Novel Angle Measurements for Assessment of Shoulder Location Using the Scapular Y Radiograph

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Abstract: Shoulder dislocation is an injury with potential long-term consequences that requires prompt diagnosis and treatment. Patient positioning and imperfect radiographic views may result in discomfort, added examination time, and problematic diagnosis. The scapular Y radiograph has been shown to be useful in diagnosing shoulder dislocation but is not considered sufficient in isolation. Using a synthetic bone shoulder model, we propose a novel technique wherein osseous landmarks are used to form angles that significantly improved diagnostic accuracy for shoulder dislocation, even in significantly rotated and otherwise indeterminate scapular Y radiographs.

The glenohumeral joint is the most mobile, but the least stable, joint in the body. It relies solely on static and dynamic soft tissue restraints for stability. This lack of bony constraints makes the shoulder susceptible to instability and dislocation, with nearly 70,000 shoulder dislocations presenting to emergency rooms annually in the United States.

These visits result in innumerable and frequently uninterpretable radiographs generally consisting of anteroposterior (AP), axillary lateral, and scapular Y views. A myriad of special views are useful for identifying specific bony lesions of the humerus or glenoid associated with dislocation. Despite its frequency, radiographic examination of the dislocated shoulder can be problematic. Patient positioning and imperfect radiographic views may result in discomfort, added examination time, and difficulty in diagnosis. Although radiographically derived measurements are common adjuncts in the diagnosis of many other musculoskeletal problems, these are not standard for the shoulder.

Shoulder dislocation has long-term consequences, and prompt accurate diagnosis is paramount. The scapular Y radiograph has been shown to be useful in diagnosing shoulder dislocation but is generally not considered sufficient for the diagnosis in isolation. Using a synthetic bone model, this article describes a novel technique defining shoulder location based on the following bony landmarks (Figure 1A): the center of the acromioclavicular joint (AC), the center of the humeral head (H), the posterolateral corner of the acromion process (A), and the tip of the coracoid process (C). The landmarks form the AC-C-H and AC-A-H angles (Figure 1B). These an-

Figure 1: Bony landmarks on an ideal scapular Y radiograph (A). The AC-C-H angle is yellow and AC-A-H angle is red (B).
gles, when used, significantly improve diagnostic accuracy, even in the setting of otherwise indeterminate radiographs.

MATERIALS AND METHODS
A left synthetic shoulder (#1020-10; Sawbones, Vashon, Washington) was secured in a custom fixation device. The specimen was positioned to obtain an ideal scapular Y radiographic image using an image intensifier (Series9600; OEC Medical Systems, Inc, Salt Lake City, Utah). The specimen was rotated in 10° increments to 30° away from the ideal position in each direction in axial and coronal planes for a total of 47 radiographs. Images were obtained at each position with the shoulder in a located, anteriorly dislocated, inferiorly dislocated, and posteriorly dislocated position.

The radiographs were randomized, numbered, and then reviewed blindly by 2 orthopedic surgeons (S.F.B., D.C.M.) and 1 musculoskeletal-trained radiologist (D.R.L.). The physicians were asked to indicate whether the shoulder was located or dislocated or if they were unable to determine diagnosis. All 3 physicians identified and marked the bony landmarks, and a single orthopedic resident (A.A.M.) took measurements of 2 specific angles (AC-C-H, AC-A-H) using the previously discussed osseous landmarks. The resultant AC-C-H and AC-A-H angles were measured by a single observer (A.A.M.) and recorded for each image. The percentage of correct diagnoses was then compared with and without the use of the angles using Fischer’s exact test with significance set at P<.05.

RESULTS
A range of angle measurements was established for each shoulder position with the benefit of metallic markers (Table). These measurements showed that over the entire range of images, both the AC-C-H and AC-A-H angles were always $\leq 60^\circ$ in the located shoulders, and 1 or both of the angles were $\geq 90^\circ$ in the dislocated shoulders. The AC-C-H angle was $>90^\circ$ in anterior dislocation, while the AC-A-H angle was $>90^\circ$ in posterior dislocation due to the change in position of the humeral head relative to the bony landmarks.

When examining the ideal scapular Y radiographs, the participating physicians correctly diagnosed shoulder location in 100% of cases. However, in each of the imperfect scapular Y radiographs, at least 1 physician’s diagnosis of shoulder location was incorrect or uncertain. Without the use of the angles, the physicians’ average correct diagnosis was 65%. When the angles were used, the average correct diagnosis significantly improved to 91% (P<.001) (Figure 2).

DISCUSSION
The use of the ideal scapular Y radiograph for accurate assessment of location has been noted previously. However, the use of commonly obtained imperfect radiographs has not been addressed. When looking at a perfect scapular Y radiograph of a posteriorly dislocated shoulder, the diagnosis is obvious (Figure 3A). When the shoulder is rotated 30° in the axial plane, bony overlap makes the diagnosis difficult (Figure 3B). Use of the AC-C-H (yellow) and AC-A-H (red) angle technique, however, highlights the constant relative relationship in space of the osseous landmarks, clearly showing that at least 1 angle in a
A dislocated shoulder will be >90°, making the diagnosis of dislocation relatively simple. This relative angle technique shows that the scapular Y radiograph is adequate for diagnosing location in both perfect views and over a range of radiographic orientations, obviating patient discomfort with positioning and the need for multiple radiographs prior to shoulder reduction. Furthermore, this relative angle technique takes unique advantage of the consistent orientation of the humeral head to the bony landmarks of the shoulder girdle for use in diagnosing shoulder location. In addition to differentiating between located and dislocated shoulders, the angle technique also differentiates between anterior and posterior dislocation with the AC-C-H angle >90° for anterior dislocation and the AC-A-H angle >90° for posterior dislocation. Although the AC-A-H angle is also >90° in the inferior dislocation, this typically presents in a clinically unique manner, luxatio erecta, with the arm raised above the head, making it clearly distinguishable from a posterior dislocation.

**CONCLUSION**

While a scapular Y radiograph alone is not sufficient for a complete examination of the dislocated shoulder, a single, comfortably obtained radiograph with a wide range of acceptability to assess location is beneficial. Use of the AC-C-H and AC-A-H relative shoulder angles significantly improves the ability to assess shoulder location, even when examining imperfect scapular Y radiographs.

**REFERENCES**