JSES Reviews, Reports, and Techniques 4 (2024) 536–539

Contents lists available at ScienceDirect

JSES Reviews, Reports, and Techniques

journal homepage: www.jsesreviewsreportstech.org

Posterior shoulder dislocation with acromion fracture: a case that illustrates a possible mechanism of posterior shoulder instability

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ARTICLE INFO

Keywords:
Posterior shoulder dislocation
Posterior shoulder instability
Scapular setting
Scapula positioning
Acromion fracture
Shoulder biomechanics
Workout

Posterior shoulder dislocation is rare and most often due to a fall onto the outstretched arm or a forceful contraction of the shoulder muscles during an electric shock or a seizure. Posterior shoulder instability, on the other hand, is much more common and even endemic in the military population.[1] It is characterized by transient but restorable loss of joint congruency.[6] The exact biomechanical mechanism of posterior shoulder instability is not well understood.[2] It has been related to a single traumatic event or repetitive microtrauma.[1,6] Sometimes it is also associated with glenoid dysplasia, increased glenoid retroversion,[3,8,21] a higher situated and more horizontally oriented acromion,[13] or a pathologic muscle activation pattern.[9,10,15] We report the case of a gentleman who sustained a posterior shoulder dislocation with a fracture of the acromion during dumbbell flys on a flat bench. Although this was a traumatic dislocation, it provides a possible biomechanical explanation for the much more common atraumatic posterior shoulder instability. The patient was informed that data concerning his case would be submitted for publication, and he provided written consent. Institutional review board approval was not required for this case report.

Case report

Patient history

A 26-year-old right-handed male amateur bodybuilder presented at our emergency department with right shoulder pain that occurred during a muscle workout in a fitness studio. The exercise that led to the injury is called flat dumbbell chest fly and serves to widen the chest and strengthen the pectoralis major muscles. It was performed in a supine position on a small horizontal bench with a dumbbell of 50 kg in each hand. The laterally outstretched arms were several times lifted up into a vertical position and lowered again while maintaining a slight bend in the elbows. After 10 repetitions, with his arms fully elevated, the athlete suddenly felt a rushing pain in his right shoulder. The coach at the head end of the bench took over the loads and the athlete brought his arms to the side. During this movement, the sportsman heard a crackling and felt some kind of snapping. He had the impression that his shoulder was briefly dislocated.

Clinical and imaging findings

Clinical examination showed a strongly built young man with a symmetrical shoulder contour. There was no visible deformity. Range of motion was limited due to pain. Palpation of the acromion was painful. A standard anteroposterior radiograph showed well-centered glenohumeral and acromioclavicular joints. The lateral view revealed a slightly displaced small bony fragment posterior to the acromion (Fig. 1). A supplemental magnetic resonance arthrogram of the shoulder made 3 days after the

Ethical committee approval was not required for this case report.

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https://doi.org/10.1016/j.xrrt.2024.04.007

Figure 1 Lateral X-ray image of the right shoulder showing a well-centered joint and a small broken bone fragment posterior to the acromion.

injury showed that the bone fragment measured 10 mm by 30 mm by 3 mm and originated from the posterior acromion corner. Additionally, a subcutaneous hematoma above the acromion, a hemarthrosis, and a small impression fracture of the humeral head medial to the lesser tuberosity (reversed Hill Sachs lesion type I[14]) were visible (Fig. 2). The rotator cuff and the posterior labrum were intact. Glenoid shape and version were normal. The small anterior humeral head impression fracture confirmed the suspicion of the athlete that he had dislocated his shoulder posteriorly with the arm flexed 90° and reduced it when he brought his arm down.

Treatment strategy and outcome

The broken fragment was small and biomechanically not relevant. We therefore decided against reduction and osteosynthesis. Shoulder stabilization surgery was not considered because the Hill Sachs lesion and re-engaging risk were small and the posterior capsule and labrum were intact. Conservative treatment was therefore chosen with relative rest of the shoulder for 4 weeks. The patient received a sling and was instructed not to perform active extension against resistance during this time. After 7 weeks, he was symptom-free and could move his shoulder normally again. No gap in the posterior deltoid could be palpated and no subacromial impingement could be induced. A lateral X-ray picture of the shoulder showed that the bone fragment was consolidated with a slight downward tilt (Fig. 3). Using a shoulder model, the patient was shown how the scapula must follow the arm during forward flexion so that the humeral head always remains well balanced[17] on the glenoid. Four months after the event, the patient was pain-free, had a normal range of motion, no posterior apprehension, and no impingement sign. The abduction force with the arm extended horizontally was 130 Newtons and the absolute Constant Score was 96 points. From this point, he was allowed to do pushups again. He was instructed one more time not to lock the shoulders in a retracted position when loading his arms in front of the body but to protract them. Three years after the event, the patient was well. He was able to use his shoulder normally in everyday life without discomfort and without subjective instability. For professional and family reasons, he had stopped weight training.

Discussion

The glenohumeral joint is a minimally constrained articulation with an excessive range of motion.[20] Numerous static and dynamic factors ensure stability, including the shape, size, and orientation of the joint surfaces, the labrum, capsule and ligaments, and balanced muscle forces. Another factor which is essential for normal shoulder function and stability, the scapulohumeral rhythm, is rarely mentioned in the literature. The purpose of our case report was therefore to draw attention to a common but under-recognized problem of posterior shoulder instability, namely the poor positioning of the shoulder blades during weight-bearing activities in front of the chest.

The shoulder is stable as long as the resultant force vector points into the glenoid cavity (concavity compression effect[12]). When the arm is moved forward or backward out of the scapular plane, the action lines of the individual muscles change their direction and the resulting force vector may point against the glenoid rim or beyond and cause a subluxation or dislocation of the joint. The latter typically occurs when the arm is brought forward and the scapula is actively locked posteriorly (Fig. 4*A*). In this position, the anterior and lateral portions of the deltoid pull the arm posteriorly and push the humeral head against the posterior labrum and capsule. This is further enhanced by the coracobrachialis, short biceps, latissimus dorsi, and long head of the triceps.

Repeated loading of the posterior labrum and capsule may damage these structures and result in posterior shoulder instability. Antosh et al[1] stated that posterior labral tears and paralabral ganglion cysts typically occur in athletes participating in high-demand, dynamic posterior-loading activities, including weightlifters and football linemen. This is consistent with our own experience. Most young athletes who consulted for atraumatic shoulder pain had posterior shoulder instability. The main reason for their instability was not an insufficiency of the static or dynamic stabilizers of the glenohumeral joint but wrong instruction or wrong execution of the dumbbell fly, bench press, and push-up workout. In fact, many coaches claim that the shoulder blades must be actively locked in a posterior position (scapular retraction) when performing these exercises.[5,18,19] They argue that locking the shoulder blades in a posterior position helps to stabilize the shoulders and upper back, to focus on using the chest muscles to perform the movement, and that it leads to greater muscle activation and muscle growth. However, locking the shoulder blades posteriorly is biomechanically unfavorable. It facilitates posterior translation of the humeral head on the glenoid and thus contributes to enlargement of the posterior capsule, damage to the labrum, and development of posterior shoulder instability. It is therefore of utmost importance that the scapula follows the movement of the arm and that the glenoid optimally supports the humeral head in any arm position (Fig. 4*B*). This should be explained to all athletes performing dynamic posterior-loading activities. Our experience has shown that patients immediately understand the problem of posterior shoulder instability when the direction of the muscle action lines relative to the glenoid plane is shown to them using a model or a sketch. The athletes should also be instructed to stop the exercises or to reduce the weight before muscle fatigue appears. In our patient, posterior dislocation occurred after 10 repetitions with very big

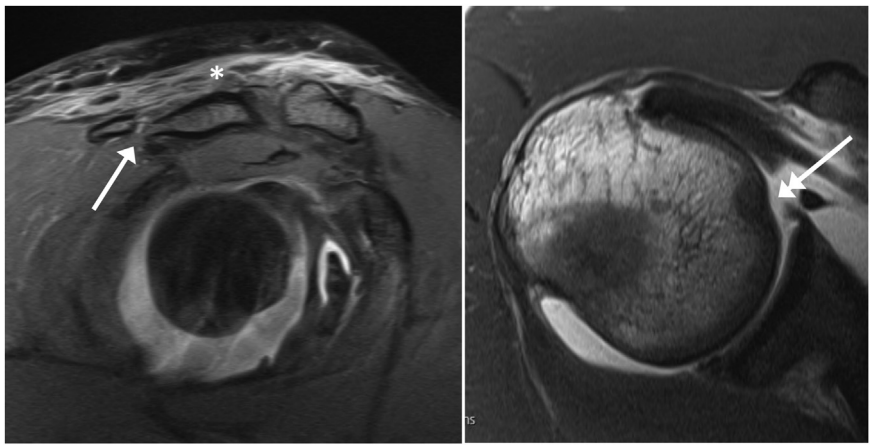

Figure 2 Parasagittal (left) and axial (right) cuts of an MR-arthrogram demonstrating the posterior acromion fracture (*arrow*), a subcutaneous hematoma (*asterisk*), a small anterior humeral head impression fracture with concomitant bone bruise (*double arrow*), a hemarthrosis, and an intact posterior labrum.

Figure 3 Lateral radiograph made 7 weeks after the trauma shows that the small acromion fragment is healed with slight angulation.

weights. It must be assumed that this was too much for the joint-stabilizing muscles and resulted in the humeral head popping backward out of the socket.

We suppose that the above-described mechanism also explains many other posterior shoulder subluxations and dislocations that occur during straight-arm pass-blocking in American football or bench-pressing,[4] and that it also corresponds to the mechanism of posterior shoulder dislocation occurring in a fall onto the outstretched arm[7] or in epileptic seizures. In the case of a forward fall, the arm is axially loaded on impact with the ground. This forces the shoulder blade into a retracted position and deprives the humeral head of posterior support. In the event of an epileptic seizure, retraction of the scapula allows the strong deltoid, coracobrachialis, short biceps, and latissimus dorsi to pull the humeral head backward out of the socket. Fig. 4 shows that the subscapularis and pectoralis major, which are repeatedly held responsible for posterior dislocation in epileptic seizures,[11] have a stabilizing and not a destabilizing effect.

The literature often refers to an unstable or provocative position of flexion, adduction, and internal rotation of the arm or the shoulder. Actually, one should put more focus on the scapula. Subluxation or dislocation only occurs when the scapula is not sufficiently protracted and/or the joint-stabilizing muscles are not adequately activated.

Some authors postulated that posterior shoulder instability without structural defects may be caused by pathologic activation patterns of the rotator cuff and the periscapular muscles.[9,15] Moroder et al therefore introduced an electrical muscle stimulation-based therapy (shoulder-pacemaker concept).[16] For this purpose, 2 transdermal electrodes were applied to achieve a tonic contraction of hypoactive external rotators and scapula-retracting muscle groups. We agree that the external rotators are relevant in preventing posterior shoulder instability. However, which of the different scapula stabilizers need to be activated for the correct positioning of the shoulder blade during forward elevation of the arm still needs to be determined.

Conclusion

Posterior shoulder dislocation and instability may be due to insufficient protraction of the shoulder blades during loading of the arms in front of the chest. When lifting or pushing heavy objects, the shoulder blades must follow the movements of the arms and not be locked behind the upper-back.

Disclaimers:

Funding: No funding was disclosed by the authors.
Conflicts of interest: The authors, their immediate families, and any research foundation with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.
Patient consent: The patient of this case report consented to the publication of his medical history and pictures in a scientific journal.

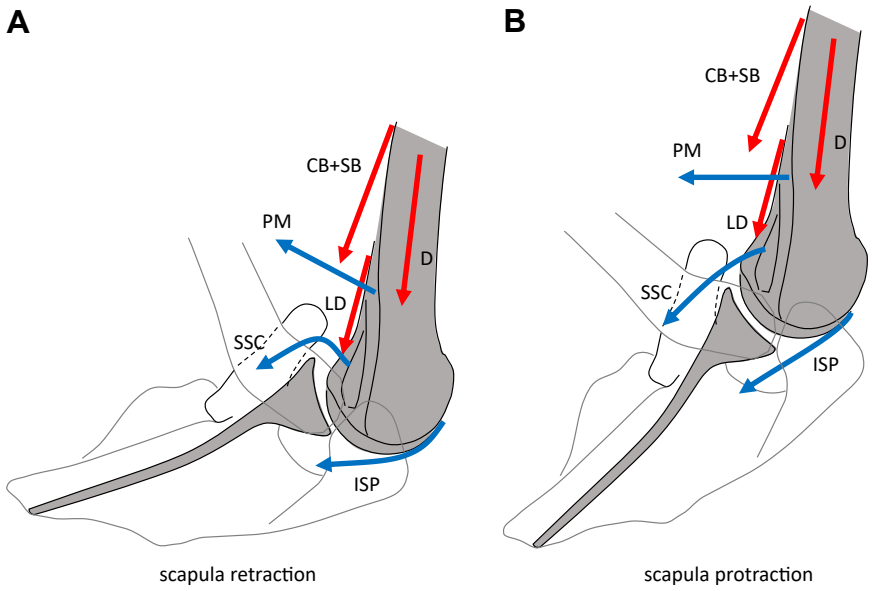

Figure 4 Schematic 2-dimensional representation of a right shoulder from above with the arm flexed, showing the orientation of the forces as a function of the position of the scapula. The stabilizing forces are drawn in blue (PM, pectoralis major; SSC, subscapularis; ISP, infraspinatus), the destabilizing forces in red (CB, coracobrachialis; SB, short biceps; D, deltoid; LD, latissimus dorsi). (**A**) Posterior subluxation occurs when the scapula is retracted. (**B**) Protraction of the scapula improves the support of the humeral head and thus improves the stability of the joint.

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