



## REVIEW ARTICLE

# Accuracy of point-of-care ultrasonography for the diagnosis and management of shoulder dislocation in the emergency department: A literature review

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**ABSTRACT**

The shoulder joint has dynamic articulation with a wide range of motion and mobility, making it more prone to common dislocations. Nearly half of all joint dislocations occur in the shoulder region, with most acute shoulder dislocations occurring in the anterior position (95%), followed by posterior dislocation (2%-5%) and rarely in the inferior region of the shoulder. The current standard approach in managing shoulder dislocations is to perform pre- and post-reduction via radiographs. Consequently, this can result in treatment delays, repeat exposure to radiation, multiple administration of sedatives in case of an unsuccessful reduction, and increased healthcare costs. Point-of-care ultrasound (POCUS) is a non-invasive diagnostic tool broadly applied in many medical and surgical fields. The emergency medicine literature contains several case reports detailing emergency physicians using POCUS to evaluate shoulder dislocations. In this literature review, the first objective is to compare different views on applying POCUS imaging and sonographic methods of diagnosing shoulder dislocation. The second objective is to determine the accuracy of this sonographic method in diagnosing shoulder dislocation by experienced and inexperienced sonographers in the Emergency department. Overall, POCUS had a 99.1% (95% CI, 84.9%–100%) sensitivity and 99.9% (95% CI, 88.9%–100%) specificity for diagnosing anterior shoulder dislocation. Furthermore, POCUS had a 99.0% (95% CI, 92.3%–99.9%) sensitivity and 99.7% specificity for diagnosing posterior shoulder dislocation. Implementation of POCUS in the clinical setting could serve as a method of developing hands-on ultrasound skills in medical school, suggesting possible future broader applicability of this skill in improving patient care. POCUS is an alternative diagnostic method for managing shoulder dislocations. However, further studies are needed before routine implementation.

## 1. Introduction

Acute shoulder dislocations are widespread injuries affecting 15–40 patients per 100,000 annually, which accounts for nearly 2% of the population.<sup>1</sup> The shoulder joint has dynamic articulation with a wide range of motion, which may also lead to the joint being more prone to dislocations.<sup>2</sup> Therefore, nearly half of the dislocations occur in the shoulder.<sup>2</sup> The most common acute shoulder dislocation injuries among occur in the anterior region (95%), followed by posterior dislocation (2%–5%), and rarely in the inferior area of the shoulder.<sup>1</sup> Rapid diagnosis of this condition is essential for effective treatment, as reduction of the shoulder becomes increasingly difficult the longer the shoulder remains dislocated.<sup>3</sup> The current standard approach for patients with suspected shoulder dislocations involves conventional radiographs obtained before the shoulder reduction in which the patient is sedated at the time.<sup>4</sup> A radiograph is used afterwards to confirm the successful shoulder reduction.<sup>5</sup> Ideally, two views are requested, anteroposterior and axial demonstration.<sup>6</sup> However, if there is pain due to the previously mentioned demonstrations, a modified axial or lateral scapular view would be acceptable.<sup>7</sup> Some of the issues of radiography include exposing patients to repeated radiation, which delays treatment and increases healthcare costs.<sup>8</sup> Also, radiographs may result in missed posterior shoulder dislocations, which requires the re-administration of sedatives after the initial attempts.<sup>9</sup>

Point-of-care ultrasound (POCUS) is non-invasive, inexpensive, and readily available in most healthcare facilities.<sup>9</sup> Bedside ultrasound (US) has been broadly applied in many medical and surgical fields and their related specialties<sup>2</sup>. While US is implemented regularly in various areas such as anaesthesia, obstetrics-gynaecology, cardiology and radiology, advances in technology have facilitated the integration of POCUS into a wider variety of medical departments such as emergency medicine and critical care.<sup>10</sup> Consequently, there is an increasing interest

in using point-of-care shoulder ultrasonography to identify dislocations and treating rapidly at the bedside in the emergency department.<sup>8</sup> Integrating POCUS training into medical education has grown and is now a component of emergency medicine residency.<sup>11</sup> Ultrasonography is more prominent in medical care, and there is increasing interest in introducing it earlier at the undergraduate medical education level.<sup>4</sup> The emergency medicine literature contains several case reports detailing emergency physicians (EP) using US to evaluate shoulder dislocations.<sup>12</sup> A streamlined, single-view US technique that assesses shoulder dislocation accessible to even the most inexperienced sonographers would be of clinical benefit to EPs.<sup>8</sup> The primary objective of this study is to evaluate the assessment of the proposed standardized method for diagnosing shoulder dislocation using a single-view approach POCUS.<sup>2</sup> The second objective is to determine the accuracy of this sonographic method in diagnosing shoulder dislocation by experienced and inexperienced sonographers in the emergency department.<sup>13</sup>

## 2. Method

This literature review included PubMed articles and publications on the use of US to diagnose shoulder dislocations specifically conducted in emergency departments (EDs).<sup>4</sup> The keywords included “musculoskeletal”, “shoulder dislocation”, “shoulder reduction”, “trauma”, “ultrasound” and “POCUS”. We compared different views to apply US imaging to an adult patient with acute, traumatic shoulder pain.<sup>1</sup> We included specificity, sensitivity values, and sonographic methods for diagnosing shoulder dislocation.<sup>9</sup>

### 2.1 Inclusion and exclusion criteria

The inclusion criteria of related articles and publications consisted of all prospective or randomized control trials assessing US for identifying shoulder dislocations. The date restriction was from 2010 to 2022. All studies must have a

confirmatory test (e.g., radiograph or computed tomogram). Excluded from the review were case reports, retrospective studies, and cadaver studies as well as studies in which participants were unable to give informed consent due to age group being <16 years or subjects having cognitive impairments. All abstracts meeting the initial criteria were reviewed as full manuscripts. The final data evaluation analysis included studies determined to meet the eligibility criteria on full-text review.

## 2.2 Collecting and Processing Data

The following information was abstracted: last name of the first author, publication year, study country, study population size, type of study (e.g., prospective or randomized controlled trial), study location (e.g., ED, intensive care unit), study inclusion criteria, study exclusion criteria, mean age of study patients, gender of study patients, percentage of shoulder

dislocations, percentage of each dislocation type (i.e., anterior, posterior, inferior), US transducer, US technique, sonographer training, operator speciality, and operator experience (i.e., attending or non-attending physician). Studies included assessments of both dislocation and reduction confirmation.<sup>3</sup> Finally, nine prospective observational trials were selected for the final evaluation analysis (Table 1). Eight studies took place in the ED, while one study did not describe the study location.<sup>3</sup>

## 2.3 Data Evaluation

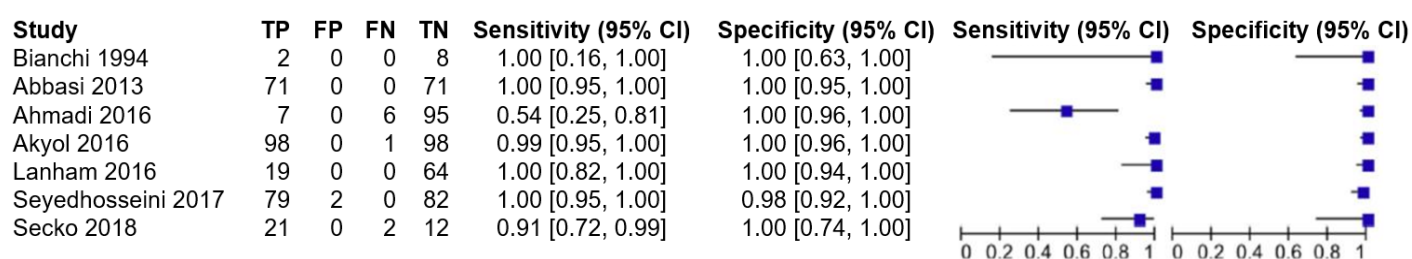
Diagnostic test accuracy variables, including sensitivity, specificity, positive likelihood ratio (LR+), and negative likelihood ratio (LR-) were analyzed. All data were calculated with 95% confidence intervals (CIs).<sup>3</sup> Table 1 shows the characteristics of the included studies and Figure 1 displays the Forest plot of overall sensitivity and specificity.

**Table 1.** Characteristics of Included Studies

Study	N	Country	Dept.	Mean age	Male patient %	Dislocation %	US transducer	US technique	Operator experience
Bianchi 1994	10	U.S.	ND	35.5	ND	20.0	Linear	Posterior	ND
Abbasi 2013	142	Iran	ED	31.6	91.3	50.0	Linear	Anterior & lateral	Attending, resident
Ahmadi 2016	108	Iran	ED	30.1	64.1	12.0	Linear	Anterior & lateral	Attending
Akyol 2016	197	Turkey	ED	33.9	80.6	50.3	Linear	Posterior	Attending
Lanham 2016	84	U.S.	ED	45.0	62.0	22.6	Linear	Posterior	Student
Seyedhosseini 2017	163	Iran	ED	35.9	83.3	48.5	Curvilinear	Posterior	Attending, resident
Secko 2018	35	U.S.	ED	ND	ND	65.7	Linear or Curvilinear	Posterior	Attending

ED, emergency department; ND, not described; US, ultrasound

**Figure 1.** Forest Plot of Overall Sensitivity and Specificity of Ultrasound for Identifying Shoulder Dislocations



TP, true positive; FP, false positive; FN, false negative; TN, true negative

### 3. Results

Emergency medicine providers performed most POCUS examinations in the studies.<sup>5</sup> All dislocations were anteriorly displaced except for six posterior dislocations cases and one inferior dislocation case.<sup>5,14</sup> Overall, POCUS had a 99.1% (95% CI, 84.9%–100%) sensitivity and 99.9% (95% CI,

88.9%–100%) specificity for diagnosing anterior dislocation.<sup>5</sup> As for posterior shoulder dislocation, POCUS had a 99.0% (95% CI, 92.3% to 99.9%) sensitivity and 99.7% specificity.<sup>5</sup> Furthermore, the anterior and lateral techniques, POCUS had a 92.9% (95% CI, 85.1%–97.3%) sensitivity and 100% (95% CI 97.8%–100%) specificity for diagnosing shoulder dislocation.<sup>5</sup>

**Table 2.** Summary of Existing Research on the Accuracy of Ultrasound for Shoulder Dislocation and Reduction

Study	Design	Population size (% dislocated)	US training	Examination protocol	Sensitivity (95% CI)	Specificity (95% CI)
Abbasi 2013	Prospective, observational	73 (94.5%) <sup>A</sup>	Sonographer 1 >5 years prior experience	Anterior (coraco-humeral distance)	100% (93.4%–100%) <sup>A</sup>	100% (39.5%–100%) <sup>A</sup>
		69 (2.9%) <sup>B</sup>	Sonographer 2 1-hour lecture & 10 shoulder US procedures supervised by sonographer 1	& lateral (acromio-humeral distance) technique	100% (19.7%–100%) <sup>B</sup>	100% (93.2%–100%) <sup>B</sup>
Akyol 2016	Prospective, observational	103 (95.1%) <sup>A</sup>	30-minute lecture & two hours of hands-on US practice	Posterior view of glenohumeral joint	100% (96.3%–100%) <sup>A</sup>	100% (47.8%–100%) <sup>A</sup>
		94 (1.1%) <sup>B</sup>		& assessment of articulation on internal & external rotation	0% (0%–97.5%) <sup>B</sup>	100% (96.1%–100%) <sup>B</sup>
Lahham 2016	Prospective, observational	84 (22.6%) <sup>A</sup>	30-minute lecture & 30 minutes of hands-on US practice	Single view measurement of glenohumeral separation distance	100% (82.4%–100%) <sup>A</sup>	100% (94.5%–100%) <sup>A</sup>
Ahmadi 2016	Prospective, observational	108 (12.0%) <sup>B</sup>	US training course in the radiology dept	Anterior & lateral views of the humerus & glenoid fossa	53.8% (29.1%–76.8%) <sup>B</sup>	100% (96.1%–100%) <sup>B</sup>

CI, confidence interval; US, ultrasound; A, assessment of initial dislocation; B, assessment of persistent dislocation after reduction attempt

## 4. Discussion

The prospective and randomized control trials assessing US for identifying shoulder dislocations included in this review indicate that primary-care US is an effective tool for diagnosing shoulder dislocation.<sup>4</sup> However, some reports did not mention the mean duration for the patient's stay during the imaging and excluded patients with a body-mass index of >35.<sup>7</sup> Standard radiograph imaging remains the main diagnostic tool in managing shoulder dislocation.<sup>6</sup> Pre-reduction and post-reduction radiographs are the current procedures that have been used for years.<sup>7</sup> History and physical examination are often insufficient, as physicians realize that fractures and associated shoulder traumas can be missed and need imaging to diagnose.<sup>15</sup> In contrast, US diagnosis of shoulder dislocation can be obtained within 5 minutes of initial evaluation, which is necessary to spare the patients from second sedation in case of unsuccessful reduction.<sup>5</sup> Because of this, POCUS improves treatment delivery to the patient by 30 minutes on average compared to radiographs alone.<sup>3</sup> Additionally, the use of repeated radiographs increases costs to both the patient and healthcare system.<sup>3</sup> Though results are promising, further studies are required to determine US diagnostic performance compared to conventional radiography in diagnosis of shoulder dislocations.

Employing a combined anterior and lateral approach, Abbasi et al showed a sensitivity and specificity of 100% for US in diagnosing shoulder dislocation in 69 dislocated patients among 73 studied.<sup>11</sup> The study demonstrated no difference in image acquisition and interpretation between an experienced emergency sonographer and a senior emergency medicine resident who had received a one-hour lecture and performed 10 supervised shoulder ultrasounds.<sup>8</sup> Studies report that the POCUS is valuable in accelerating the treatment process and diminishing medical errors.<sup>2</sup> Blakeley et al indicated that POCUS could show the dislocation and relocations and pick out the anterior-posterior

confusion based on five cases.<sup>3</sup> However, they did not report replacing the radiograph by POCUS completely.<sup>3</sup> Yuen et al, showed that the POCUS for anterior shoulder evaluation could also be performed for posterior shoulder evaluation.<sup>5</sup> In Yuen et al, two cases of acute posterior shoulder dislocation, which are usually misdiagnosed at a rate of >50%, were confirmed by POCUS.<sup>1</sup>

Acute posterior shoulder dislocations are usually misdiagnosed at a rate of >50%.<sup>3</sup> In Yuen et al's report, POCUS confirmed the diagnosis of acute posterior shoulder dislocation, showing POCUS's high accuracy.<sup>5</sup> Further supporting this, another study showed that POCUS with posterior approach technique had a 100% sensitivity and specificity in confirming successful shoulder reduction in ED.<sup>16</sup> POCUS also identified three unsuccessful joint reductions after the initial reduction procedure in this study.<sup>16</sup> Abbasi et al, the biggest study so far, reported that POCUS is 100% sensitive and specific for shoulder dislocation and may provide more rapid management compared with radiography.<sup>11</sup> The present study also showed that POCUS is 100% sensitive and specific for pre-reduction diagnosis and 100% specific for post-reduction.<sup>3</sup> However, Lahham et al were also unable to blind sonographers to the visual appearance of the shoulder and potential deformities.<sup>8</sup> More experienced practitioners did not repeat US scans to confirm findings.<sup>8</sup> Data from other injuries were not evaluated and failed to report posterior shoulder dislocations.<sup>5</sup> An additional study showed a 100% sensitivity and specificity for diagnosing suspected shoulder dislocation and a 43-minute reduction in triage-to-imaging time.<sup>14</sup> In addition, 48% of fractures were missed, especially in traumatic or first-time dislocation.<sup>14</sup> All studies assessing the accuracy of US for detecting shoulder dislocation and reduction identified shoulder dislocation with 100% specificity.<sup>8</sup> Gottlieb et al mentioned that most studies were also 100% sensitive, except one study demonstrating a sensitivity of 54% which suffered from several methodologic flaws, including unclear sonographer training,

unclear US protocol, and an inadequate criterion standard (i.e., single view anteroposterior shoulder radiograph).<sup>3</sup>

## 5. Conclusion

The results of this literature review indicate that using POCUS for diagnosing shoulder dislocations is an effective, accurate, and reliable tool to rule in or rule out shoulder dislocations in the ED, impacting the duration for patients to receive treatment and minimising the risk of repeated exposure to radiation, along with sedatives in the case of unsuccessful shoulder reduction. Implementation of POCUS in the clinical setting could serve as a method of developing hands-on ultrasound skills in medical school, suggesting possible future broader applicability of this skill in improving patient care. POCUS is an alternative diagnostic method for the management of shoulder dislocations. More studies are needed comparing the different techniques to determine which is most accurate and time effective. In addition, data is limited regarding identifying posterior dislocations and fracture identification.

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None

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