Easily Missed Fractures of the Upper Extremity

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KEYWORDS

• Fracture • Upper extremity • Missed diagnosis • Diagnostic error

KEY POINTS

- Radiographs remain the mainstay for fracture assessment; their assessment remains challenging.
- Error rates can decrease by review of missed fractures.
- Three categories of challenging injuries are reviewed: common but challenging; out of mind, out of sight; and satisfaction of search.

INTRODUCTION

Interpretation of radiographs may not have the glamour of newer, high-tech imaging techniques, but remains the staple in the evaluation for acute orthopedic injury. It is difficult: experimental studies spanning a half century have consistently documented a roughly 30% error rate in radiographic interpretation.[1] "Misses" may result in a delay in diagnosis, increased patient pain and suffering, and delay in appropriate therapy.[2] Detriment may not be limited to the patient; in addition to emotional angst, disbelief, and self-doubt, radiologists may be faced with a claim of malpractice. In a recent review of closed malpractice claims in the United States, radiology was the sixth most frequent specialty despite making up less than 5% of United States physicians.[3] Nearly 3 out of 4 claims against diagnostic radiologists cite errors in interpretation resulting in missed diagnoses.[1] A 2013 study found that claims against radiologists related to an error in diagnosis outpaced the next most common cause by nearly 10-fold.[3]

Interpretation errors in radiology can broadly be classified into 2 categories: cognitive and perceptual. Cognitive errors might be owing to a lack of knowledge or mistaken judgment, for example, and are the minority. Perceptual errors, in which an abnormality is simply not seen, account for up to 80% of radiologic errors.[4] Perceptual errors in the identification of fractures are related to many factors, including not just the subtlety of the finding,[2,5] but the amount of clinical information available,[1] technical factors such as the quality of the images and the views obtained,[1] and poorly understood factors seemingly inherent to "human nature."[5]

Given that diagnostic errors in skeletal radiology, along with mammography, are the leading causes of claims against radiologists,[1,3] it is unsurprising that missed fractures are a particular problem in emergency and trauma care. A recent Canadian study showed that fractures accounted for 70% of missed injuries in a level 1 trauma center.[6] Another study has shown emergency physicians' radiographic interpretations for fracture had an 8% false-negative rate.[7] Missed fractures also were the most common discrepancy upon staff review of radiology resident interpretations for the emergency department, accounting for 62.5% in a recent study.[8] This is in keeping with other studies, which have shown that 70% of missed fractures are identifiable in retrospect.[2] In addition, radiologists may change their own interpretations up to 20% of the time.[9] These observations suggest that there may be ways to improve performance, and a recent study has shown just that: Itri and colleagues[10] were able to decrease

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resident misinterpretation of musculoskeletal emergency films at the Hospital of the University of Pennsylvania after giving a series of upper and lower extremity focused missed case conferences. In 1 year, resident misinterpretations of shoulder and elbow injuries decreased by 80%.[10]

We prefer to think of this as cognitive training to minimize perceptual error: it is easier to see what you know to look for, and easy to miss what you do not. Knowledge of what is missed is paramount, because it allows the generalization of what one learns from his own errors to others. Thankfully, there is a wealth of quality information available on missed fractures in the emergency department, whether by emergency physicians, radiology residents, or staff radiologists. With respect to the subject at hand, upper extremity fractures consistently have accounted for just under one-half (43%–48%) of all missed fractures independent of the group of readers investigated.[2,7,8] A closer look at these studies provides a road map both for what to look for when interpreting films and for this review, with the goal of minimizing errors.

The Wei and colleagues[2] study included more than 3000 extremity fractures. One hundred fifteen missed fractures were identified for an overall missed fracture rate of 3.7%, in keeping with other reports.[4] Subtlety (37%) and imperceptibility (33%) were by far the most common reasons. Less common reasons were obscuring devices and artifacts, multiplicity, osteoporosis, lack of clinical information, and poor technique. It is noteworthy that 5% of the misses were later diagnosed using specialized views, underscoring the importance of knowing how to supplement or tailor the radiographic study to the question at hand. The rate of missed extremity fractures was similar between the upper and lower extremity. Nearly one-third (30.4%) of all missed extremity fractures were in the hand and wrist, and these sites accounted for nearly 2 out of 3 (65%) of missed upper extremity fractures. Per anatomic site, however, fractures were most likely to be missed in the following order: elbow (6.0%) more often than hand (5.4%) more often than wrist (4.1%) more often than shoulder (1.9%).

Of upper extremity fractures missed even on retrospective review, the distal radius was the most common site. Including missed proximal radius fractures at the elbow, the radius alone accounted for one-third of missed diagnoses. Other retrospectively missed upper extremity fracture sites included the clavicle, humeral head, distal humerus, olecranon, scaphoid, hamate, trapezium, ulnar styloid, and phalanges.

Similar results were reported by Kung and colleagues.[8] Fractures were missed by radiology residents in the upper extremity in 1.6% of patients, slightly more than in the lower extremity. The radius as a whole accounted for one-half (50%) of these, split between the head and distally. Sixty-four percent were in the hand and wrist, with other sites of misses including the clavicle, humerus, triquetrum, metacarpals, and phalanges. Misinterpretation of hand and wrist films for fracture was also the leading cause of misdiagnosis in a study of emergency physician interpretations.[7]

In addition to this foreknowledge of the injuries likely to be missed on radiographs, optimizing clinical information, radiographic technique, and views are all important to improving diagnostic performance. In each, the radiology technologist can play a valuable role. With adequate clinical history and high-quality images, attention can be directed to the basics of fracture evaluation at the appropriate sites: cortical disruption, buckling, or crimping; lucent fracture lines; sclerotic fracture lines (overlap, impaction, or intramedullary callus); and double densities owing to overlap by displaced fragments. Careful attention to soft tissue findings such as swelling, laceration, or effusion can direct attention to the injured area.

Our review of easily missed upper extremity fractures in adults emphasizes the following 3 categories of pitfalls, with particular attention to their epidemiology, imaging findings, and optimal radiographic evaluation:

- "Common but challenging": we know to look for it but the findings may be subtle
- "Out of mind, out of sight": the uncommon injuries that are beyond the normal search pattern and hence, "out of mind"
- "Satisfaction of search": the less common or more diagnostically challenging injuries that occur in association with more obvious ones.

COMMON BUT CHALLENGING

Isolated Fracture of the Greater Tuberosity of the Humerus

Almost one-half of all humeral fractures involve the proximal humerus, with isolated greater tuberosity fractures comprising about 20% of all proximal humeral fractures (**Fig. 1**).[11,12] Unlike other proximal humerus fractures, which generally affect older populations with medical comorbidities, isolated greater tuberosity fractures tend to affect younger, healthier patients. In a reported series of 610 proximal humeral fractures, Kim and colleagues[13] compared demographics of patients with isolated greater tuberosity fractures with all other proximal humerus fractures, and showed that mean age