

A Literature Review of the Use of Ultrasound in the Evaluation and Treatment of Shoulder Dislocation

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ABSTRACT

Ultrasound technology has rapidly grown throughout the medical community as image quality has vastly improved over recent decades. In particular, emergency departments can utilize bedside ultrasonography for numerous medical applications including accurate evaluation of shoulder dislocations and reductions. In this review of the literature, the usefulness of ultrasound in the diagnosis of a shoulder dislocation as well as concomitant fractures and other shoulder pathology will be reviewed. Additionally, the use of ultrasound for shoulder nerve blocks as well as current known methods for training medical personnel to use ultrasound via phantom models will be explored. Lastly, trends in research will be discussed that may indicate where the next advances in the use of this technology for shoulder dislocations.

KEYWORDS

Ultrasound in the Evaluation of Shoulder Dislocation; Shoulder Dislocation and Ultrasound; Emergency Department Ultrasound Applications; Emergency Department and Shoulder Dislocation; Management of Shoulder Dislocation and Ultrasound; Ultrasound Phantom and Shoulder; Ultrasound Phantom; Ultrasound and Diagnosis of Shoulder Fracture; Ultrasound and Reduction Shoulder Dislocation; Ultrasound and Nerve Blocks and Shoulder Dislocation Reduction.

INTRODUCTION

The application of ultrasound technology to the human shoulder joint was first described in the literature as early as 1979 as a fast, effective and radiation-free method for physicians to evaluate the shoulders of their patients. Since then, the technology has rapidly advanced for a variety of shoulder pathologies ranging from rotator cuff tears, biceps tendonitis, Hill-Sachs' lesions and interventional procedures including injections and cyst drainage [1]. More recently, ultrasound imaging of the shoulder has been compared to the use of X-rays to assess for shoulder dislocation and successful reduction with good results [2]. Additionally, a large collection of case reports, case series, reviews, editorial comments and prospective studies have described the successful use of ultrasound in shoulder dislocation and fracture identification in numerous patients [1, 3-8].

Based on these trends in the research, following questions will be addressed in this literature review:

- 1) Is ultrasound a useful, effective method to evaluate for shoulder dislocations, fractures and other types of shoulder pathology?
- 2) Is ultrasound useful in the application of nerve blocks as an alternative to conscious sedation?
- 3) Is phantom model training for ultrasound a feasible way to train healthcare personnel in this user-dependent imaging modality?

METHODS

PubMed [Pubmed.com] searches were performed to identify research publications pertinent to the following questions:

- 1) Is ultrasound useful in the diagnosis of shoulder dislocation, shoulder fracture or other shoulder pathology?
- 2) Is ultrasound useful in the application of nerve block for shoulder dislocation reduction?
- 3) Is phantom training with shoulder ultrasound effective for ultrasound use in shoulder dislocation?

The following broad keyword searches were entered to focus on each of these questions: “ultrasound shoulder dislocation”, “ultrasound and shoulder fracture”, and “ultrasound phantom shoulder”. Of these keyword searches, results were classified into which question or questions they best address. Over 250 publications resulted from the above searches, of which 35 were found to be pertinent to the above outlined questions with some degree of overlap. Papers were read, organized and evaluated for inclusion into their respective areas in the results section.

RESULTS

1) Is Ultrasound Useful in the Diagnosis of:

- A) Shoulder dislocation?
- B) Shoulder fracture?
- C) Other shoulder pathology?

A) Is ultrasound useful in the diagnosis shoulder dislocation?

Shoulder dislocation is a common acute presentation to emergency departments or urgent care centers and occurs due to the decreased stability but increased range of motion of the glenohumeral joint [1]. This acutely painful process requires timely analgesia, imaging and ultimately reduction with confirmatory imaging [2]. There are several questions pertaining to the speed of this process in the emergency department: how can I quickly confirm that the joint is truly dislocated? How long will I need to give the patient analgesic medications before the patient can be adequately imaged? How skilled do I have to be with the ultrasound to feel comfortable that I am achieving the standard of care with ultrasound alone?

Due to its speed and lack of radiation, ultrasound technology is ideal for the fast evaluation of a shoulder dislocation in an emergency department population [2]. In a prospective observational study, Abbasi et al. showed good results when using ultrasound as compared to traditional radiographic imaging for shoulder dislocation evaluation. This study came after several case reports, case series and smaller studies describing dislocation visualization in varying age populations [3-11]. Other comparisons to traditional methods of assessment for

shoulder subluxation included a study in 2014 by Kumar et al. comparing ultrasound to fingerbreadth palpation of the shoulder joint [12]. Because of the shortened time to treat utilizing ultrasound, the need for analgesia was shown to be decreased as well in this patient population [2]. With accuracy at the same level as traditional radiographs, these studies have given us a faster, more effective way to treat these patients [2, 3]. Regarding the experience of the provider, Moosmayer and Smith showed in 2005 that even novice practitioners could accurately evaluate the shoulder joint of a patient with minimal training in ultrasound [13]. Therefore, bedside ultrasound is a timely method of confirming shoulder dislocation, reduces the need for prolonged analgesic medication administration due to reduced time to shoulder reduction, and can be practiced by even novice providers with good results.

B) Is ultrasound useful in the diagnosis shoulder fracture?

The evaluation of the shoulder joint via ultrasound can only replace traditional radiography in patients with shoulder dislocation if it can accurately identify bony pathology. A number of case reports and case series describe cases of several fracture patterns successfully diagnosed via bedside ultrasound including lesser tuberosity fractures, scapular body fractures, clavicle fractures, coracoid fractures and proximal humerus fractures [14-19]. The strength of ultrasound in many of these studies was found to be in children and infants as the cartilaginous nature of the skeleton at this age can be seen easier with ultrasound waves [9].

In terms of fracture evaluation in the setting of shoulder reduction, the study by Abbasi did not have enough power to demonstrate fracture identification after shoulder dislocation in adults [2]. Therefore, patients with history of trauma require classical radiographic assessment in addition to ultrasound evaluation [20]. On the other hand, patients with well-established recurrent dislocations may avoid large amounts of radiation by having adequate evaluation with ultrasound. This includes athletic individuals with Hill-Sachs lesions or patients with rotator cuff laxity secondary to the sequelae of a previous stroke [10, 12, 21, 22]. Specifically, Hill-Sachs and Bankart lesions have been shown to be particularly evident with ultrasound evaluation, making risk stratification for future dislocations possible solely with ultrasound assessment [21, 23].

C) Is ultrasound useful in the diagnosis of other shoulder pathology?

A previous review on shoulder ultrasound by Allen and Wilson in 2001 showed that ultrasound has been used effectively for many types of shoulder pathology in the 20th century

including rotator cuff tears, biceps tendon pathology, osteophyte formation, subacromial impingement and ganglion cyst drainage [1]. Additionally in 2007 McNally and Rees reviewed the use of ultrasound in impingement syndromes and recurrent dislocations via the identification of Hill-Sachs lesions as described here previously [11]. Additional studies during the early 21st and 20th centuries describe the use of ultrasound for soft tissue pathology, muscle avulsions, joint effusions and glenohumeral subluxation [24].

2) Is Ultrasound Useful in the Application of Nerve Block for Shoulder Dislocation Reduction?

Sedation and analgesia particularly for young patients presenting to an emergency department with an acute dislocation is often an area of much debate regarding safety. Conscious sedation offers patient comfort, but carries risks of aspiration and respiratory depression [25]. To avoid these risks and to achieve maximal patient comfort, intra-articular injections and nerve blocks have been described to serve this purpose. A pediatric emergency medicine review by Aronson and Mistry in 2014 describe intra-articular injection of lidocaine via landmarks showing success rates from 48-100% based on studies from 1995-2011 [25]. A case report in the same year reported success in utilizing ultrasound for intra-articular lidocaine block, noting that several studies proposing solely landmark approaches reported that adequate analgesia was mainly limited by adequate landmark identification [26].

Alternatively, the interscalene brachial plexus block under ultrasound guidance has been described in many studies and summarized by a review for regional anesthesia outside of the operating room by Buck et al. in 2012 with good results [27]. A case report and small prospective study by Tezel et al in 2014 has also reported suprascapular nerve block approaches for analgesia in shoulder reduction [28, 29]. Additionally a prospective comparison of sedation and interscalene nerve blocks in the ED by Blaivas et al. in 2011 showed a significant reduction in patient length of stay without any reduction in patient satisfaction or increase in adverse events [30]. These studies illustrate that adequate analgesia and increased safety can be obtained with the use of ultrasound for visualizing both intra-articular and nerve block injections in patients with acute shoulder dislocation.

3) Is Phantom Training with Shoulder Ultrasound Effective for Ultrasound use in Shoulder Dislocation?

As is the case with all ultrasound examinations, the skill of the practitioner is the most important predictor of success [13]. As a standard of care, an imaging modality must be reproducible. However, the largest limit to ultrasound use is reproduc-

ibility secondary to user differences [23, 31, 32]. Additionally, static images are a poor method of reporting ultrasound findings to radiologists, leading to many false positives and negatives that could be evaluated better with a more dynamic approach [23]. This makes the ultrasonographer's performance of the ultrasound examination and dynamic evaluation of the study imperative [3, 6, 9, 22, 23]. As ultrasound technology has evolved over the years, training for the use of ultrasound for various applications has advanced as well in the way of Phantom models. These models are made of a radiolucent material that replicates human tissue and anatomy for a variety of situations to train practitioners to utilize ultrasound in a variety of ways. In 2014, Adusumilli, McCreesh and Evans described the development of an anthropomorphic shoulder phantom model with the purpose of measuring acromiohumeral distance [33]. Additional shoulder models including those for rotator cuff pathology are also available for practitioner training to improve the reproducibility of these examinations. To date, however, there has not been a model developed specifically for the use of ultrasound for shoulder dislocation and associated fractures, though this methodology is used in clinical practice [2].

DISCUSSION

Through this review of the literature, trends in ultrasound examinations of the shoulder over the recent decades were reviewed, with specific focus on shoulder dislocation diagnosis and treatment.

The approach to this topic included three pertinent questions to guide the discussion:

- 1) Is ultrasound useful in the diagnosis of shoulder dislocation, shoulder fracture or other shoulder pathology?
- 2) Is ultrasound useful in the application of nerve block for shoulder dislocation reduction?
- 3) Is phantom training with shoulder ultrasound effective for ultrasound use in shoulder dislocation?

In response to the first question current literature in the use of ultrasound for shoulder dislocations (specifically in the emergency department) was evaluated. Ultrasound approaches the sensitivity to that of traditional radiographs but with quicker results and shorter patient stays [2, 3]. It appears that there is still a population of patients that would benefit from traditional radiographs as full evaluation for fracture cannot be fully explored with ultrasound based on the current literature [20]. There are, however, a number of pathological states that predispose certain individuals to chronic easy dislocations where

the risk of fracture in these patients is minimal. In these patients, an assessment with only ultrasound may be sufficient to meet the standard of care although this has not been specifically studied to date [21, 23]. It appears that the field of ultrasound use in shoulder assessment has been expanding rapidly as ultrasound technology has improved [1]. Further research should specifically include risk criteria for fracture and absolute sensitivity and specificity measurements for ultrasound assessment of concomitant fractures associated with dislocations to better risk stratify patients.

The use of ultrasound for intraarticular and regional anesthesia nerve blocks for shoulder reduction was reviewed. Although there are methods for landmark intra-articular injections that are routinely practiced, studies in the literature review of these techniques show that the main cause of failure to achieve analgesia in these patients is due to lack of ability to identify landmarks. To simplify this process, utilizing ultrasound for intra-articular injections improves both accuracy and provider confidence [25, 27, 34]. Additional research should look at more robust prospective study designs comparing landmark intra-articular injections to ultrasound guided injections in terms of success, patient satisfaction, and degree of analgesia. Further studies should also compare regional anesthesia methods to intra-articular injections in terms of efficacy and safety.

Lastly, it appears that the successful use of ultrasound depends on the user's ability to improve the reproducibility of this imaging modality. The use of phantom models has increased dramatically over the recent decade, and a preliminary shoulder model has been developed for a variety of shoulder pathologies but none for shoulder dislocations specifically [33]. It is felt that further research is needed here in regard to shoulder dislocations as much of the literature on the use of ultrasound in this application relies on user expertise. A reliable, reproducible model that has dislocate/relocate capabilities would benefit the use of ultrasound in this field greatly. Additionally, a shoulder model that allows for practice with regional anesthesia block practice would be particularly beneficial especially given that concerns for safety have been raised from anesthesiologists that feel emergency medicine physicians may not have adequate training to avoid complications with these techniques [35].

CONCLUSION

Ultrasound technology has rapidly grown throughout the medical community as image quality has vastly improved over recent decades. In particular, emergency departments can utilize bedside ultrasonography for numerous medical appli-

cations including accurate evaluation of shoulder dislocations and reductions. In this review of the literature, the usefulness of ultrasound in the diagnosis of a shoulder dislocation as well as concomitant fractures and other shoulder pathology was reviewed. Additionally, the use of ultrasound for shoulder nerve blocks as well as current known methods for training medical personnel to use ultrasound via phantom models was explored. Lastly, trends in research were discussed that may indicate where the next advances in the use of this technology for shoulder dislocations. From this review of the literature, it appears that ultrasound is a robust way of evaluating and treating shoulder dislocations in ways that other imaging modalities cannot offer.

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