

# Contrast-enhanced Ultrasonography for the Diagnosis of Frozen Shoulder

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## Abstract

**Introduction:** Adhesive capsulitis (AC), also known as frozen shoulder, is challenging for diagnosis, particularly in early stages. A promising tool is contrast-enhanced ultrasonography (CEUS), which has been successfully applied on musculoskeletal ultrasonography. **Methods and Results:** Two antecedent studies reported the application of CEUS on AC patients although different methods were used. The first research team administered the contrast media intravenously to facilitate detection of microcirculation through observing different distributions of time–intensity curves between the affected and unaffected shoulders. The second study has introduced a pioneering approach, injecting the contrast media mixed with saline directly into the glenohumeral joint. The authors designated this novel method as “US arthrography”. According to our best knowledge, this is the first study reporting the application of intraarticular CEUS in humans. **Conclusion:** Both presented studies reported CEUS to be capable of differentiating shoulders with AC from normal controls.

**Keywords:** Adhesive capsulitis of the shoulder, arthrography, contrast agent, diagnostic ultrasound, frozen shoulder

## INTRODUCTION

Adhesive capsulitis (AC), also referred to as frozen shoulder, is presented with insidious onset of severe shoulder pain and range of motion restriction. Accurate diagnosis can be challenging because findings on currently available imaging (such as radiographs, ultrasound, plain magnetic resonance imaging [MRI], and computed tomography) are usually unremarkable.<sup>[1]</sup> The imaging modalities are, therefore, limited to ruling out concurrent pathologies, like rotator cuff tendon tear and glenohumeral joint osteoarthritis.<sup>[2]</sup>

## ULTRASOUND IMAGING METHODS

The imaging tool mostly applied on patients with AC is high-resolution, real-time musculoskeletal ultrasonography (MUS),<sup>[3]</sup> which has emerged as the first line to scrutinize shoulder pathology. Until now, there is a lack of specific ultrasound findings for the diagnosis of AC. A commonly referred ultrasound finding is the presence of fluid accumulation around the long head of the biceps

tendon. However, this effusion may accompany rotator cuff disorders or biceps tenosynovitis. Therefore, although biceps peritendinous effusion is prevalent in shoulders with AC, it is insensitive for AC diagnosis because it might be a result of other shoulder pathology.<sup>[4]</sup> To be comprehensive, several investigators reported ultrasound evidence of thickening of the coracohumeral ligament (CHL) in patients with AC.<sup>[5,6]</sup> Anyhow, CHL morphology is frequently challenging to evaluate precisely with MUS, due to its location (deep to the deltoid muscle), possible anatomic variants, and a restricted range of motion to inspect the rotator interval in the stiff shoulder. Furthermore, there is no clear cutoff value to indicate AC using the above-mentioned methods, making them less useful in daily clinical practice. Since frozen shoulder has a great impact on patient’s quality of life and work performance, there is an urgent need for an advanced imaging technique to early diagnose AC.

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### Contrast-enhanced ultrasonography

Two antecedent studies reporting the application of contrast-enhanced ultrasonography (CEUS) in AC patients have recently been published.<sup>[7,8]</sup> Application of the microbubble-based ultrasound contrast agents (increasing liquid substance echogenicity) in musculoskeletal medicine has already been adopted for selected indications.<sup>[9]</sup> A research team of Ahn *et al.* administered the contrast media intravenously to facilitate the detection of microcirculation. The investigators studied different scores of time–intensity curves between the affected and unaffected shoulders. Contrast-enhanced MRI records served as controls. On the other hand, Cheng *et al.* introduced a pioneering approach, injecting the contrast media (mixed with saline) directly into the glenohumeral joint. The authors designated this novel method as “US arthrography”. According to our best knowledge, this is the first rigorously reported intraarticular injection of ultrasound contrast agent in humans. Of note, 2 years before the publication of US arthrography, Cheng *et al.* conducted a parallel study injecting the contrast agent into the subacromial bursa, labeling the method more deferential lane as “US-guided bursography.”<sup>[10]</sup> Both studies reported contrast-enhanced ultrasound to be capable of differentiating shoulders with AC from normal controls.

### DISCUSSION

The study by Ahn *et al.* investigating intravenous contrast media administration in five AC patients describes the enhancement of the capsule margining rotator interval, capable of evaluating capsular vascularity comparable to contrast-enhanced MRI. To summarize, filling defects and enhanced synovial microcirculation of the joint cavity and under US arthrography may be treated as a useful sign to indicate AC.

On the contrary, high cost, rapid microbubble removal from circulation, invasiveness, possible adverse effects from the contrast media and patient safety aspects might burden adopting CEUS as the widespread method of choice for patients suspected from AC. The value of contrast agents in confirming AC diagnosis appears to be promising, particularly in ambiguous clinical scenarios. Contrast-enhanced ultrasound diagnosis of AC is a matter of discussion and an auspicious subject for further investigation. What’s more, the

above-discussed research has emerged to describe the first rigorous study reporting intraarticular injections of ultrasound contrast agents. The novel method entitled by authors as US arthrography has been established. Fresh insight followed by potential progress in CEUS research is anticipated. One important limitation of this manuscript is an absence of relevant US images.

### Acronyms

US arthrography: a new term the authors used for intraarticular contrast media administration and subsequent ultrasound examination.

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### Conflicts of interest

There are no conflicts of interest.

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