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Cross-Sectional Analysis

Ultrasound- Versus Landmark-Guided Corticosteroid Injections for Shoulder Pain: Evaluating the Overlapping Meta-Analyses of Randomized Controlled Trials

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Background: Shoulder pain is frequently treated with corticosteroid injections administered via ultrasound-guided (USG) or landmark-guided (LMG) approaches. Despite the widespread use of these injections, consensus on their comparative efficacy is lacking due to conflicting results reported in prior meta-analyses.

Objective: To compare overlapping meta-analyses of USG to those of LMG injections in order to resolve current discrepancies, determine the highest-quality evidence, and offer clear recommendations for clinical practice.

Study Design: A cross-sectional analysis.

Setting: English-language systematic reviews and meta-analyses searched in PubMed, Embase, and Cochrane Library up to February 12, 2025, regarding USG management of shoulder pain.

Methods: A comprehensive literature search was conducted to identify meta-analyses of randomized controlled trials (RCTs) that assessed USG and LMG corticosteroid injections in the treatment of shoulder pain. Methodological quality of the included meta-analyses was assessed, and the Assessment of Multiple Systematic Reviews (AMSTAR) scores were calculated. The Jadad decision algorithm was applied to determine the highest-quality evidence.

Results: The analysis encompassed 9 meta-analyses, the AMSTAR ratings of which ranged between 5 and 9. Through the Jadad algorithm, one high-quality study was identified. Its findings indicated that USG injections did not significantly outperform LMG injections in terms of pain relief or functional outcomes for subacromial bursa and glenohumeral joint targets. However, for injections involving the brachial bicipital groove, the USG approach demonstrated greater efficacy in alleviating pain.

Limitations: First, the restriction to English-language literature might have introduced language bias by excluding relevant non-Anglophone studies. Second, the included studies provided only Level II evidence, so this analysis could not establish clinical recommendations grounded in the highest tier (Level I) of empirical support.

Conclusions: USG corticosteroid injections are recommended for targeting the brachial bicipital groove due to their superior efficacy in pain reduction, while LMG injections remain appropriate for the subacromial bursa or glenohumeral joint.

Key words: Shoulder pain, ultrasound, landmark, corticosteroid, injections, meta-analysis

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Shoulder pain is a widespread issue within the musculoskeletal system, impacting countless individuals worldwide (1). The condition significantly diminishes quality of life and contributes to considerable financial strain on both individuals and health care systems (1,2). Estimates of the prevalence of shoulder pain range from 0.7% to 55.2%, with a median of 16% across populations (1). This high prevalence drives substantial health care costs, encompassing both direct medical expenses and indirect costs from lost productivity (2). A cost analysis conducted in Sweden estimated that the financial impact of shoulder pain reached approximately €4,139 per individual, with more than 80% of the cost attributed to time off work due to illness (2). These figures underscore the urgent need for effective and efficient treatment strategies for shoulder pain (1,2).

One widely used treatment is corticosteroid injection, known for its anti-inflammatory effects and capacity to deliver prompt pain alleviation (3,4). Traditionally, these injections have been administered based on anatomical landmarks in a "blind" fashion, meaning the exact placement of the injection is guided by external reference points rather than real-time visualization (3-5). However, LMG accuracy may be influenced by anatomical variability, obesity, and operator experience, leading to suboptimal treatment outcomes (3-5). Recently, ultrasound-guided (USG) injections have emerged as a promising alternative (4,5). USG injection allows real-time visualization of the target structures, potentially enhancing the precision and effectiveness of the injections (4).

A substantial number of systematic reviews and meta-analyses have explored the comparative effectiveness of USG versus landmark-guided (LMG) injections in the treatment of shoulder pain (3,4,6-12). However, these studies report inconsistent findings, with some demonstrating meaningful improvements in pain relief and functional outcomes with the USG approach (3,10), while others show no notable differences between the 2 methods (4,12). These discrepancies highlight the need for a more thorough and comprehensive evaluation of the available evidence.

Cross-sectional analyses of overlapping meta-analyses represent a rigorous approach to synthesizing evidence, offering insights by assessing the consistency and quality of multiple meta-analyses on the same clinical question (13,14). However, this approach has not yet been applied to the comparison between USG and LMG techniques for shoulder conditions. The current study aimed to address this gap by performing a cross-sectional synthesis of existing meta-analyses, and to support evidence-based clinical decision-making and clarify guidance for practitioners facing contradictory conclusions in the literature.

Methods

Search Strategy

This cross-sectional analysis was conducted following established methodologies used in similar research (13,14). On February 12, 2025, a structured search was performed using 3 major biomedical databases: PubMed, Embase, and the Cochrane Library. Search terms included "shoulder pain," "frozen shoulder," "adhesive capsulitis," "shoulder impingement syndrome," "rotator cuff," "bursitis," "image-guided," "ultrasound," "ultrasound-guided," "ultrasonography," "meta-analysis," and "systematic review." Two reviewers executed the database queries independently, restricting results to English-language articles. Additionally, the reference lists of selected studies were hand-searched to uncover potentially relevant articles not found through database queries.

Eligibility Criteria

To be included in this analysis, studies were required to meet the following standards: (1) they must have compared USG and LMG corticosteroid injections directly as methods of managing shoulder pain; (2) they had to be meta-analyses composed solely of randomized controlled trials (RCTs); and (3) they needed to report at least one pertinent clinical measure, such as pain intensity, functional outcomes, or adverse events. Studies were excluded if they were narrative reviews, conference proceedings, letters, or meta-analyses that incorporated non-RCT designs or lacked quantitative synthesis.

Study Selection

The selection process was carried out by 2 independent reviewers. A preliminary review of titles and abstracts was conducted to filter out irrelevant articles. Full texts of studies considered potentially appropriate were then evaluated in detail. Any disagreements between reviewers were settled through discussion, and if no consensus was reached, a third reviewer provided the final judgment on the article's inclusion.

Data Extraction

Data collection was carried out independently by 2

reviewers, who used a standardized template to ensure consistency. Extracted information included the name of the first author, the year of publication, the journal name, the databases utilized, the date of the final literature search, the language and publication status restrictions, the number of RCTs included, the software used for analysis, the I^2 values, and the primary clinical outcomes. Any inconsistencies in data extraction were resolved by involving a third author.

Quality Appraisal

The rigor of each included meta-analysis was evaluated based on 2 assessment tools: the Oxford Levels of Evidence (13), designed to categorize the strength of evidence, and the Assessment of Multiple Systematic Reviews (AMSTAR) tool (16), a validated instrument for assessing the methodological quality of systematic reviews (17,18). These evaluations were performed independently by 2 reviewers. In cases of disagreement, discussions were held to resolve the issue, with a third reviewer intervening when necessary.

Jadad Decision Algorithm Application

To explore the reasons behind divergent results among the included meta-analyses, the Jadad decision algorithm was employed (19). This method facilitated the examination of potential sources of variation, such as differences in study selection criteria, quality assessments, statistical approaches, and definitions of clinical questions (19). The Jadad algorithm, a well-established method for resolving discordant results in meta-analyses (13,14), was employed by 3 independent reviewers to identify the most trustworthy and comprehensive evidence for informing clinical decisions.

Results

Study Screening

The study selection process is illustrated in the flow diagram (Fig. 1). An initial search yielded 876 records, from which 9 meta-analyses were ultimately deemed eligible for inclusion (3,4,6-12). A summary of their major characteristics is presented in Table 1. These meta-analyses were published between 2011 and 2025 and incorporated primary RCTs conducted between 2004 and 2021. The number of RCTs included in each meta-analysis ranged from 2 to 20 (Table 2).

Search Methodology

Of the 9 included studies, 5 focused exclusively

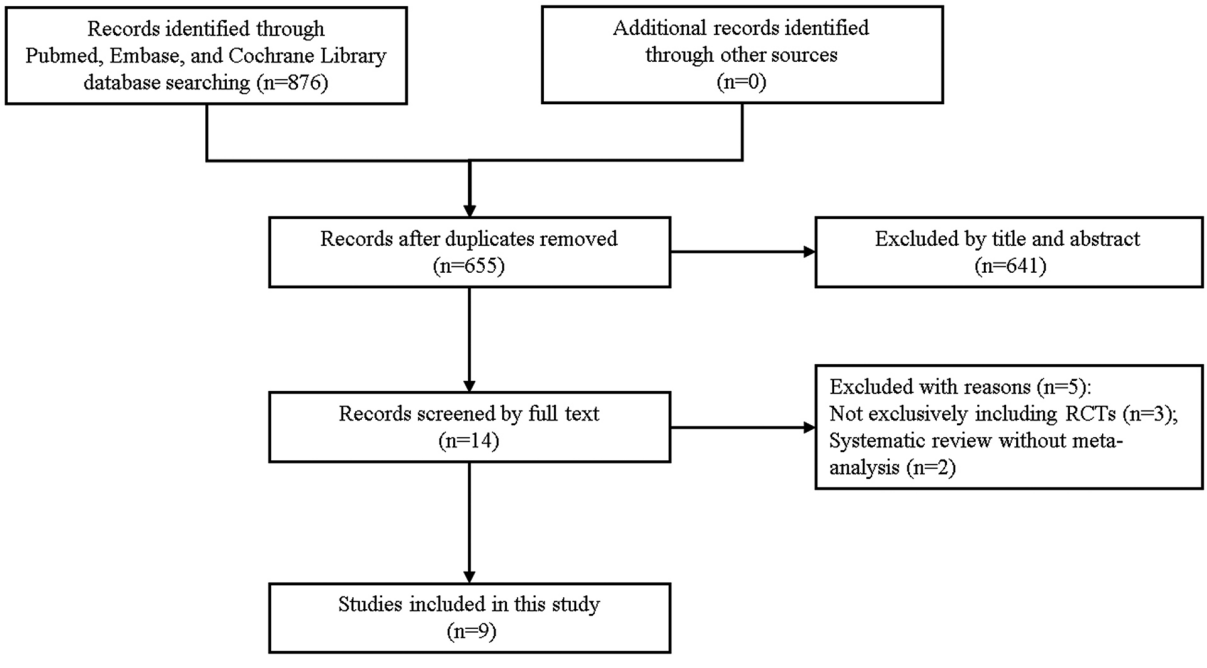


Fig. 1. *Flowchart of study selection.*

Table 1. *Characteristics of included meta-analyses.*

First Author	Publication Year	Journal	Last Literature Search Date	Number of Included RCTs
Soh E (15)	2011	BMC Musculoskeletal Disorders	March 2011	2
Aly AR (20)	2015	British Journal of Sports Medicine	July 2013	9
Wu T (11)	2015	Seminars in Arthritis and Rheumatism	March 2015	7
Ayekoloye CI (21)	2020	Indian Journal of Orthopaedics	April 2017	4
Kumar PH (19)	2021	Cureus	June 2021	20
Deng X (6)	2022	American Journal of Physical Medicine & Rehabilitation	August 2021	12
Fan D (8)	2022	Arthroscopy	April 2021	15
ElMeligie MM (7)	2023	Journal of Ultrasound	July 2021	18
Zhang Y (12)	2025	Journal of Clinical Ultrasound	December 2023	13

Table 2. *Primary studies included in meta-analyses.*

First Author (Year)	Soh E (2011) (43)	Aly AR (2015) (3)	Wu T (2015) (44)	Ayekoloye CI (2020) (4)	Kumar PH (2021) (25)	Deng X (2022) (14)	Fan D (2022) (18)	ElMeligie MM (2023) (17)	Zhang Y (2024) (49)
Naredo E (2004) (22)	+	+	+		+			+	+
Chen MJ (2006) (23)		+	+		+	+		+	+
Ucuncu F (2009) (24)	+	+	+		+		+	+	+
Lee HJ (2009) (25)		+			+		+	+	+
Ekeberg OM (2009) (26)					+				
Panditaratne N (2010) (27)					+	+		+	
Zhang J (2011) (28)		+			+		+	+	
Hashiuchi T (2011) (29)		+			+			+	
Zufferey P (2012) (30)		+	+		+		+	+	
Dogu B (2012) (31)		+	+	+	+	+	+	+	+
Hsieh LF (2013) (32)		+	+	+	+	+	+	+	+
Chang WH (2014) (33)									+
Saeed A (2014) (34)			+		+	+		+	
Lee HJ (2015) (35)							+		
Haghighat S (2015) (36)				+	+	+	+	+	+
Cole BF (2016) (37)				+	+	+	+	+	+
Raeissadat SA (2017) (38)									+
Kamal K (2018) (39)					+		+		
Bhayana H (2018) (40)					+	+	+	+	
Cao W (2018) (41)						+			
Yiannakopoulos CK (2020) (42)					+		+	+	+
Raeissadat SA (2020) (43)					+			+	
Akbari N (2020) (44)					+	+	+	+	
Roddy E (2021) (45)						+			
Azadvari M (2021) (46)						+	+		+
Cho CH (2021) (47)					+		+	+	+

on English-language literature (3,6,8-10), while the remaining 4 either reported no language restrictions or avoided imposing them (4,7,11,12). PubMed was the most commonly searched database, followed by the Cochrane Library. The inclusion of other databases, such as Medline, Web of Science, Embase, Google Scholar, and Scopus, was inconsistent across the studies. Table 3 provides a comprehensive comparison of the search methods employed.

Methodological Quality

All included studies synthesized Level II evidence (Oxford criteria) by analyzing RCTs exclusively (Table 4). RevMan (Cochrane) dominated as the analytical tool (3,4,6,8-12), while only one study applied the GRADE methodology (6). AMSTAR scores, reflecting systematic review quality, spanned 5-9 (median = 7) (Table 5).

Evaluation of Heterogeneity

Heterogeneity was quantified using the I2 index (Table 6). Sensitivity analyses were performed in 4 studies (4,6,7,9), whereas 3 meta-analyses neglected sensitivity or subgroup testing (Table 4) (3,10,11).

Results of Jadad Decision Algorithm

To identify the most robust source of evidence among the 9 included meta-analyses, the Jadad decision algorithm was employed (19). A summary of the

Table 3. *Search methodology for included meta-analyses.*

First Author (Year)	Language Restriction	Publication Status Restriction	Search Database							
			PubMed	Medline	Embase	Cochrane Library	Web of Science	Google Scholar	Scopus	Others
Soh E (2011) (15)	NA	NA		+	+					
Aly AR (2015) (20)	Yes	NA	+	+		+				
Wu T (2015) (11)	NA	NA	+	+	+	+	+	+	+	
Ayekoloye CI (2020) (21)	NA	NA	+	+	+	+	+	+	+	+
Kumar PH (2021) (19)	Yes	NA	+			+	+			
Deng X (2022) (6)	Yes	NA	+		+	+	+		+	+
Fan D (2022) (8)	Yes	NA	+		+	+				
ElMeligie MM (2023) (7)	Yes	NA	+	+		+	+		+	+
Zhang Y (2025) (12)	No	NA	+							

Table 4. *Methodological information about included meta-analyses.*

First Author (Year)	Study Design	Level of Evidence	Software Used	GRADE Used	Subgroup Analysis	Sensitivity Analysis
Soh E (2011) (15)	RCT	Level II	Revman	No	No	No
Aly AR (2015) (20)	RCT	Level II	Revman	No	No	No
Wu T (2015) (11)	RCT	Level II	Revman	No	No	No
Ayekoloye CI (2020) (21)	RCT	Level II	Revman	No	No	Yes
Kumar PH (2021) (19)	RCT	Level II	OpenMeta	No	No	Yes
Deng X (2022) (6)	RCT	Level II	Revman, STATA	Yes	Yes	Yes
Fan D (2022) (8)	RCT	Level II	Revman	No	Yes	No
ElMeligie MM (2023) (7)	RCT	Level II	R	No	Yes	Yes
Zhang Y (2025) (12)	RCT	Level II	Revman	No	Yes	No

Table 5. *AMSTAR scores of included meta-analyses.*

Items	Soh E (2011) (15)	Aly AR (2015) (20)	Wu T (2015) (11)	Ayekoloye CI (2020) (21)	Kumar PH (2021) 19	Deng X (2022) (6)	Fan D (2022) (8)	ElMeligie MM (2023) (7)	Zhang Y (2025) (12)
1. Was an a priori design provided?	0	0	0	0	0	1	1	0	0
2. Was there duplicate study selection and data extraction?	1	0	0	1	0	1	1	0	1
3. Was a comprehensive literature search performed?	1	1	1	1	1	1	1	1	0
4. Was the status of publication (e.g., grey literature) used as an inclusion criterion?	0	0	0	0	0	0	0	0	0
5. Was a list of studies (included and excluded) provided?	1	0	0	0	0	0	0	1	0
6. Were the characteristics of the included studies provided?	1	1	1	1	1	1	1	1	1
7. Was the scientific quality of the included studies assessed and documented?	1	1	1	1	1	1	1	0	1
8. Was the scientific quality of the included studies used appropriately in formulating conclusions?	1	1	1	1	1	1	1	1	1
9. Were the methods used to combine the findings of studies appropriate?	1	1	1	1	1	1	1	1	1
10. Was the likelihood of publication bias assessed?	0	0	0	1	0	1	1	1	0
11. Was the conflict of interest stated?	1	1	0	1	1	1	1	1	1
Total scores	8	6	5	8	6	9	9	7	6

comparative results is depicted in Fig. 2. Although all studies addressed a common research question, variations in trial inclusion and methodological criteria led to divergent conclusions. According to the Jadad framework, the optimal evidence should be selected based on factors such as publication status, methodological rigor of the included randomized trials, presence or absence of language restrictions, and use of individual patient data. When those criteria were applied, the meta-analysis conducted by Fan et al (8) was identified as the most methodologically sound synthesis (Fig. 3). Their analysis indicated that, for corticosteroid injections targeting the subacromial bursa and glenohumeral joint, USG did not outperform significantly LMG techniques in terms of pain reduction or functional outcomes. However, when the target was the brachial bicipital groove, USG injections demonstrated superior analgesic efficacy over non-image-guided approaches. In light of these findings, USG injections are recommended for procedures involving the brachial bicipital groove, as such injections are more effective in alleviating pain. Conversely, LMG injections remain a valid and appropriate option for the subacromial bursa and glenohumeral joint.

Discussion

Shoulder pain poses a considerable public health concern worldwide, given the high incidence and associated financial impact of the condition (1,2,4). These factors highlight the urgent necessity for interventions that are both grounded in evidence and economically sustainable (3,4,6-12). Corticosteroid injections, a cornerstone of nonsurgical management, have traditionally relied on LMG techniques (4). However, the emergence of USG injections has sparked debate over their comparative efficacy, as meta-analyses to date have yielded conflicting conclusions (3,4,6-12). Cross-sectional analyses of overlapping meta-analyses

Table 6. *I^2 statistic values for each variable in meta-analyses.*

Items	Soh E (2011) (15)	Aly AR (2015) (20)	Wu T (2015) (11)	Ayekoloye CI (2020) (21)	Kumar PH (2021) (19)	Deng X (2022) (6)	Fan D (2022) (8)	ElMeligie MM (2023) (7)	Zhang Y (2025) (12)
VAS	61%	0%	89%	98%	85%	77%	79%	79%	90%
VAS by different injection approaches							74%		
VAS by brachial bicipital groove injection							64%		
VAS by subacromial bursa injection							74%		
VAS by glenohumeral joint injection							0%		
Shoulder function scores	22%	70%	34%	67%	15%	93%		61%	
CMS score							96%	70%	
CMS score by subacromial bursa injection							97%		
ASES score							0%		
SPADI				92%	0%		0%	98%	
SDQ score			0%	97%			0%	65%	
DASH score								0%	
Range of motion						0%			
Abduction			87%		95%		0%	96%	0%
Flexion							0%		0%
External rotation									0%
Internal rotation									35%
Effective rate			0%						
Adverse effects	0%	NA			0%			0%	

provide a robust framework for synthesizing evidence by examining the consistency and quality of various systematic reviews on a particular subject (13,14,19). This approach helps to identify the most reliable evidence and resolve discrepancies among studies (13,14). Our research is the inaugural cross-sectional evaluation of related meta-analyses that compare USG and LMG injections for treating shoulder pain. By evaluating the methodological quality, heterogeneity, and consistency of findings across multiple meta-analyses, we aimed to provide clarity on the comparative efficacy of these 2 injection techniques (13,14,19).

Most of the included meta-analyses, though conducted during overlapping time frames and employing broadly similar search strategies, exhibited significant heterogeneity in their selection of primary trials and conclusions regarding shoulder pain treatment (3,4,6-12). These discrepancies highlight the challenges of synthesizing evidence when systematic reviews of a subject diverge in methodology and interpretation (13,14,19). Jadad et al (19) highlighted several important factors that led to these inconsis-

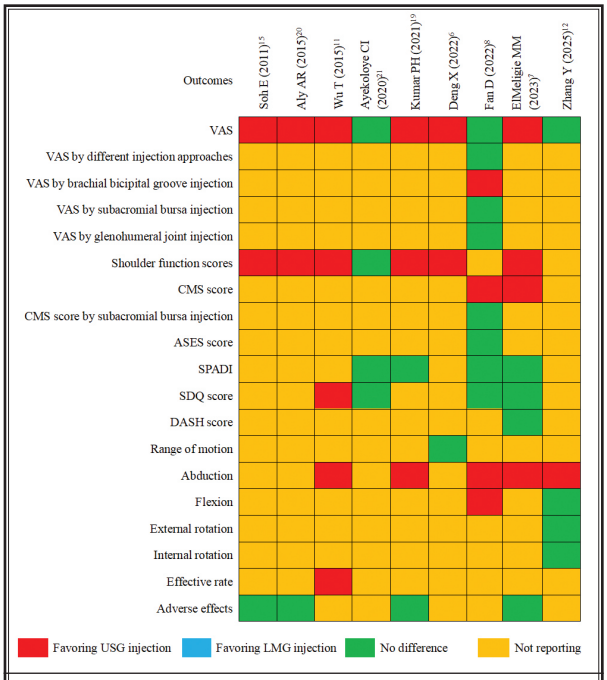


Fig. 2. *Results of included meta-analyses.*

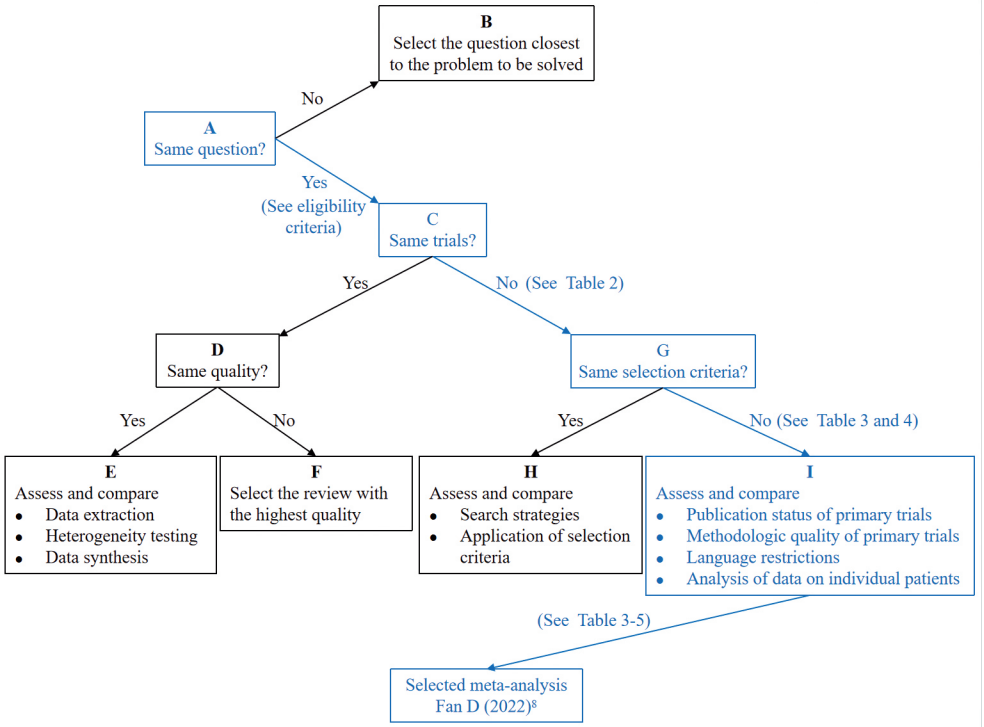


Fig. 3. *Flowchart of Jadad decision algorithm.*

tencies, such as variations in the definitions of clinical questions, differences in study inclusion and exclusion criteria, inconsistencies in data extraction methods, discrepancies in quality assessment techniques, variations in evaluations of combinability, and differing statistical methods of data synthesis. To address these issues, our research utilized Jadad's decision algorithm (19), a recognized framework designed to pinpoint the highest-quality evidence from conflicting systematic reviews. This method prioritizes methodological rigor, transparency in selection criteria, and analytical coherence, enabling researchers to systematically navigate overlapping but contradictory meta-analyses (13,14,19). By adopting this approach, we ensured that clinical recommendations for shoulder pain management were grounded in the most robust available evidence, minimizing bias introduced by methodological variability across reviews (13,14,19).

The Jadad decision algorithm identified Fan et al's meta-analysis (8) as the study with the highest-quality evidence, showing that in terms of pain relief or functional enhancement, USG provided no notable benefits over LMG for interventions into the subacromial bursa or glenohumeral joint. This finding aligns with previous studies suggesting that anatomical accessibility and operator expertise may mitigate the theoretical benefits of real-time visualization in these regions (4,12). However, USG injections provided greater pain relief than LMG injections when targeting the brachial bicipital groove, likely because of the deeper and more variable anatomy of this site, where precise needle placement is challenging without imaging guidance (3,8). The disparity in accuracy between USG and LMG techniques is more pronounced in the brachial bicipital groove than in other injection sites, underscoring the importance of precise targeting in this anatomical area (8). LMG injections exhibit lower accuracy in deeper anatomical structures, which heightens the risk of off-target injections (4). These findings highlight the critical importance of anatomical specificity when evaluating injection efficacy; this factor is frequently overlooked in broader analyses (3-5,8). Based on these findings, USG injections are recommended for targeting the brachial bicipital groove due to their superior efficacy in pain reduction, while LMG techniques remain appropriate for other anatomical sites, such as the subacromial bursa or glenohumeral joint, where anatomical accessibility and cost-effectiveness outweigh the need for real-time visualization.

Another important aspect of our results is the overall methodological quality of the meta-analyses reviewed. Each of these analyses included only RCTs, which offered robust evidence (13). However, the variability in methodological quality, as indicated by AMSTAR scores, highlights the importance of scrutinizing the rigor of the systematic reviews themselves (16). Sensitivity analyses conducted in some studies demonstrated how methodological quality could influence study outcomes, further emphasizing the need for careful evaluation of the evidence (3,4,6-12). Our use of the Jadad decision algorithm helped identify the most reliable evidence based on publication status, methodological quality, and data analysis, allowing us to present a more robust conclusion (16).

Our results carry significant implications for clinical practice and future research. Clinically, this study suggests that USG injections should not be prioritized universally over LMG injections. For clinicians, the inconsistent superiority of USG injections to their LMG counterparts suggests that the choice of injection technique should be guided by the specific anatomical target, the patient's characteristics, and the availability of ultrasound equipment (3,4,6-12). For readily accessible sites like the subacromial bursa, LMG remains a cost-effective option, particularly in resource-limited settings in which ultrasound equipment and trained personnel are scarce (3,4,6-12). This selective approach aligns with cost-effectiveness principles, since unnecessary use of USG could exacerbate the already substantial economic burden of shoulder pain, as exemplified by Swedish data showing that over 80% of costs derive from indirect factors like lost productivity (1). Conversely, USG's superiority in complex anatomical targets (e.g., the bicipital groove) justifies its use in cases that require precision for the avoidance of off-target injections, which are associated with reduced efficacy and prolonged recovery (3,4). For future research, our analysis underscores the need for more rigorous and consistent methodological approaches in meta-analyses. These approaches include the use of comprehensive search strategies, explicit language inclusion criteria, and robust heterogeneity assessments. Moreover, additional high-quality RCTs are required to better understand the comparative effectiveness of the USG and LMG approaches in various anatomical locations and among different patient groups (3,4,6-12).

The current study has several limitations. Firstly, while this cross-sectional analysis incorporated searches across multiple databases, its scope was restricted to literature published only in English. Consequently, non-English studies meeting the inclusion criteria were excluded, potentially introducing language bias and overlooking relevant research from non-Anglophone regions. Secondly, the methodological framework prioritized high-quality evidence by including only RCTs in meta-analyses. However, the evidence in all retained studies was classified as Level II. Consequently, this study cannot establish clinical recommendations grounded in Level I evidence, which represents the highest tier of empirical support.

Conclusions

The current study is the inaugural cross-sectional evaluation of overlapping meta-analyses designed to assess the evidence on USG and LMG injection techniques for the treatment of shoulder pain. The most reliable findings suggest that USG injections are the superior choice for targeting the brachial bicipital groove, as they have proven more effective in alleviating pain. In contrast, LMG techniques are still suitable for other anatomical sites, such as the subacromial bursa or glenohumeral joint, where ease of access and cost-effectiveness are more important than the need for real-time visualization. Clinicians should adopt a tailored approach, balancing anatomical complexity, resource availability, and cost considerations to optimize outcomes in this prevalent and economically consequential condition. Future research should focus on rigorous methodological approaches and high-quality RCTs to further elucidate the comparative efficacy of these injection techniques.

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