[Imaging]

Sideline Coverage: When to Get Radiographs? A Review of Clinical Decision Tools

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Context: Sidelines coverage presents unique challenges in the evaluation of injured athletes. Health care providers may be confronted with the question of when to obtain radiographs following an injury. Given that most sidelines coverage occurs outside the elite level, radiographs are not readily available at the time of injury, and the decision of when to send a player for radiographs must be made based on physical examination. Clinical tools have been developed to aid in identifying injuries that are likely to result in radiographically important fractures or dislocations.

Evidence Acquisition: A search for the keywords *x-ray* and *decision rule* along with the anatomic locations *shoulder, elbow, wrist, knee*, and *ankle* was performed using the PubMed database. No limits were set regarding year of publication. We selected meta-analyses, randomized controlled trials, and survey results. Our selection focused on the largest, most well-studied published reports. We also attempted to include studies that reported the application of the rules to the field of sports medicine.

Study Design: Retrospective literature review.

Level of Evidence: Level 4.

Results: The Ottawa Foot and Ankle Rules have been validated and implemented and are appropriate for use in both pediatric and adult populations. The Ottawa Knee Rules have been widely studied, validated, and accepted for evaluation of knee injuries. There are promising studies of decision rules for clinically important fractures of the wrist, but these studies have not been validated. The elbow has been evaluated with good outcomes via the elbow extension test, which has been validated in both single and multicenter studies. Currently, there are no reliable clinical decision tools for traumatic sports injuries to the shoulder to aid in the decision of when to obtain radiographs.

Conclusion: Clinical decision tools have been developed to aid in the diagnosis and management of injuries commonly sustained during sporting events. Tools that have been appropriately validated in populations outside the initial study population can assist sports medicine physicians in the decision of when to get radiographs from the sidelines.

Keywords: clinical decision tools; sidelines; extremity injury; radiographs

Although it is imperative that fractures be diagnosed to avoid complications associated with treatment delays, overtriaging patients with low suspicion for a fracture is also undesirable and uses unnecessary resources. Radiographs are generally easily obtained in the clinical setting, but many games and practices occur after hours when offices are closed, and patients must be sent to the emergency department for imaging. To avoid the time and expense associated with such visits, it is important to carefully select patients who require imaging based on physical examination. To assist physicians in

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deciding when to obtain radiographs, several clinical decision tools have been developed and validated.

FOOT AND ANKLE

Foot and ankle injuries are the most commonly encountered sports-related extremity injury, accounting for 25% of all athletic-related injuries.[14] Furthermore, injuries to the foot and ankle account for the most frequent causes of lost playing time among athletes.[14]

The Ottawa Foot and Ankle Rules have been developed to help guide the decision to obtain radiographs after ankle or foot injuries. These well-validated guidelines, although developed initially for use in the emergency department, can be applied to sporting event settings. The guidelines have a sensitivity of almost 100% for excluding fractures of the ankle and midfoot.[36]

Foot radiographs should be obtained when (1) the athlete is unable to bear weight immediately after the injury, on the sidelines, and for 4 steps and (2) bone tenderness of the navicular bone or base of the fifth metatarsal is present.

Ankle radiographs are necessary if the patient has 1 or more of the following indications: (1) inability to bear weight immediately after the injury or after a period of rest on the sideline or (2) bone tenderness at the posterior edge or tip of either malleolus.[35] Again, these indications can be modified to add a period of observation followed by an assessment of the ability to ambulate.

The Ottawa Foot and Ankle Rules have been validated in both adult and pediatric populations.[11,12,18] A meta-analysis reported results from 12 studies of midfoot and ankle injuries in the pediatric population.[11] The Ottawa Foot and Ankle Rules had a pooled sensitivity of 98.5% (95% confidence interval, 97.3-99.2) and were a reliable tool to evaluate the need for radiographs in children older than 5 years.[11] The Ottawa Foot and Ankle Rules are the most sensitive guidelines for identifying pediatric fractures.[18] A majority of pediatric emergency medicine physicians have adopted the Ottawa Foot and Ankle Rules in clinical practice to evaluate the need for radiographs.[12]

Emergency department nurses were able to accurately utilize the rules and order radiographs prior to physician evaluation after a brief training period.[9,34] The mnemonic "44-55-66PM" led to improved recall of the Ottawa Foot and Ankle Rules at 5 to 9 months after teaching the rules to resident physicians and medical students on a pediatric emergency rotation.[19] The patient needs radiographs if:

4 Unable to walk 4 steps initially and unable to walk 4 steps in the emergency department

5 Has pain at the base of the 5th metatarsal or pain at the navicular

6PM Tenderness in the 6-cm posterior edge of the lateral malleolus or in the 6-cm posterior edge of the medial malleolus.

However, a high false positive rate was reported when the Ottawa Foot and Ankle Rules were used by physiotherapists in a rehabilitation setting.[24]

Fractures of the foot and ankle occur at a rate of 20% in the emergency department but only 2.4% in outpatient sports medicine centers.[24] Thus, the implication is that the rules may be even more useful in nonemergent settings where fracture rates are lower.

KNEE

Knee injuries account for the second most common cause of lost playing time among sports-related injuries, after ankle injuries.[14]

Clinical decision guidelines for knee radiographs after trauma have been the focus of much research, which has resulted in 2 well-validated clinical decision tools. The Ottawa Knee Rules take into account age, tenderness, and function. They state that radiographs are necessary with knee injuries under any of the following conditions: (1) age 55 years or older, (2) tenderness at the head of the fibula, (3) isolated tenderness of the patella, (4) inability to flex to 90°, and (5) inability to bear weight for 4 steps both immediately and after a period of observation on the sideline.[37] The validated Ottawa Knee Rules have a sensitivity of 97% for identifying fractures, with a specificity of 27%.[31]

The Ottawa Knee Rules have been shown to be applicable in the field of sports medicine, although they may not be uniformly applied. A study of the Ottawa Knee Rules at a rural mountain clinic treating skiing and snowboarding injuries found a sensitivity of 87.5%.[17]

The Pittsburgh Knee Rules are an alternate set of decision guidelines for obtaining knee radiographs after traumatic knee injury.[3] They recommend radiography when the mechanism of injury is blunt trauma/fall and 1 or more of the following factors are present: (1) age <12 years or >50 years and (2) inability to walk 4 weightbearing steps in the emergency department or after a period of observation on the sideline.[3,31] The validated Pittsburgh Knee Rules have a sensitivity of 99% and a specificity of 60%.[31] It should be noted that children younger than 12 years uniformly required radiographs regardless of physical examination according to the Pittsburgh Knee Rules. The Ottawa Knee Rules in children aged 2 to 16 years had a sensitivity of 100% and a specificity of 48.2%.[4] A comparison study of the 2 knee rules found the Pittsburgh Knee Rules to be more specific than the Ottawa Knee Rules (51% vs 21%), with equal sensitivity (86%). Interobserver agreement was higher for the Pittsburgh Knee Rules (0.71) than the Ottawa Knee Rules (0.51).[7]

WRIST

In a 10-year study of all injuries at the Olympic Training Center, 8.7% involved the wrist and hand.[29] Fractures of the distal radius account for approximately 17% of all diagnosed fractures.[33] Female gender and older age are associated with most of these fractures, but they are still common in the younger athlete population.[33]

Figure 1. Demonstration of the radioulnar drawer test. The distal radius is stabilized while applying an alternating dorsal-volar stress to the distal ulna. The test examines the stability of the distal radioulnar joint.

There are several physical examination findings that are good predictors of wrist fracture in acute wrist trauma patients. Wrist deformity is the most specific finding; however, fracture can occur without deformity.[6] Other physical examination tests that have a high positive predictive value in diagnosing wrist fractures include edema (95.2%), pain on passive motion (94.3%), pain on grip (89.3%), and pain on supination (96%).[6]

In 1 study, all patients with wrist fractures presented with at least 1 of the following: (1) age ≥35 years, (2) edema of the dorsum of the wrist, (3) limited supination or active radial deviation, and (4) pain or instability on the distal radioulnar drawer test[5] (Figure 1). The use of these examination characteristics was 100% sensitive and 37.7% specific to detect patients with wrist fractures on radiography after acute trauma.[5]

Scaphoid fracture is a common sports-related injury in which initial radiographs can be negative in 41% of patients. Early immobilization is usually preferred to avoid sequelae of missed or untreated injuries. Magnetic resonance imaging is of greater diagnostic value in patients with higher probability of fracture.[13] A prospective study of 260 patients was used to develop predictive demographic and clinical risk factors of scaphoid fractures.[13] The probability of fracture was 91% in patients with 4 positive results: (1) anatomic snuff box pain on ulnar deviation of the wrist within 72 hours of injury, (2) scaphoid tubercle tenderness at 2 weeks, (3) sports-related injury, and (4) male sex. Sensitivity was 82% and specificity was 80% with 3 or more positive factors.[13]

In a prospective cohort study of more than 200 pediatric patients with wrist trauma, positive radial tenderness, focal swelling, and abnormal supination/pronation were all predictive of wrist fractures with a high sensitivity (99%) and low specificity (24%). A separate study in which all patients had wrist radiographs found distal radial point tenderness and a 20% decrease in grip strength to be predictive of fractures, with sensitivity of 79% and specificity of 63%.[26,40]

ELBOW

Elbow injuries comprise 1% to 2% of emergency department visits, while only a small percentage of these patients will have fractures on radiography.[1] Acute sports-related elbow injuries can range from soft tissue contusions to complex fracture dislocations, with almost half of elbow dislocations in patients older than 10 years occurring in sports.[38,39] A fall onto the outstretched arm may result in fracture of the radial head or neck, olecranon or coronoid process, supracondylar humerus, and a simple or complex dislocation of the elbow.[27]

The ability to fully extend the elbow, with the patient in a supine position is a diagnostic test that predicts the need for radiographs.[1,23] A positive test is defined as being unable to fully actively extend the elbow in a supine position as compared visually with the uninjured side.[23] A positive test demonstrated a sensitivity ranging between 92% and 96%.[14,23] Patients with a hairline radial head fracture and a negative test resulted in a lower specificity of 48% to 61%.[14,23]

An increase in sensitivity but not the specificity was shown with tenderness over the radial head, olecranon, or medial epicondyle and presence of bruising.[2,8,10]

SHOULDER

Upper extremity injuries, including fractures and shoulder dislocations, are relatively common in sports. A multiyear study of high school athletes found injury rates of 2.15 per 10,000 athlete-exposures. The most common injuries were strains/sprains followed by dislocations/seperations.[30] The most commonly fractured bone overall in the shoulder complex is the clavicle, accounting for 35% of all fractures in the shoulder girdle.[27]

In practice, many shoulder relocations are performed on the sideline without radiographs, and while there are no decision rules that directly address the shoulder as a whole, studies have looked at the need for radiographs before attempting reduction of shoulder dislocations. One study of acute suspected traumatic dislocations found that when physicians were certain of a dislocation by examination (40 of 59 patients), they were correct in all cases. The study also reported no added value to the prereduction radiographs in these cases.[32]

The Quebec Decision Rule was developed in an attempt to determine which patients could safely have radiographs deferred during treatment for shoulder dislocations.[15] They were reported to have a sensitivity of 42% and a specificity of 40%.[15,25] Unfortunately, under the Quebec rules, a traumatic dislocation, such as a sports injury, is a criterion for radiography. Other studies have assessed the need for prereduction

radiographs using physician judgment and mechanism of injury.[20,21] Similar to the Quebec rules, however, blunt injury prompted radiographic evaluation, thus limiting the sideline utility.[22] In the absence of validated decision rules for shoulder radiographs, clinicians should consider radiographs in the presence of localized tenderness to palpation, instability of the shoulder, or neurologic compromise.

There are clinical factors that predict fractures associated with anterior shoulder dislocations. These include (1) age 40 years or older, (2) first time dislocation, and (3) high-energy mechanism of injury (eg, fall greater than 1 flight of stairs, motor vehicle crash, fight, or assault).[16]

Fractures occur in up to 50% of anterior shoulder dislocations in adults; the frequency is much lower in children, with incidences ranging from 3% to 5%.[28] Most pediatric patients with anterior shoulder dislocations can forgo prereduction radiographs to expedite definitive pain relief, lower radiation, and reduce emergency department length of stay and overall costs.[28]

CONCLUSION

There is good evidence that the Ottawa Foot and Ankle Rules and Ottawa Knee Rules can safely be used to guide clinicians in the need for radiology after injury.[11,31,35,37] For elbow injuries, the inability to fully extend the elbow should prompt referral for radiographs.[1,23] Prereduction radiographs are likely unnecessary when experienced clinicians suspect an anterior shoulder dislocation.[28,32] There is some evidence that certain clinical findings may predict upper extremity fractures in injured athletes[5,6,13,16,26,40]; however, decision rules for other injuries about the shoulder and wrist need further study before they can help guide sideline treatment.

Clinical Recommendations

SORT: Strength of Recommendation Taxonomy
A: consistent, good-quality patient-oriented evidence
B: inconsistent or limited-quality patient-oriented evidence
C: consensus, disease-oriented evidence, usual practice, expert opinion, or case series

Clinical Recommendation	SORT Evidence Rating
The Ottawa Foot and Ankle Rules have been validated and implemented and have been shown to be appropriate for use in both pediatric and adult populations.[11,35]	A
The Ottawa Knee Rules have been widely studied, validated, and accepted for evaluation of knee injuries.[31,36]	A
Athletes who are unable to fully extend their elbow after an injury should have radiographs.[1,2,8,23,33]	B

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