



# Techniques for reduction of anteroinferior shoulder dislocation

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## Abstract

Dislocation of the shoulder joint is common. The shoulder is affected in up to 60% of all major joint dislocations, one study citing an incidence of 1.7% in the general population. The most common form is anteroinferior dislocation. A variety of techniques to reduce shoulder dislocation has been described. The key to successful relocation is a thorough understanding of the anatomy of both the enlocated and the dislocated shoulder joint.

**Key words:** *dislocation, method, reduction, shoulder, technique.*

## Methodology

A comprehensive literature search was performed with these methods: MEDLINE search using keywords ('shoulder', 'dislocation', 'reduction', 'technique', 'method') identifying 47 relevant papers; manual search of bibliographies; scans of abstracts of recent international meetings; trawl of standard Emergency Medicine, Orthopaedic and Anatomy textbooks.

## Anatomy of the shoulder

The glenohumeral joint is a highly mobile ball and socket joint. This comes at a cost to stability. Stability and resistance to translating forces is provided by:

1. The suction cup effect of the labrum. The socket is formed by the shallow glenoid fossa reinforced by a fibrous labrum that doubles the depth of the fossa and creates a suction cup effect on the humeral head.
2. Limited joint volume and negative intra-articular pressure.
3. Static stabilizers: the fibrous labrum is composed of fibrocartilage. The loose joint capsule is reinforced by rotator cuff tendon insertions. The glenohumeral ligaments are important anterior stabilizers providing resistance to anterior translation at different stages of abduction. The inferior glenohumeral ligament (IGHL) is a complex made up of anterior and posterior bands with an interposing pouch. Injury to IGHL complex is common in younger patients, leaving the joint unstable.<sup>1,2</sup>
4. Dynamic stabilizers: several groups of muscles act over the shoulder joint contributing to stability. Milch separated these into four groups based on length and insertion onto the humerus, radius and ulna.<sup>3</sup> Group one is the rotator cuff muscles. These muscles are the most important stabilizers, their tendons reinforcing the joint capsule. Group two is larger and more superficial and inserts onto the

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proximal humeral shaft. Group three inserts more distally onto the humerus. Group four is the longest and inserts into the bones of the forearm.

## Anatomy in dislocation

In dislocation the anatomy and inherent stability changes. The humeral head sits in either a subcoracoid or subglenoid position. Return of the humeral head to the glenoid fossa is confronted by two major obstacles, static and dynamic forces.

### Static forces

The patient classically presents with the humerus in abduction. The arm however, can appear *adducted*, because the patient slouches to the affected side with the scapula fully rotated and anteverted. This can be felt clinically and seen on X-ray radiograph (Fig. 1). Consequently supralateral to the displaced head is a fixed obstacle, the prominent anteriorly placed glenoid rim and labrum. To relocate from this position and move past the glenoid rim the humeral head must move anteriorly and lateral/supralaterally.

This obstacle is overcome by external rotation of the humeral head; a greater articular surface on the humeral head is presented superiorly to the receiving fossa allowing it to roll past the rim.<sup>4</sup> Alternatively rotation of the scapula with retroversion presents an easier path for the returning head.



**Figure 1.** Subcoracoid dislocation.

### Dynamic forces

With the humerus in the anatomical position the resultant force of the shoulder girdle muscles acts to pull the humeral head and neck in a medial direction. The dynamic stabilizers normally function to hold the joint in place. However, when the humeral head is displaced these muscles continue to contract reflexly. Muscular spasm, and therefore shortening, continues to pull the humeral head (through the tuberosities) and shaft despite the head being malpositioned. The long head of biceps and subscapularis resist reduction of the displaced humeral head.<sup>3</sup>

Longitudinally directed muscles positioned across the glenohumeral joint, act to pull the humeral head upwards, fixing it in the subcoracoid/glenoid areas. The long head of biceps is proximally inserted at the supraglenoid tubercle and superior labrum, the tendon then passing anterior to the humeral head. In spasm this muscle resists anterior movement of the head. It might also have the added effect of bowstringing anterolateral to the axis of the head, further restricting the lateral/supralateral movement of the humeral head required to move past the glenoid rim/labrum.

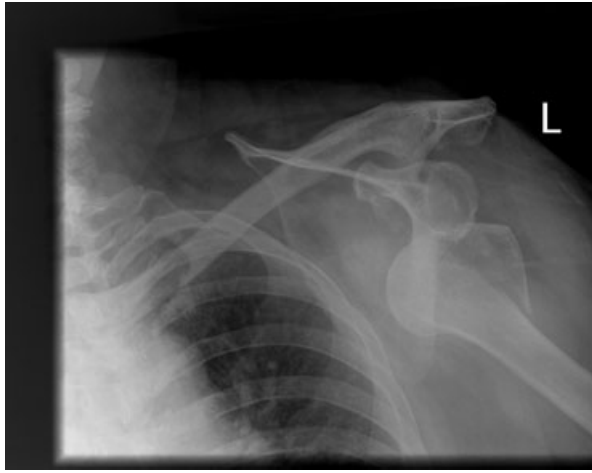
Subscapularis inserts into the lesser tuberosity, acting to internally rotate the humerus and hold the head medially, resisting lateral movement. Spasm of this muscle also restricts the external rotation required for reduction.

## Types of dislocation

There are four types of anteroinferior shoulder dislocation, denoted by the final position of the humeral head. Subcoracoid dislocations constitute 70% of all dislocations.<sup>5,6</sup> Subglenoid dislocations (Fig. 2) are the second most common, 30%.<sup>5</sup> Subclavicular and intrathoracic dislocations are associated with fractures and violent forces.<sup>7</sup> *Luxatio erectae* is regarded as a pure inferior dislocation and is not discussed here.

## Mechanism of injury

Anteroinferior dislocations classically occur with a combination of abduction, external rotation and extension. A fall onto the outstretched arm transmitting the force to the glenohumeral joint is a typical mechanism.<sup>7</sup> A fall onto the point of the shoulder is an alternative mechanism of injury, forcing the humeral head anteriorly.



**Figure 2.** Subglenoid dislocation with greater tuberosity fracture.

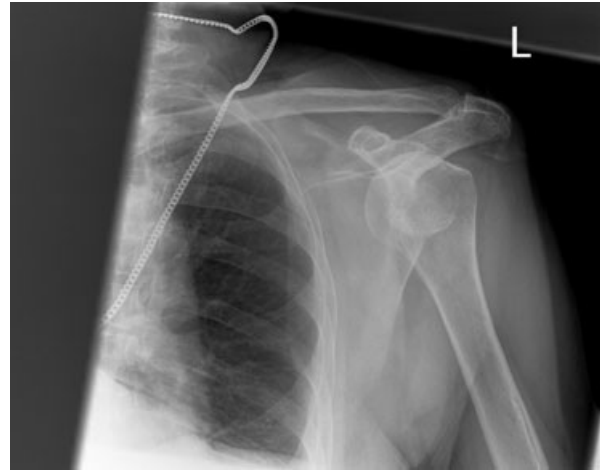
Subcoracoid dislocation occurs when the arm is in the low to mid range of abduction and externally rotated.<sup>8</sup> Subglenoid dislocations usually result from rapid hyperabduction. Subclavicular and intrathoracic dislocations involve large lateral to medial forces on the abducted humeral shaft.<sup>7</sup>

## Complications

### Fractures

Fractures occur in about 30% of cases.<sup>9,10</sup> The most common are:

1. Hill Sach's lesion (Fig. 3), seen in 54–76% of cases, is a compression fracture that results in the formation of a groove in the posterolateral aspect of the humeral head.<sup>2,9–11</sup> Also known as a hatchet deformity it is best viewed with internal rotation of the arm.<sup>9</sup>
2. Fractures of the anterior rim of the glenoid fossa (Fig. 4) or Bankart's lesion<sup>12,13</sup> (a separation of capsule and/or labrum from the anteroinferior rim, the term is often used to refer to bony disruption).<sup>2,10</sup> It is the result of impaction of the humeral head against the anteroinferior glenoid labrum, and is associated with rupture of joint capsule and IGHIL damage. It is more common in younger patients and has a strong association with recurrent dislocations (85–87%).<sup>2,13,14</sup>
3. Avulsion fracture of the greater tuberosity (Fig. 5) is seen in 10–16% of cases.<sup>5,9,10,15,16</sup>
4. Uncommonly, the coracoid process can be damaged by the humeral head resulting in painful non-union.



**Figure 3.** Hill Sach's Lesion.

5. Humeral shaft fracture is rare, associated with significant forces.

### Damage to the glenohumeral ligaments

These important static stabilizers are damaged in about 55% of cases, more commonly in the young.<sup>2,16</sup>

### Rotator cuff injury

The rotator cuff is more commonly damaged in the elderly (35–86%).<sup>17</sup>

### Neurological injury

Some form of neurological damage occurs in 21–50% of cases of anteroinferior dislocation.<sup>2,10</sup> The axillary nerve is the most commonly damaged (3%),<sup>15</sup> brachial plexus and other isolated nerve injuries can occur.

### Vascular injury

Axillary artery rupture presents with pain, axillary haematoma and a cool limb with absent pulses (distal pulses might be present, resulting from collateral flow). Of axillary artery complications 86% occur in patients aged more than 50 years.<sup>18</sup> This is very rare but should be considered if a brachial plexus injury is identified.<sup>2</sup>

### Recurrence

Age is a major factor in likelihood of recurrence. In the <20 years age group, 80–94% of patients develop

recurrence.<sup>2,13,14</sup> Bankart's lesion and its association with IGHL damage is the major pathology. In the <40 years group 26–48% develop recurrence.<sup>2,11</sup> The major pathology is disruption of the labral attachment of the glenohumeral ligaments. In the >40 years group only 0–10% recur.<sup>2,13</sup> The major pathology is rotator cuff tear.<sup>2</sup>

Greater tuberosity fractures are associated with lower rates of recurrence (4.5%).<sup>2</sup> Bankart's and Hill Sach's lesions are strongly associated with recurrence.<sup>16</sup> Minor trauma producing dislocation is associated with high recurrence rates (86%).<sup>13</sup>

## Techniques of reduction

There are a large number of techniques for reduction of anteroinferior shoulder dislocation. Many, however, are variations on classic techniques as first described by Kocher,<sup>19,20</sup> Milch,<sup>3</sup> Stimson<sup>13,21</sup> and Bosley.<sup>22,23</sup> Techniques are usually classified as traction, leverage, scapular manipulation and combinations thereof.<sup>7,24</sup>

There are problems with current classification guidelines. There is often confusion about the use of traction and leverage, some texts describing Milch's technique incorrectly as a traction technique,<sup>25,26</sup> others adding traction steps to Kocher's leverage method.<sup>25,27</sup> In clinical practice inappropriate traction and poor technique can result in complications with otherwise safe methods. Kocher's method fell into disrepute because of its association with complications occurring with the application of large forces,<sup>28–30</sup> but has been shown to be a safe technique when applied correctly.<sup>31</sup> Combination techniques are simply two or more separate

manoeuvres with the humerus in different positions, leaving the mechanism of relocation unclear.<sup>29,30</sup>

The position of the humerus can be used as the discerning feature in classification. With the scapula fixed in the anatomical position the operator has a clear impression of the position of the humeral head in relation to the glenoid fossa and the various stresses and forces acting on the humeral head, shaft, glenoid labrum and muscle and ligament insertions. Good anatomical knowledge provides a clear awareness of the forces being applied by the operator in a dynamic situation.

The position of the humeral head in relation to the glenoid fossa at the point of reduction is the critical feature. Scapular rotation on the chest wall must be taken into account with some techniques, and the position of the scapula at clinical presentation should be sought. Many of the techniques discussed below can be employed with the patient supine, seated or prone. If unsuccessful with one technique, the skilled operator can then employ a second choice method without having to move the patient.

## Techniques with the arm in the anatomical position

The starting point for these techniques is with the humerus in the anatomical position, adducted against the torso. Adduction can be difficult or unobtainable in obese patients.

### *Kocher's method*

Originally described in 1870 Kocher's method did not involve traction.<sup>19,20,32</sup> Many texts have incorporated



**Figure 4.** Fracture of anterior rim of glenoid fossa.



**Figure 5.** Greater tuberosity fracture.

traction,<sup>25,27</sup> which has been associated with complications,<sup>28-30</sup> yet in various case series the original technique has been used safely.<sup>31</sup> Significant traction forces in combination with forced internal or external rotation place undue stress on the humeral shaft and neck.

The original technique is: 'Bend arm at the elbow, press it against the body, rotate outwards until resistance is felt. Lift the externally rotated upper arm in the sagittal plane as far as possible forwards and finally turn inwards slowly'.<sup>19</sup>

Variations include:

- Leidelmeyer's external rotation technique, which describes the first manoeuvre of Kocher (elbow flexed, adduction of humerus, external rotation) and then adds traction<sup>24</sup>
- Mount Beauty method, which describes downward traction followed by external rotation.<sup>33</sup> An assistant stabilizes the scapula

#### *Snowbird technique*

This technique is essentially downward traction with the humerus in the anatomical position.<sup>34</sup>

The patient is sitting up straight with humerus in anatomical position, elbow flexed, and forearm supported by the unaffected limb or operator. The operator places a foot into a stockinette loop wrapped around the forearm. Downward traction from the foot is applied, with additional rotation or pressure from the operator's hands if needed.

#### *The Cunningham technique*

This technique addresses static obstruction by posteriorly directed shrugging of the shoulders.<sup>35</sup> This uses the rhomboids to retrovert the scapula reducing the obstruction of the glenoid rim and labrum to the returning humeral head. The dynamic obstruction of the spasming biceps is actively reduced by massaging the muscle at the mid-humeral level.

The patient sits without slouching in a hard backed chair, the affected arm adducted to the body and the elbow fully flexed. The operator kneels next to the patient and places his wrist onto the patient's forearm, the patient's hand resting on the operator's shoulder. The patient is asked to shrug the shoulders superiorly and posteriorly, which 'squares off' the angle of the shoulder (reducing scapular anteversion and the static obstruction of the glenoid rim). The biceps is massaged at mid-humeral level to specifically relax the muscle (removing dynamic obstruction). The head reduces quickly, painlessly and without traction.

### **Techniques with the arm in the zero position**

Saha originally described the zero position as that 'where the humero-scapular aligned axes coincide with the common axis of the cone muscle groups... the humerus is 165° overhead and 45° in front of the coronal plane... (the scapula) being at the limit of vertical rotation and forward migration on the chest wall. In this position the glenohumeral joint loses all active rotation'.<sup>36</sup>

Milch separated the muscles around the shoulder into cone groups.<sup>3</sup> He noted that with the arm in elevation (full glenohumeral abduction and full scapular rotation/anteversion) the cone groups arrange in a similar direction along the humerus and lose their rotatory/transverse component.

Milch's technique used this overhead position as the critical point at which relocation could most easily occur. This was chosen as 'the only position in which a single force, exerted along the axis of the humerus, is accurately directed to overcome each and all of the muscle actions at the same time'. This statement was used to explain the choice of position as a point of theory and not as an endorsement in the use of force during the manoeuvre. Indeed, in the supporting case studies he talks about elevating the arm 'with the greatest gentleness'. Traction has been recommended as part of the Milch technique,<sup>6,7,37</sup> but the original description does not use traction.

Importantly, with the humerus in complete overhead abduction the scapular has rotated fully on the chest. This puts the humerus (in relation to the rotated scapula) in the zero position.

#### *The Milch technique*

'The patient lies in the supine position, while the surgeon takes his position on the side of the dislocation. First manoeuvre – in a right sided dislocation the surgeon places his right hand upon the patient's right shoulder, so that the fingers find firm support on the top of the shoulder, while the thumb is braced against the dislocated humeral head. Second manoeuvre – the right hand fixes the head as the left hand gently abducts the arm into the overhead position. During this manoeuvre the head of the humerus is supported so that it cannot move from its dislocated position. As a consequence, instead of moving downward as the arm moves upward, the head rotates in place. Third manoeuvre – once the arm has been brought into complete abduction in this overhead position, all cross stresses exerted by all the muscles have been eliminated; the head can be



gently pushed over the rim of the glenoid and the dislocation reduced'.<sup>3</sup>

Variations include:

1. Patient prone with elbow flexed.<sup>38</sup>
2. Janecki's 'forward elevation' combination manoeuvre<sup>29</sup> begins with forward flexion to 90° (step one), then traction is applied and abduction increased (step two). The final position is the overhead position and the humeral head is pushed by direct pressure if reduction has not occurred (step three).
3. 'Reduction in the position of maximum muscular relaxation'.<sup>6</sup> Gentle traction is applied while the shoulder is abducted to 45° (step one). Traction is then increased with further abduction 120° and anteversion 30° (step two). External rotation is then applied (step three). Finally, direct pressure is applied on the humeral head in the axilla (step four).
4. Russell placed the patient supine with back at 30°. <sup>39</sup> The patient moves his arm slowly to the overhead position and places his hand behind his head. Gentle traction is then applied to the flexed elbow while the humeral head is guided over the glenoid rim.

The author uses a new modification of the technique that fixes the scapula. This limits the rotation (around a vertical axis) and anteversion (tilting forward) of the scapula that ordinarily occurs with glenohumeral movement during abduction past 30°. This allows the 'zero position' (used here to describe the critical angle between glenoid fossa and humeral head at point of relocation rather than Saha's classically described position with the scapula in full rotation and anteversion) to be reached more easily, at about 100° abduction (no more than 120° abduction is possible at the glenohumeral articulation<sup>4</sup>). This technique is usually performed with the patient seated but has been used in the supine position and, as in the original, no traction is used.

#### *Modified Milch technique (for a right-sided dislocation)*

The patient is seated in a hard backed chair, the operator standing behind the affected limb. The left hand is placed over the trapezius and spine of scapula. This fixes the scapula and detects any scapular movement. The right arm is held by the wrist and gently abducted to 100°. External rotation is applied gradually as the arm is lifted. The humeral head can be gently pushed in a supralateral direction if relocation has not occurred.

For a larger patient an assistant might be employed to fix the scapula, the operator in front of the patient using the left hand, leaving the right free to push the humeral head if needed.

## **Techniques with the arm in lateral flexion**

### *Eskimo technique*<sup>40</sup>

The patient is placed on the ground lying on the non-dislocated shoulder. Two persons now lift the patient by the dislocated arm, keeping the opposite shoulder suspended a couple of centimetres from the ground. If no reduction occurs direct pressure on the humeral head is applied.

Stimson also described this technique as the 'pendle method'.<sup>41</sup>

### *Hippocratic method*

The patient lies supine while the surgeon holds the arm applying traction. A 'well stockinged foot' in the axilla applies countertraction and is also used to lever the humeral head supralaterally. This technique is still recommended in some texts.<sup>25,26,37</sup>

### *Traction countertraction*<sup>7,32,37,42</sup>

Traction is applied to the arm with the shoulder in abduction; an assistant applies firm countertraction to the body using a folded sheet.

## **Techniques with the arm in forward flexion**

### *Stimson's hanging arm technique*<sup>13,43,44</sup>

The patient lies prone on a table with the affected arm hanging downward. A weight of 10 lb is applied to the wrist. Reduction occurs secondary to fatigue of the spasming muscles.

Variations include:

- Step two of Janecki's 'forward elevation' combination manoeuvre<sup>29</sup>
- Lippert's 'modification of the gravity method'<sup>43</sup> has the patient prone with the affected arm hanging vertically and the elbow flexed. Downward traction to the humerus is then applied through the forearm by the operator
- Rollinson used the hanging method in combination with a supraclavicular nerve block<sup>44</sup>

### *Spaso technique*<sup>30</sup>

With the patient supine the arm is gently lifted vertically. While applying traction rotate the shoulder externally. Push the head of the humerus in the axilla.

## Techniques with the arm in forward flexion plus scapular manipulation

### *Scapular manipulation*

This technique was described by Bosley in 1979:<sup>22</sup>

The patient is placed prone on the examining table with the shoulder in a position of 90 degrees of forward flexion and external rotation. The forearm is suspended from the table with the wrist secured and the elbow flexed. Traction on the forearm is maintained with 5 to 15 lbs for a variable period, usually less than five minutes. After the patient begins to relax, the surgeon pushes on the tip of the scapula medially (lifting it on occasion), while simultaneously rotating the superior aspect of the scapula laterally.

The technique works by applying constant traction to the externally rotated humerus to reduce pressure of the humeral head on the glenoid rim (sitting supralateral to the dislocated head). This allows the abducted inferior tip of the scapula to be rotated bringing the scapular neck and glenoid fossa into correct alignment. Originally described with the patient prone this caused problems positioning uncooperative patients or women with large breasts.<sup>23</sup>

Variations include:

- Arm hanging vertically with weights hung from wrist<sup>45</sup>
- Seated patient<sup>46</sup> with one physician performing gentle traction in the forward flexion position with counterbalancing in the patient's midclavicular region. A second physician manipulates the scapula
- Supine patient<sup>47</sup>

### *Boss Holzach matter*

This technique relies on movement of the scapula with the humerus fixed by axial traction.<sup>8</sup>

The scapula is rotated by the patient by actively shrugging the shoulders (anteriorly). The patient sits on an examination table, the wrists bound together and placed around the flexed (homolateral) knee. The head of the table is lowered and patient asked to lean back and hyperextend neck exerting anterior axial traction on the humeral head. The patient then shrugs the shoulders anteriorly increasing anteversion of the glenoid cavity.

## Techniques with the arm in abduction/forward flexion with external fulcrum

Use of an external fulcrum in the axilla as leverage and/or countertraction has been recommended since

Hippocrates.<sup>25,41</sup> The choice of fulcrum and direction of traction varies:

- Nordeen uses the back of a chair in the axilla combined with downward traction<sup>48</sup>
- Manes uses downward traction with the operator's forearm as an external fulcrum<sup>49</sup>
- Slump reduction technique.<sup>50</sup> An assistant supports the axilla from behind while the physician applies longitudinal traction. If unsuccessful external rotation and then scapular manipulation are added
- White uses the back of a chair as an external fulcrum and abduction with downward traction<sup>51</sup>

## Use of analgesics/sedation/anaesthetic

Benzodiazepines and opiates have been the drugs of choice when manipulating shoulder dislocations. Both carry the risk of cardiovascular and respiratory depression, especially in the elderly. Some techniques require positioning that would preclude the use of these drugs in high risk groups. Some operators feel that chemical sedation/analgesia should usually or always be given.<sup>6,32,45,49</sup> Many studies using a variety of techniques have however, shown the standard use of drugs to be unnecessary.<sup>8,20,28,34,38,50</sup> Intra-articular and suprascapular nerve blocks have been used. These techniques have a theoretical risk of joint infection.

## Success rates

Success rates range between 60 and 100%. Some techniques have difficulty with older patients,<sup>8</sup> some with particular subtypes of dislocation.<sup>5,6,28</sup> This highlights the importance of being skilled in more than one method.

## Discussion

There has traditionally been a belief that traction is necessary to overcome the forces of muscular spasm when reducing shoulder dislocation;<sup>6,29</sup> however, a number of effective techniques not using traction have similar success rates.<sup>3,20,35,52</sup> These techniques are physiologically sound in that their mechanisms rely upon careful manipulation of the humeral head around the obstructions, blocking its path back to the glenoid fossa. When used correctly, these techniques require no force,

reducing the risk of secondary injury to the joint and surrounding structures.

It is arguable that techniques relying solely on traction to 'overcome' muscle spasm (Hippocratic, traction/countertraction) should not be used. Some techniques combining traction and rotation (scapular manipulation) or relying on muscle fatigue (Stimson) are less traumatic for both joint and patient.

The following algorithm suggests a hierarchy of techniques for the clinician to become expert in.

The suggested first and second line techniques for reduction of anteroinferior shoulder dislocation are:

- First line
  - Seated – Kocher, Milch (classic or modified), Cunningham
  - Supine – Milch, Kocher
  - Prone – Milch
  - (All can be performed with the patient seated, Milch in any position)
- Second line
  - Scapular manipulation (can be performed seated, supine or prone) or Stimson

An understanding of the anatomy of the shoulder in dislocation is essential when attempting clinical reduction. Scapular position in relation to the humeral head is a key to successful reduction and unintentional movement of one of these components during a manoeuvre will determine the success or failure of a technique. A good clinical examination prior to attempted reduction and, if necessary, an assistant fixing the scapula aids in reducing the dislocation in a timely and painless fashion.

The addition of traction to the classic techniques of Kocher and Milch has been perpetuated throughout recent literature obscuring their effectiveness. Incorrect application of these techniques, especially Kocher's, has resulted in complications. Traction is not required to reduce the overwhelming majority of anteroinferior shoulder dislocations and is likely to cause pain and distress to patients.

Emergency physicians should become expert in a number of techniques in order to quickly and safely reduce shoulder dislocations.

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## Competing interests

None declared.

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