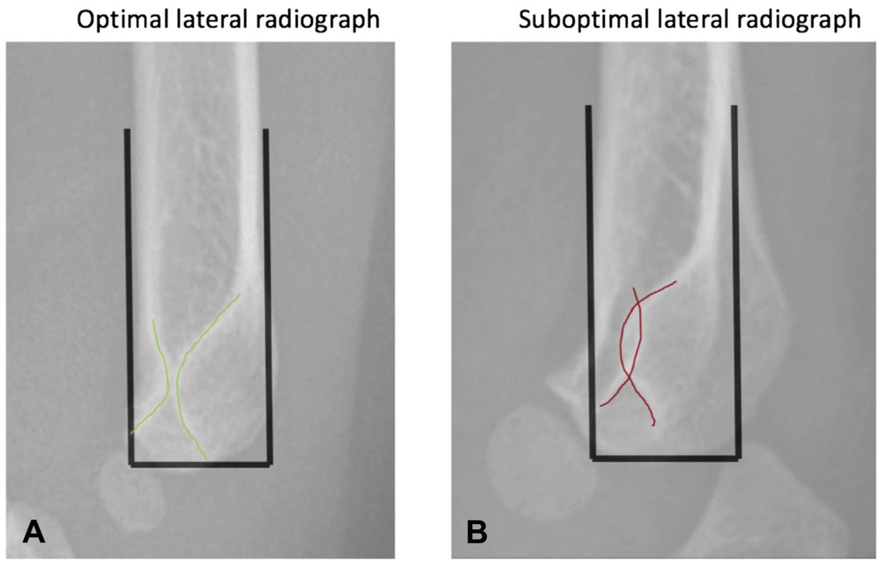

Figure 2. Examples of the hour glass tracings in (A) optimal and (B) suboptimal lateral radiographs. The humeral diaphysis was fit to the tracing of a box to standardize the size of each elbow radiograph. Then the cortex of the coronoid fossa and olecranon fossae were traced. This was done for all optimal and suboptimal lateral radiographs without fracture. The shape and position of the hour glass of the two groups were then evaluated.

RESULTS

A total of 286 consecutive elbow radiographs were taken of children after injury at our hospital over the 2-month period. For the anteroposterior (AP) images, 231/286 (81%) were found to be optimal, 51/286 (18%) adequate, and 4/286 (1%) suboptimal. In contrast, only 70/286 (24%) of the lateral images were deemed optimal, 179/286 (63%) adequate, and 37/286 (13%) suboptimal, therefore making the lateral radiographs the focus of our investigation. Demographic information for the cohort is summarized in Table 1.

When assessing location where the radiographs were obtained, ED (n = 144) vs. clinic (n = 135) vs. hospital's inpatient ward (n = 7), there were significantly more suboptimal AP radiographs in the ED ($p = 0.038$) and no difference in quality of lateral radiograph based on location ($p = 0.921$; Table 2).

When immobilization (i.e., splint or cast) was present, we found that the quality of the AP (n = 28) radiographs was significantly worse ($p = 0.003$). The quality of the lateral radiographs (n = 28) did not change with the presence of immobilization ($p = 0.92$). When a fracture (n = 164) was present, there was no significant difference in the quality of radiograph when compared with the non-fracture group (n = 123) in AP ($p = 0.89$) and lateral ($p = 0.21$) projections.

Suboptimal lateral radiographs were more prevalent among older children, with the mean ages for suboptimal radiographs being 8.8 years, 7.6 years for adequate, and optimal 4.2 years ($p \leq 0.001$). There was no difference in the quality of AP radiographs based on age ($p = 0.482$).

There was no variation of radiograph quality when technicians of varying experience levels were compared, whether considering the AP ($p = 0.12$) or lateral ($p = 0.33$).

Images were repeated a total of six times in this series. Two were repeated after immobilization was removed, and the other four were repeated due to the initial suboptimal image. Three of these were poor lateral images, and the other was an oblique image.

Of the radiographic parameters utilized in defining an optimal, adequate, and suboptimal radiograph, the LDHMD ratio and the presence and quality of the hourglass were identified to be the most useful when assessing the lateral projection.

The LDHMD ratio on the lateral radiograph was defined as the width of the metaphysis from the top of the olecranon fossa compared with the width of the diaphysis 1 cm proximal. We compared the all-optimal lateral radiographs without fracture from our series (n = 21) to all suboptimal lateral radiographs without fracture that were malrotated (n = 11). We found that the average LDHMD ratio on an optimal lateral radiograph is 0.96, and the ratio on suboptimal lateral radiographs is 0.84 ($p \leq 0.001$; Table 3, Figure 4).

When evaluating the hourglass on lateral elbow radiographs, we found that in optimal radiographs without fracture (n = 21), the shape formed by the olecranon and coronoid fossae should be formed in such a way to allow a few grains of sand to pass at a time if it as in an

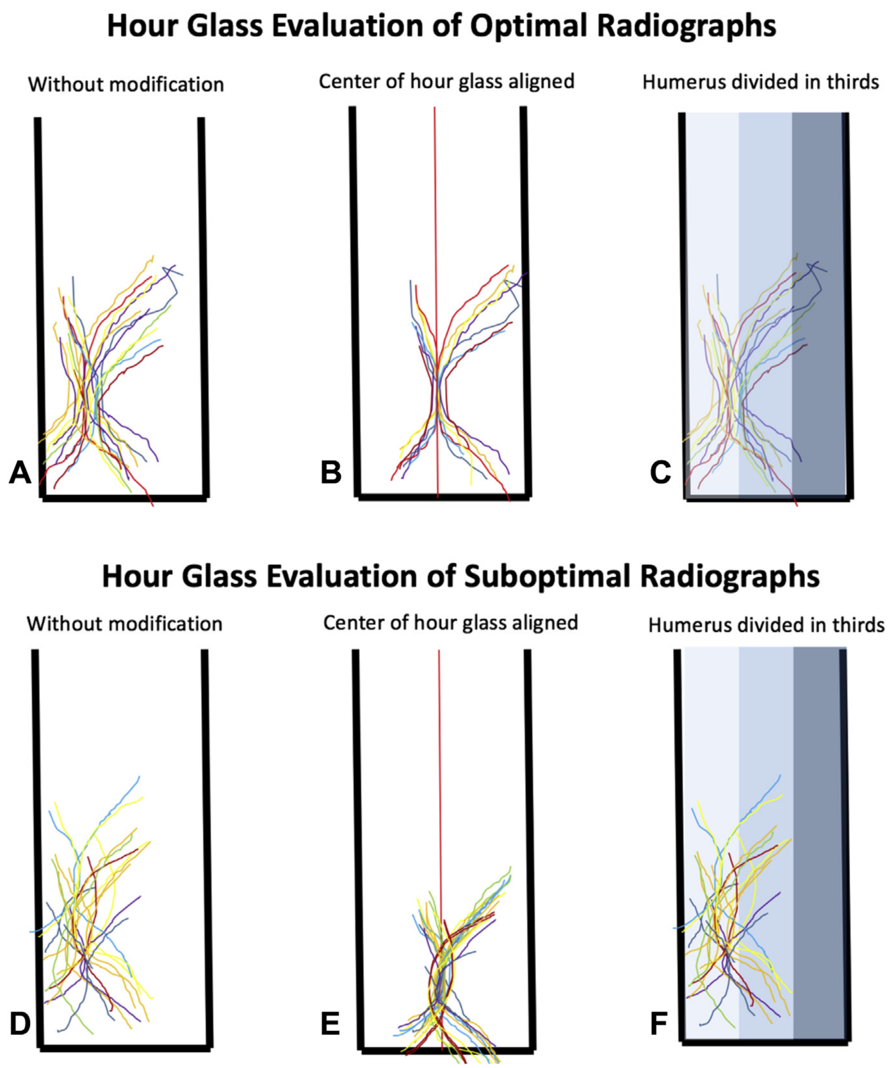

Figure 3. The figure demonstrates the hourglass evaluation of all the nonfracture optimal and suboptimal lateral radiographs. All elbows were fit to the black box and the hour glass was outlined in different colors. The compilation of these can be seen in (A). In (B), the center of all the hourglass shapes was then lined up in the center. This image demonstrates that the hourglass off all the optimal radiographs has a consistent shape. The olecranon fossa and coronoid fossa come together to form a thin wall of bone. This appears on radiographs like an hourglass that would allow a few grains of sand to pass at a time. (C) The black box that was aligned with the humerus is divided into thirds. Here it is seen that the hourglass is found within the anterior third of the humerus. This is a radiographic representation of a larger olecranon fossa and smaller coronoid fossa. Images (D–F) show the same evaluation of the suboptimal lateral radiographs.

Table 1. Demographics

Number of radiographs	286
Average age, years	6.9 (1–17)
Male	149
Female	137
Number with fracture	164
Number without fracture	122
Immobilization	28
Without immobilization	258
Emergency department	144
Clinic	135
Inpatient ward	7

actual hourglass. The hourglass was located within the anterior third of the humerus in this group. In the suboptimal group without fracture, the hourglass shape is not present or will cross over (Figure 3).

DISCUSSION

The lateral radiograph of an injured child's elbow is often the key radiograph utilized by the treating physician to determine the appropriate type of definitive treatment indicated. It has been our experience that

Table 2. Quality of Elbow Radiographs

	Optimal (%)	Adequate (%)	Suboptimal (%)	*p*-Value
Total AP (n = 286)	231/81.3	17.3	1.4	0.046
Total lateral (n = 286)	24.6	62.8	12.6	
Fracture AP (n = 30)	79.8	18.4	1.8	0.894
No fracture AP (n = 19)	83.3	15.8	0.8	
Fracture lateral (n = 100)	28.8	61.3	9.8	0.206
No fracture lateral (n = 78)	19	64.5	16.5	
Emergency department AP	82.4	15.5	2.1	**0.038**
Clinic AP	80.7	19.3	0	
Emergency department lateral	25.9	60.8	13.3	0.921
Clinic lateral	23	64.4	12.6	
Immobilization AP	57.1	35.7	7.1	**0.003**
No immobilization AP	83.9	15.3	0.8	
Immobilization lateral	28.6	60.7	10.7	0.924
No immobilization lateral	24.2	62.9	12.9	
Experienced radiograph tech AP	78.6	20.7	0.7	0.119
Moderate radiograph tech AP	82.7	16	1.2	
Inexperienced radiograph tech AP	87.2	7.7	5.1	
Experienced radiograph tech lateral	22	63.8	14.2	0.332
Moderate radiograph tech lateral	25.9	67.9	6.2	
Inexperienced radiograph tech lateral	23.1	59	17.9	
Average age AP	7	6.3	6.2	0.482
Average age lateral	4.2	7.91	8.8	**< 0.001**

AP = anteroposterior.
Bolded values are statistically significant.

there is often a variability in the appearance of this x-ray study.

There are several variables that negatively affect obtaining radiographs of the injured child's elbow. Thus, multiple factors such as whether the child has pain or anxiety, the presence or absence of overlying splint or cast material, and the position the limb is placed in when imaged can all lead to varied results regarding image quality.

Factors that significantly affected the quality of the radiographs included the AP view in the presence of immobilization. This can be understood by the fact that the arm cannot be fully extended for the radiograph. Similarly, the quality of the AP radiographs taken in the ED was affected. This is thought to be caused by taking the AP radiograph while the arm is in a flexed position. Many of the patients have been transferred in from outside facilities with some form of immobilization or have difficulty extending a painful elbow.

Older patients were also found to have significantly higher rates of suboptimal lateral radiographs. One reason may be that the very young patients have little to no ability to follow instructions and hold their arm in appropriate position for a radiograph. This requires a second person to hold the arm in a good position during the radiograph. Whereas the older pediatric patients can follow instructions, and are trusted to hold their arm in position. However, they are still young and likely to move their arm out of position more than the younger pediatric patients whose arms are held in position.

In addition, pediatric elbow radiographs are especially difficult to interpret due to the multiple ossification centers found within the elbow. Descriptions within the literature describing the features of an ideal elbow radiograph are often based on adult elbow osteology and typically describe the relationship of the mature ossification centers. Depending on the child's age, these ossification centers can be at various stages of appearance, ossification, and fusion (10). This inherent dynamic nature of the pediatric elbow makes it difficult to describe the features of an ideal pediatric elbow radiograph.

Previous studies have highlighted some of the aspects present in pediatric lateral elbow radiographs, as well as maturation time for secondary ossification centers (9,10,13,16). Yet, even with awareness of those radiographic parameters, defining a true lateral elbow radiograph is still challenging. The majority of information regarding radiograph quality and the definition of a "true" image seems to be in texts, passed down verbally, and not a lot is written on the topic in the current

Table 3. Metaphyseal Diaphyseal Ratio

	Optimal Lateral Radiographs (n = 21)	Suboptimal Lateral Radiographs (n = 11)	*p*-Value
Ratio	0.96	0.84	< 0.001

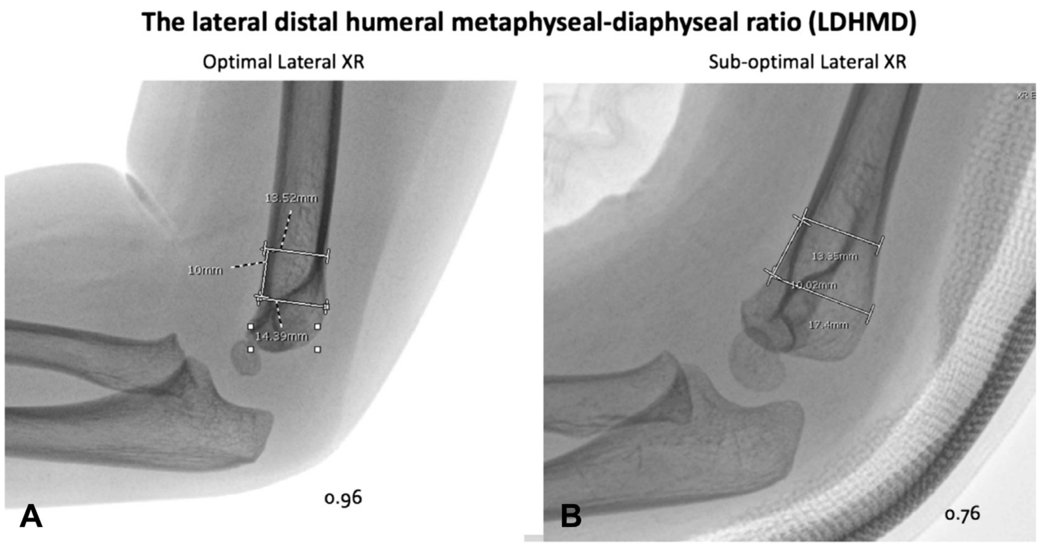

Figure 4. The lateral distal humeral metaphyseal-diaphyseal ratio (LDHMD) is measured by measuring the width of the metaphysis at the top of the hourglass and measuring the width of the diaphysis 1 cm above the metaphyseal measurement. (A) Measurement of LDHMD ratio on an optimal lateral radiograph is close to 1; in this example the LDHMD is 0.96. (B) This image demonstrates the LDHMD on a suboptimal radiograph. As the humerus is rotated in either internal or external rotation, the coronal width of the metaphysis becomes more on profile and appears wider on the lateral radiograph. The LDHMD in (B) measures 0.76, demonstrating a large difference in the width of the metaphysis and diaphysis, showing that this is a suboptimal radiograph. The exact measurement of the LDHMD is not as important as understanding the fact that on an optimal lateral radiograph, the metaphysis and diaphysis should be a similar width. If this is not the case, the position of the elbow should be re-positioned.

literature, hence, our initial interest in the project. There is a paucity of literature on the quality of elbow radiographs in children. Skibo and Reed, in their review of 74 radiographs, arrived at a similar conclusion, that the metaphysis is a consistent structure and important to examine when evaluating radiographs of the child's elbow (15). They state that there should be overlap of the supracondylar ridges to determine the quality of a pediatric lateral radiograph. In contrast, we reviewed 286 radiographs, and to our knowledge, our study is one of the larger studies investigating the subject.

We too noticed that the most consistent radiographic aspect of the elbow throughout growth is the distal humeral metaphysis, as has been noted by Skibo and Reed (15). Thus, to overcome the issues with describing the features of a true pediatric lateral radiograph along with the constantly changing epiphyseal structures occurring during skeletal maturation, we set out to evaluate the commonly described hourglass structure and the width of the metaphysis compared with the diaphysis (17).

The parameters that we concluded may lead to improved recognition of the diagnostic utility of elbow radiographs in the injured child are the appearance of the hourglass sign in the anterior third of the distal humerus and an LDHMD ratio that is at least 0.96.

To be able to first recognize a suboptimal radiograph, and then correct it to obtain a better subsequent image, first requires an understanding of what is wrong. With this understanding a correction can be made, limiting the attempts for a repeat image to obtain an image that can be accurately interpreted. By evaluating a lateral pediatric elbow radiograph, we have developed a simple set of steps to correct the image. Ideal parameters to define a true lateral elbow radiograph in a pediatric patient are as follows: a concentric ulnohumeral joint, elbow positioned at 90 degrees of flexion, forearm supinated, radius pointing to capitellum, radial head and coronoid overlap, the hourglass is in the anterior third of the humeral shaft with its edges not touching or crossing over each other, overlap of the supracondylar ridge, and a constant width of the humerus through the diaphysis and metaphysis, with a lateral distal humeral metaphyseal:diaphyseal ratio of 0.96–1.0 (Table 4, Figure 5). Following these parameters can not only help with radiographs, but with fluoroscopy in the operating room when judging reduction and hardware position.

Table 4. Points of a True Pediatric Lateral Elbow Radiograph

1. Concentric ulnohumeral joint
2. Elbow at 90 degrees of flexion
3. Forearm supinated
4. Radius pointing to the capitellum
5. Radial head and coronoid overlap
6. Hourglass does not overlap and is within the anterior third of the humerus
7. Supracondylar ridges overlap
8. Metaphyseal:diaphyseal ratio is close to 1

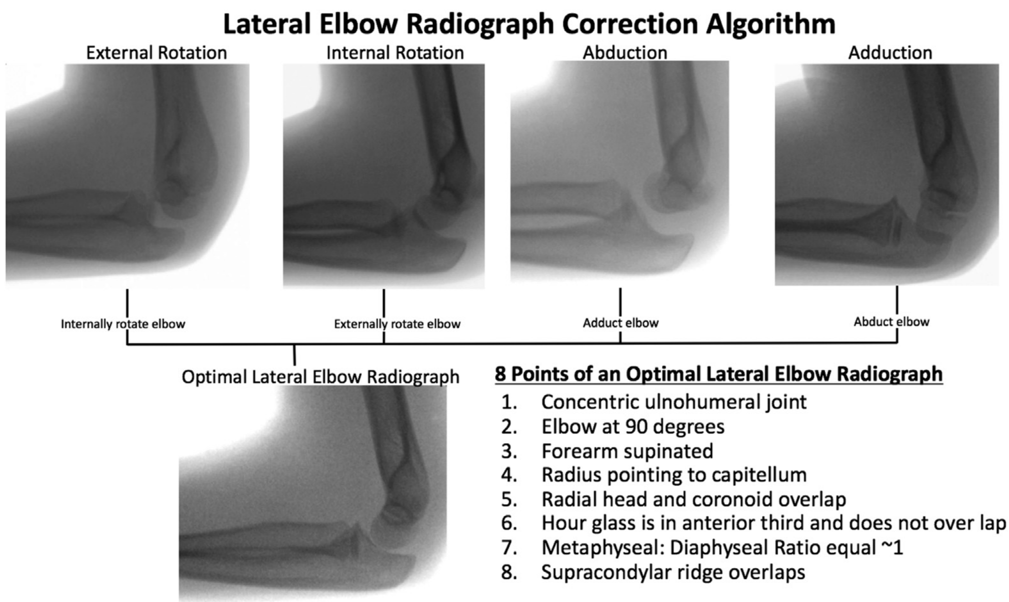

Figure 5. When an elbow radiograph is internally or externally rotated, the metaphyseal:diaphyseal ratio decreases, or the metaphysis becomes wider than the diaphysis. This is easily recognizable, and by rotating the arm, the image can be corrected. Specifically, when an elbow is externally rotated the large smoothly curved lateral epicondyle comes into profile. When this is the case the arm should be slightly internally rotated to correct the image. When the elbow is internally rotated, the medial epicondyle comes into profile. When this is seen, the elbow should be externally rotated to correct the image. When the elbow is overly abducted to adducted, the congruency of the joint will be lost. Interpreting an overly abducted or adducted image can be difficult. An easy way to correct this is to adjust the position of the arm so that the beam of the x-ray study is close to perpendicular to the carrying angle of the elbow. More specifically, when the elbow is overly abducted, the capitellum, the first ossification center of the elbow that is usually visible, appears to move away from the joint, creating a false sense of joint space widening; when this is the case the elbow should be adducted. Conversely, when the elbow is overly adducted, the capitellum appears to move closer to the joint, creating a false sense that the joint space has narrowed. When this is the case the elbow should be abducted to correct the image.

Our study is not without limitation. Some of the limitations of our study include its retrospective nature and small sample sizes, as well as the subjectivity for some of the parameters used in defining and classifying the radiographs in this series. Other common radiographic findings described in relation to pediatric elbow radiographs such as: the anterior humeral line, fat pads, and radiocapitellar alignment were not measured in this investigation, as these parameters are used to identify a fracture or dislocation and not to assess the quality of a radiograph.

In our cohort, the lateral elbow radiograph was deemed suboptimal in 13% of cases, whereas AP elbow radiographs were nearly always optimal. By understanding what an optimal elbow radiograph is and how to correct a poor radiograph, the work-up/evaluation of an injured child's elbow can be improved.

Further larger multicenter cohort studies are needed to validate our terms, definitions, and findings, as well as a quality-improvement initiative at our institution aimed to reduce the number of suboptimal radiographs.

Limitations

A limitation of the study is the initial determination of radiographs being either optimal, adequate, or suboptimal being subjective. This was determined by the authors. This rating was based on current available knowledge of pediatric elbow radiographs and was used as a tool to analyze how often optimal and suboptimal radiographs were obtained. This may affect the rate of optimal, adequate, and suboptimal radiographs. However, we feel that the exact rate is not as important as understanding the dramatic difference in the quality of AP and lateral radiographs. This does not affect the points we have described, to enable nonradiologists to use simple rules and principles to determine when a true pediatric lateral elbow radiograph has been obtained.

CONCLUSION

Radiographic imaging is essential in assessing the severity and determining the appropriate treatment of pediatric elbow injuries. The lateral elbow radiograph is the key view to determine treatment. It is also the most difficult view to obtain. Understanding the different points of a true lateral elbow radiograph, including an LDHMD ratio that is approximately 1 and an hourglass sign appearing in the anterior third of the distal humerus, are criteria for determining a true pediatric lateral radiograph. With the understanding of the LDHMD ratio and other points regarding the quality of an elbow radiograph, any professional should be able to quickly assess the quality of the radiograph. This can be done without making the measurement or calculation of the LDHMD. With increased awareness, this will lead to improved diagnostic utility of radiographs when assessing the injured child's elbow and determining management.

REFERENCES

1. Zaitsev M, Maclaren J, Herbst M. Motion artifacts in MRI: a complex problem with many partial solutions. J Magn Reson Imaging 2015;42:887–901.
2. Mulpuri K, Hosalkar H, Howard A. AAOS clinical practice guideline: the treatment of pediatric supracondylar humerus fractures. J Am Acad Orthop Surg 2012;20:328–30.
3. Ballal MS, Garg NK, Bass A, Bruce CE. Comparison between collar and cuffs and above elbow back slabs in the initial treatment of Gartland type I supracondylar humerus fractures. J Pediatr Orthop B 2008;17:57–60.
4. Oakley E, Barnett P, Babl FE. Backslab versus nonbackslab for immobilization of undisplaced supracondylar fractures: a randomized trial. Pediatr Emerg Care 2009;25:452–6.
5. Pandey S, Shrestha D, Gorg M, Singh GK, Singh MP. Treatment of supracondylar fracture of the humerus (type IIB and III) in children: a prospective randomized controlled trial comparing two methods. Kathmandu Univ Med J (KUMJ) 2008;6:310–8.
6. Kaewpornsawan K. Comparison between closed reduction with percutaneous pinning and open reduction with pinning in children with closed totally displaced supracondylar humeral fractures: a randomized controlled trial. J Pediatr Orthop B 2001;10:131–7.
7. France J, Strong M. Deformity and function in supracondylar fractures of the humerus in children variously treated by closed reduction and splinting, traction, and percutaneous pinning. J Pediatr Orthop 1992;12:494–8.
8. Pirone AM, Graham HK, Krajbich JI. Management of displaced extension-type supracondylar fractures of the humerus in children. J Bone Joint Surg Am 1988;70:641–50.
9. Herman MJ, Boardman MJ, Hoover JR, Chafetz RS. Relationship of the anterior humeral line to the capitellar ossific nucleus: variability with age. J Bone Joint Surg Am 2009;91:2188–93.
10. Skaggs DL, Flynn JM. Supracondylar fractures of the distal humerus. In: Skaggs DL, Flynn JM, eds. Rockwood and Wilkins' fractures in children. 8th edn. Philadelphia: Lippincott Williams and Wilkins; 2015.
11. Skaggs D, Pershad J. Pediatric elbow trauma. Pediatr Emerg Care 1997;13:425–34.
12. Omid R, Choi PD, Skaggs DL. Supracondylar humeral fractures in children. J Bone Joint Surg Am 2008;90:1121–32.
13. Crosby NE, Greenberg JA. Radiographic evaluation of the elbow. J Hand Surg 2014;39:1408–14.
14. Frank ED. Merrill's atlas of radiographic positioning and procedures, 1. St. Louis, MO: Mosby; 2001.
15. Skibo L, Reed MH. A criterion for a true lateral radiograph of the elbow in children. Can Assoc Radiol J 1994;45:287–91.
16. Iyer RS, Thapa MM, Khanna PC, Chew FS. Pediatric bone imaging: imaging elbow trauma in children–a review of acute and chronic injuries. AJR Am J Roentgenol 2012;198:1053–68.
17. DeFroda SF, Hansen H, Gil JA, Hawari AH, Cruz AI Jr. Radiographic evaluation of common pediatric elbow injuries. Orthop Rev (Pavia) 2017;9:7030.

ARTICLE SUMMARY

1. Why is this important?

True lateral elbow radiographs can be difficult to obtain, specifically in a pediatric population. This is due, in part, to the changing and maturing ossification centers of the elbow. Evaluation and determination for surgery often depend on a radiographic series of the elbow. Although there have been previous radiographic parameters noted in the literature, they do not always yield optimal lateral radiographs. These parameters involve the relationship of the epiphyseal structures of the elbow, which are often not present or fully developed in the pediatric patient. By examining optimal radiographs for a metaphyseal-diaphyseal ratio, we found that a ratio close to 1 provides a more accurate determination of a true lateral elbow image, which will prevent excessive surgical treatment in patients for which it may not actually be required.

2. What does this study attempt to show?

At our institution, there was a disproportionate number of suboptimal lateral radiographs when compared with anteroposterior. Because this view of the elbow is integral in the determination for surgical treatment, it is imperative that the lateral radiograph be optimal to have diagnostic utility. By assessing the metaphyseal-diaphyseal ratio and presence and quality of the hourglass sign, we found that a ratio approximating 1 and a clear hourglass sign in the anterior one-third of the distal humerus were the most indicative of a true lateral radiograph.

3. What are the key findings?

The prevalence of a suboptimal lateral radiograph of an injured child's elbow at our institution was 13%. The variables that were most associated with a suboptimal image were presence of immobilization and acuity/location for anteroposterior images. Suboptimal images were seen more commonly in lateral radiographs, with a lateral distal humeral metaphyseal-diaphyseal ratio of < 0.96.

4. How is patient care impacted?

By understanding what an optimal elbow radiograph is and how to correct a poor radiograph by looking at such factors as joint congruency to evaluate if the elbow is overly abducted or adducted and the lateral distal humeral metaphyseal-diaphyseal ratio of 0.96 to evaluate if the elbow is overly rotated, these can aid in obtaining optimal elbow radiographs for interpretation improving diagnostic accuracy, decreasing the need for repeat imaging, and limiting radiation exposure in children.