Accuracy and Efficacy of Intra-articular Knee Injections/ Aspirations Under Ultrasound Versus Landmark Guidance

A Systematic Review

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Purpose: The aim of the study was to review the current literature on the accuracy and efficacy of ultrasound- and landmark-guided intra-articular knee injections.

Methods: A systematic review was performed following the Cochrane process from April 2023 to August 2023 utilizing PubMed, Embase, Web of Science, and Scopus. Branched logic was used to include articles containing terms regarding the knee AND ultrasound AND injections. Two authors screened studies for eligibility, and any disagreement was resolved through discussion with a third reviewer. Risk-of-bias assessments were performed.

Results: A total of 13 studies were included in the review. Cumulative accuracies amounted to 95.4% (356/373) versus 82.0% (268/327) for ultrasound-guided and landmark-guided intra-articular knee injections/ aspirations, respectively. All but one study looking at efficacy showed significantly improved outcomes in the ultrasound-guided injection/ aspiration groups.

Conclusions: This systematic review provides data to support that ultrasound-guided intra-articular knee injections/aspirations are more accurate and efficacious than landmark-guided intra-articular knee injections/aspirations.

Level of Evidence: Level I - systematic review.

Key Words: Ultrasound, Landmark, Knee, Injection

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Knee pain is extremely frequent in the general population and accounts for one third of musculoskeletal complaints in the primary care setting.[1] Commonly seen intra-articular knee pathologies include osteoarthritis, chondral defects, and meniscal pathology. Conservative treatment includes lifestyle modification, physical therapy, oral medications, and injections. Intra-articular injections can be both diagnostic and therapeutic, and common injectates for the knee include corticosteroids, hyaluronic acid, blood-derived products such as platelet-rich plasma, and biologic cellular products from bone marrow, placenta, and/or adipose tissue.[2] Accurately injecting into the intra-articular space helps guarantee diagnostic value and maximal efficacy,[3] and given the costs of some of the latter products, this can also have financial implications if not accurately delivered. Additionally, complications from inaccurate injections can also include pain or swelling at the injection site, inflammation of the synovium, damage to patellar cartilage,[4] and septic arthritis.[5]

There are many different approaches to intra-articular knee injections: superior lateral, inferior lateral, superior medial, and inferior medial. There are also many different approaches used to perform them, that is, landmark (LM)-guided which is the most common, ultrasound (US)-guided, and fluoroscopy (FL)-guided. There are studies evaluating the accuracy and efficacy of each of these injection methods individually or in two arm studies, but they are limited in sample size to generalize the results. The objective of this study was to perform a systematic review of the literature regarding the accuracy and efficacy of US- and LM-guided intra-articular knee injections. Fl-guided injections were not included because there were not any studies that met our search criteria comparing the Fl-guided knee injections' accuracy and efficacy compared with the other two modalities. An understanding of the existing literature is required before a determination can be made on the necessity of image guidance for knee injection/aspirations in clinical use.

METHODS

Search Strategy

A systematic review was performed following the Cochrane process from April 2023 to August 2023. Review guidelines were established before performing the search. A multisystem search was performed (PubMed, Embase, Web of Science, and Scopus) for English published articles. We utilized branched logic to include articles containing terms regarding the knee (knee OR knee injuries OR knee osteoarthritis OR tibial meniscus injuries OR knee joint OR meniscus) AND ultrasound (ultrasonography OR interventional ultrasonography OR ultrasound OR ultrasound-guided) AND injections (injections OR steroids OR steroid injection OR saline solution OR placebo OR local anesthetics OR hyaluronic acid OR orthobiologics OR platelet-rich plasma OR mesenchymal stem cells OR adipose tissue OR MFAT OR botulinum toxins OR palpation OR anatomic landmarks OR physical therapy modalities).

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Two authors (DK and RW) screened the studies for eligibility, and any disagreement was resolved through discussion with a third reviewer (NBJ).

Outcome Measures

The main outcome measure for this systematic review was to evaluate the accuracy of each intervention arm. Secondary outcomes were to evaluate efficacy of each treatment arm based on the outcome measures used by existing studies. Because of the limited number of studies that evaluated two different injection techniques and the heterogeneous nature of efficacy measures, a decision was made to prioritize the evaluation of injection accuracy.

Data Abstraction

Data abstraction was completed by a standardized approach for each study. We included the following fields when appropriate: first author, study objective, study design, country location of the study, age in terms of years of the participants, eligibility criteria outlined by the study, number of cases and controls, and results of the study. Results of the studies could include accuracy of the injection, clinician perception on ease of performing the procedure, and patient reported outcomes. See Table 1 for a summary of the included studies.

Assessment of Study Quality

The Newcastle-Ottawa Quality Assessment Scale (NOS) and the Revised Cochrane Risk-of-bias Tool for Randomized Trials (RoB 2) were utilized to assess the studies included in our systematic review. The NOS evaluated the quality of observational studies. It provides a numerical score evaluating a study based on three domains: selection bias, comparability for assessment of confounding, and outcome/exposure. The RoB 2 evaluated the quality of randomized trials. It evaluates the given exposure risk and determines whether a study is at risk of "low," "some concerns," or "high risk."

A Preferred Reporting Items for Systematic Reviews and Meta-analyses checklist is included as supplemental material, http://links.lww.com/PHM/C786.

RESULTS

Overview

Initially a total of 9350 articles were identified to include our search terms; 3812 articles from PubMed, 2078 articles form Embase, 2052 articles from Web of Science, and 1408 articles from Scopus. There were 2503 duplicate records that were removed before screening. We screened 6847 articles across all databases. We excluded 6802 articles based on their title and abstract. A total of 45 articles underwent a full-text review for eligibility. Out of these articles that had a full-text review, 32 articles were excluded because of wrong study design (systematic review, abstract only, or letter to the editor), wrong outcomes (not looking at measures of accuracy), or did not include a comparison group. Thirteen studies were included for final review after meeting our established criteria (Fig. 1).

Most of the studies (8/13) compared the accuracy of US-guided versus LM-guided injection/aspirations.[6–13] This was done utilizing postinjection radiographs (contrast was in the injectate) in the majority of the studies (5/8).[7,8,10–12] However, two of the studies measured accuracy based on successful aspiration of fluid,[6,13] while the last study looked at the amount of colored latex solution in a postinjection dissection (cadaveric study).[9]

A total of seven out of the 13 included studies evaluated efficacy between the two groups,[8,13–18] two of which had also looked at accuracy.[8,13] The remaining five studies compared efficacy but did not look specifically at accuracy.[14–18] Methods to measure efficacy were variable, ranging from visual analog scale (VAS) scores to postinjection arthroplasty rates. See Table 1 for details.

Risk of Bias Assessment

Out of the 13 studies, three were observational studies and were therefore assessed using the NOS.[6,9,15] All studies scored 8 out of 9 points, each losing 1 point in comparability as they did not provide study controls for "additional factors." The other 10 studies were assessed using the RoB 2 and all found to have "low risk of bias." The summary of those evaluations can be found in Tables 2 and 3.

Intra-articular Knee Injection Accuracy

Eight of the 13 studies had performed direct comparison of US-guided versus LM-guided injection/aspirations. In all of them but one,[13] US-guidance led to significantly greater accuracy when compared to LM-guidance. Reported accuracy for US-guided intra-articular knee injections/aspirations in these studies ranged from 91.4% to 96.5%, while those for LM-guided injections/aspiration ranged from 40% to 92.6%. Curtiss et al.[9] and Hashemi et al.[10] showed that the differences in accuracy rates were even more exaggerated in providers who were less experienced. Cumulative accuracies amounted to 95.4% (356/373) versus 82.0% (268/327) for US- and LM-guided injections/aspirations, respectively. The cadaveric study conducted by Curtiss et al.[9] was excluded as absolute numbers were not provided (with only final percentages).

Intra-articular Knee Injection Efficacy

Seven of the 13 studies included in this systematic review looked at efficacy between US- and LM-guided intra-articular knee injections/aspirations. Cunnington et al.[8] looked at a 100-mm VAS, modified Health Assessment Questionnaire, EuroQol 5-domain questionnaire, and range of motion using a standard goniometer and were the only ones to not find a significant difference in efficacy measures between their US- versus LM-guided groups.

The other studies measured efficacy with some similar and some different methods, but all found significant differences in favor of their US-guided injection/aspiration groups. Kianmehr et al.[14] found significant differences in the Western Ontario and McMaster Universities Arthritis Index (WOMAC) scale for pain and function as well as 10-cm VAS scores at 6 and 12 wks between those who underwent US- versus LM-guided intra-articular knee injections with hyaluronic acid. Four of the other studies[13,16–18] also showed improved postprocedural pain scores after 2- to 6-wk follow-up in the US-guided group when compared to the LM-guided group. They all showed less procedural pain in the US-guided groups

TABLE 1. Characteristics of the studies included

S. No.	Study	Objective	Design	Country	Age in Years (Range)	Eligibility Criteria	No. Cases and Controls	Results
1	Balint et al., 2002	To compare success of ultrasound guided versus conventional joint and soft tissue fluid aspiration.	Non randomized experimental study	UK	US-guided: average age of 60 yrs (range = 29–95 yrs) Conventional: average age of 55 yrs (range = 22–92 yrs)	Patients referred for US-guided aspiration with presence of an effusion of the joint or a soft tissue fluid collection of the limbs after examination by a rheumatologist. Patients referred for US-guided aspiration with no US evidence of fluid were excluded from this study.	US: 32 joints (19 knees) Conventional: 32 joints (10 knees)	US: 18/19 knee aspirations successful. Conventional: 4/10 knee aspirations successful. Mean volume of fluid obtained from successful aspirations was similar in both groups (11.7 ml in the US group and 14 ml in the conventional group).
2	Bum Park et al., 2011	To compare the accuracy rates between US-guided and blind knee intra-articular injection via the suprapatellar bursa.	Prospective, single-blind, randomized, controlled study with blinded observer	South Korea	US: 60.2 ± 8.1 Blind: 59.8 ± 7.9	Patients with knee joint osteoarthritis (Kellgren and Lawrence grades 2 and 3) were selected according to the American College of Rheumatology criteria. Patients had been symptomatic for at least 6 mos and reported pain on most days over the previous 3 mos. Other inclusion criteria included no inflammatory joint disease, no chondrocalcinosis, no infection in or around the study knee, no current anticoagulant therapy, and no viscosupplementation treatment during the previous 6 mos.	Total cases = 99 US = 50 Blind = 49	US-guided HA injection exhibited a significantly greater accuracy (48 of 50 knees, 96.0%) than blind injection (41 of 49 knees, 83.7%) $P < 0.05$.
3	Cunnington et al., 2010	To investigate whether ultrasound US guidance improves the accuracy and clinical outcome of joint injections as compared with LM guidance in patients with inflammatory arthritis.	Randomized double-blind controlled study	USA	US: 57.9 ± 14.5 CE: 58.4 ± 13.9	Evidence of an inflamed joint involving either the shoulder (glenohumeral joint), elbow, wrist, knee, or ankle. Patients were excluded if they required an immediate change in their treatment, if they had had a change in their treatment within 28 days before study entry, if they had a second joint requiring IA injection, or if they had evidence of potential sepsis or allergy to corticosteroids or contrast agent.	184 patients US: 92, 69% female LM: 92, 75% female	Number of all Joints accurately injected: US: 76/92 (83%) LM: 61/92 (66%) $P = 0.010$ Number of knee joints accurately injected: Knee US: 32/35 (91%) Knee LM: 27/33 (82%) $P = 0.242$

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TABLE 1. *(Continued)*

S. No.	Study	Objective	Design	Country	Age in Years (Range)	Eligibility Criteria	No. Cases and Controls	Results
4	Curtiss et al., 2011	To evaluate the accuracy of ultrasound US-guided and palpation-guided knee injections by an experienced and a less-experienced clinician with use of a superolateral approach.	Single-blinded, prospective study	USA	Cadavers, average age of 75.7 with a standard deviation of 14.5	Twenty cadaveric knee specimens without trauma, surgery, or major deformity, unembalmed fresh-frozen adult lower limb cadaveric specimens	20 cadavers	Guided accuracy: 100% (95% confidence interval = 89%–100%) Unguided accuracy: 78% (95% confidence interval = 62%–88%) $P = 0.004$ US experienced accuracy: 100% (95% confidence interval = 81%–100% US inexperienced accuracy: 100% (95% confidence interval = 19%–100% Palpation experienced accuracy: 100% (95% confidence interval = 81%–100%). Palpation inexperienced accuracy: 55% (95% confidence interval = 34%–74%)
5	Guermazi et al., 2022	To determine the success rate of IA injection of an investigational treatment of knee osteoarthritis pain into the knee joint with ultrasound guidance or palpation based.	Double-blind, multicenter, placebo-controlled, parallel group, randomized control trial	Netherlands	59.2 (SD ± 10.2) yrs	Moderate to severe symptomatic knee osteoarthritis	109 patients US: 58 Palpation: 51	Success rates: US: 50/58, 86.2% Palpation: 38/50, 76% $P = 0.17$, not statistically different

6	Hashemi et al., 2016	To compare the accuracy of intra-articular injection under ultrasound guide versus blind injection by expert and inexpert clinician.	Randomized controlled study	Iran	Group A: 63.2 ± 7.48 Group B: 63.58 ± 7.27	Patient with osteoarthritis diagnosis based on the American College of Rheumatology (ACR) definition (age >50 yrs, crepitating or morning stiffness less than 35 mins and radiologic findings), and having symptoms more than 3 mos. Exclusion criteria were diabetes, other causes of arthritis, history of surgery or fracture in the knee, history of prolotherapy in past year, or injection of corticosteroid or hyaluronic acid, contraindication to injection including thrombocytopenia, or bleeding diathesis, severe effusion of knee, and infection of local skin.	220 patients: US: 100 Expert: 50 Inexpert: 50 Blind: 123 Expert: 47 Inexpert: 76	Expert: failed intraarticular injection: - US: 2% - Blind: 4.26% - $P = 0.61$, no significant difference Inexpert: failed intraarticular injection: - US: 6% - Blind: 21% $P = 0.02$, significant difference
7	Im et al., 2009	To investigate the feasibility of using real-time high-resolution sonography to guide an injection needle into the intra-articular space within the knee.	Randomized controlled study	South Korea	US: 60.6 ± 7.9 Blind: 59.6 ± 9.9	Radiographically confirmed knee osteoarthritis (Kellgren-Lawrence grade 2 or 3) without an effusion who were symptomatic for at least 6 mos and reported pain on most days for the previous 3 mos included. Exclusion criteria included inflammatory joint disease, chondrocalcinosis, or an infection in or around the study knee, anticoagulant therapy, and viscosupplement treatment within the past 6 mos.	89 patients US: 45 Blind: 44	Success rates: US: 43/45 (95.6%) Blind injections: 34/44 (77.3%) $P = 0.01$

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TABLE 1. *(Continued)*

S. No.	Study	Objective	Design	Country	Age in Years (Range)	Eligibility Criteria	No. Cases and Controls	Results
8	Jang et al., 2013	To compare the accuracy rates between ultrasound (US)-guided in-plain (IP), out-of-plain (OOP) and blind knee intra-articular (IA) injection via the midmedial portal.	Prospective, single-blind, randomized, controlled study	South Korea	OOP: mean 62.02 IP: mean 61.48 Blind: mean 61.10	Diagnosis of knee joint OA based on the clinical and radiologic criteria proposed by the American College of Rheumatology. Exclusion criteria: knees with a history of mechanical derangement, fibromyalgia, inflammatory arthritis, microcrystalline arthropathy, or knee trauma/surgery; cases with a greater reduction in the width of the lateral joint space compared to that of the medial femorotibial joint space (concomitance with lateral knee OA); chondrocalcinosis; infection in or around the study knee; current anticoagulant therapy; and IA steroid knee injection during the previous 3 mos assessed by history taking, inspection, physical examination, radiologic evaluation, or synovial fluid analysis.	126 patients: OOP: 41 knees IP: 44 knees Blind: 41 knees	Accuracy: US-guided IA in IP: 43/44, 97%, $P < 0.05$ US-guided IA in OOP: 39/41, 95%, $P < 0.05$ Blind: 32/41, 78%
9	Kianmehr et al., 2018	Comparison between the effect of sonographic guided and blind knee injection of hyaluronic acid.	Prospective two-armed parallel group randomized blinded clinical trial	Iran	61.52 ± 9.09 yrs	Patients above 18 yrs old with primary knee OA, based on the guideline recommended by the American College of Rheumatology (ACR), who had not undergone knee arthroplasty, and had not received intra-articular injection in the last 3 mos, with any radiological grade on Kellgren-Lawrence classification. Exclusion criteria included patients with congenital immunologic disorders, intravenous (IV) drug abusers, critically ill patients, those on anticoagulation therapy with warfarin (those on low molecular weight [LMW] heparin were advised not to take their last dose of drugs before the intervention), and those with skin lesions on the site of injections.	US: 31 knees Blind: 30 knees	Mean differences in WOMAC scale for pain and function were significantly different between US and blind at 6 and 12 wks. Mean differences in 10-cm VAS (both at rest and after 50-feet walk) were significantly different between US and blind at 6 but not 12 wks.

10	Lundstrom et al., 2019	To determine whether ultrasound (US) guidance to ensure needle placement for HA knee injection resulted in improved outcomes as reflected by surgery-free survival compared to landmark-guided HA knee injection.	Retrospective Cohort study	USA	US: 60.6 ± 14.8 Landmark guided: 63.4 ± 13.3	Patients residing in 6 contiguous surrounding counties and receiving an HA knee injection (all formulations were included) during the years 2008–2014, a time frame that allowed an adequate postprocedure duration to determine the need for subsequent knee arthroplasty.	US: 500 knees Landmark-guided: 647 knees	Knee arthroplasty rates reduced in US-guided cohort: US-guided cohort (33.2%) Landmark-guided cohort (45.8%; $P < 0.001$, Pearson χ^2 test) Fewer patients in the US-guided cohort (27.4%) received a subsequent corticosteroid injection than the LM-guided cohort (34.0%; $P < 0.002$)
11	Sheth et al., 2020	To determine if differences exist in the level of patient satisfaction, functionality, and the quality of life in adult patients receiving US-guided (USG) versus landmark-guided (LMG) knee procedures.	Prospective, randomized study	USA	LMG: 58.27 ± 9.64 US: 60.89 ± 10.4	Adult patients (age ≥18 yrs) receiving knee steroids injection at JMC arthritis clinic during the period Oct 1, 2015, to June 30, 2016.	LMG: 18 knees US: 19 knees	Improvement in the immediate postprocedural pain in USG vs. LM-guided (VAS 1.63 ± 1.6 (95% CI = 0.91, 2.35) vs. 4.05 ± 2.5 (95% CI = 2.90, 4.62) $P = 0.001$). Pain relief at 4–6 wks USG vs. LM-guided (VAS 2.68 ± 2.0 (95% CI = 1.78, 3.58) vs. 6.38 ± 3.8 (95% CI = 4.62, 8.14) $P = 0.004$). Patient satisfaction USG vs. LM-guided (4.89 ± 0.3 (95% CI = 4.76, 5.02) vs. 4.11 ± 1.0 (95% CI = 3.65, 4.57), $P = 0.002$) and after 4–6 wks of follow-up (4.52 ± 0.9 (95% CI = 4.12, 4.92) vs. 3.38 ± 1.6 (95% CI = 2.64, 4.12), $P = 0.028$).

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TABLE 1. *(Continued)*

S. No.	Study	Objective	Design	Country	Age in Years (Range)	Eligibility Criteria	No. Cases and Controls	Results
12	Sibbitt et al., 2012	To compare arthrocentesis of the effusive knee followed by corticosteroid injection by the conventional anatomic landmark palpation-guided technique and ultrasound (US) needle guidance.	Randomized controlled trial	USA	N/A	Inclusion criteria included: (i) palpable symptomatic effusion of the knee with suprapatellar distention, (ii) indications for therapeutic-diagnostic arthrocentesis, (iii) indication for corticosteroid injection, and (iv) formal consent of the patient to undergo the procedure and participate in the research.	Palpation: 22 knees US RPD syringe: 22 knees US automatic syringe: 20 knees	US guidance resulted in 48% less procedural pan (VAS; palpation-guided: 5.8 3.0 cm, US-guided: 3.0 2.8 cm, $P < 0.001$), 183% increased aspirated synovial fluid volumes (palpation-guided: 12 10 ml, US-guided: 34 25 ml, $P < 0.0001$), and improved outcomes at 2 wks (VAS; palpation-guided: 2.8 2.4 cm, US-guided: 1.5 1.9 cm, P ¼ 0.034).
13	Wiler et al., 2008	To assess the success of emergency physicians performing landmark (LM) vs. ultrasound (US)-guided knee arthrocentesis techniques.	Prospective, nonblinded randomized, controlled study	USA	US-guided: average age 54.5 yrs LM group: average age 50.5 yrs	Patients between 18 and 90 yrs old requiring knee arthrocentesis who presented to one urban university ED and two community EDs between June 2005 and February 2007. Exclusion criteria included patients who were pregnant, unable to give consent, had signs of cellulitis involving the arthrocentesis area, had knee joint replacement materials, and those younger than 18 and older than 90 yrs of age.	66 patients: US-guided: 39 LM-guided: 27	No difference in arthrocentesis success (US 37/39 vs. LM 25/27); $P = 1.0$. Patients reported less pain with ultrasound and providers felt it was easier to perform and total procedure time was shorter. No difference in amount of fluid obtained. Pain: US-guided 3.71 (95% CI = 2.61–4.80) cm vs. LM 5.19 (95% CI = 3.94–6.45) cm; $P = 0.02$. 2) Providers felt the US-guided technique was easier to perform than LM; 1.67 units on 5-point scale (95% CI = 1.37–1.97) vs. 2.11 (95% CI = 1.79–2.42) units; $P = 0.02$. 3) The total procedure time was shorter with the US-guided technique; 10.58 (95% CI = 7.36–13.80) min vs. LM 13.37 (95% CI = 9.83–16.92) min; $P = 0.05$. 4) There was no difference in the amount of fluid obtained between techniques; US-guided 45.33 (95% CI = 35.45–55.21) ml vs. LM 34.7 (95% CI = 26.09–43.32) ml; $P = 0.17$.

14	Wilmer et al., 2009	To determine whether sonographic needle guidance affected clinical outcomes of intraarticular (IA) joint injections.	Randomized controlled study	USA	Palpation: 55.5 ± 12.8 US: 51.7 ± 15.5	Inclusion criteria included (1) focal joint pain attributed to arthritis unresponsive to conventional modalities (analgesics, anti-inflammatory medications, exercise, or splinting as appropriate); (2) pain with passive range of motion of the joint; (3) impairment of the activities of daily living related to pain; (4) significant pain by the 0–10 cm visual analog pain scale (VAS pain scale) in the involved joint, where VAS ≥ 5 cm; and (5) the wish of the patient to have IA corticosteroid injection. Exclusion criteria included (1) obvious tendon-ligamentous pathology or internal derangement; (2) superficial bursitis; (3) end-stage joint by radiography; (4) confounding neuropathy; (5) hemorrhagic diathesis; (6) use of warfarin or antiplatelet drugs; or (7) the presence of infection.	148 joints (62 knee joints): US-guided: 74 (31 knees) Palpation-guided: 74 (31 knees)	Procedural pain: 43% reduction in US-guided vs. palpation $P < 0.001$). Absolute pain scores at the 2 wk outcome- 58.5% reduction in US-guided vs. palpation ($P < 0.001$). Significant pain: 75% reduction in US-guided vs. palpation (VAS pain score ≥5 cm; $P < 0.001$). Sonography also had a 25.6% increase in the responder rate (reduction in VAS score ≥50% from baseline; $P < 0.01$), and 62.0% reduction in the nonresponder rate (reduction in VAS score <50% from baseline; $P < 0.01$). Sonography also increased detection of effusion by 200% and volume of aspirated fluid by 337%.

as well. Lundtrom et al.[15] looked at patients with knee osteoarthritis undergoing US- versus LM-guided hyaluronic acid injections and found that those in the US-guided cohort had reduced rates of knee arthroplasty and subsequent corticosteroid injections.

DISCUSSION

The results showed that US-guided intra-articular knee injections/aspirations were more accurate than LM-guided intra-articular knee injections/aspirations. In our Level I analysis, we found cumulative accuracies of 95.4% (356/373) versus 82.0% (268/327) for US- and LM-guided injections/aspirations, respectively. The need for using US guidance can be even more important in less experienced proceduralists.[9,10]

Given the growing popularity of orthobiologics that are expensive, guaranteeing accurate placement into the knee joint capsule is essential. Additionally, extra-articular injections with such products can increase the risk of potential adverse effects, including increased pain, skin rash, flushing, difficulty moving the knee, and infections.[19,20] There are multiple imaging modalities available for providers to use for guidance including fluoroscopy, computed tomography, and magnetic resonance imaging; but there is little to no existing level I evidence looking at the accuracy with these modalities. US is an easily accessible option as it can be available in the clinic, does not give radiation, and allows real-time visualization of the needle.[21] US machines are also relatively inexpensive and highly accurate in experienced hands. Some potential barriers include the additional training required to perform these procedures and a steep learning curve. However, studies have found that US guidance was more cost-effective for patients, with a 58% ($224) reduction in cost per responder per year when compared to LM guidance.[22]

In 2015, Finoff et al.[23] published an American Medical Society for Sports Medicine Position Statement, which provided a strong review of the existing literature evaluating the accuracy, efficacy, and cost-effectiveness of US-guided injection in major, intermediate, and small joints, and soft tissues. Wu et al.[24] in 2016 and more recently Fang et al.[25] in 2021 published systematic reviews looking more specifically at accuracy of US- versus LM-guided knee injections. Our systematic review adds to this existing evidence by reporting on comparative-effectiveness between the two groups and found that knee injections/aspirations under US guidance had better patient reported outcomes (e.g., WOMAC and VAS scores) or need for a subsequent corticosteroid injection as compared with LM guidance.

Limitations

The primary limitation of our systematic review is the heterogeneity in the original literature. Some studies also had smaller sample sizes making it difficult to reach conclusions. There is also lack of studies reporting on long-term outcomes.

CONCLUSIONS

This systematic review provides data that US-guided intra-articular knee injections/aspirations are more accurate than LM-guided intra-articular knee injections/aspirations. These differences are more pronounced in injectors with less experience. Additionally, outcomes including VAS scores are

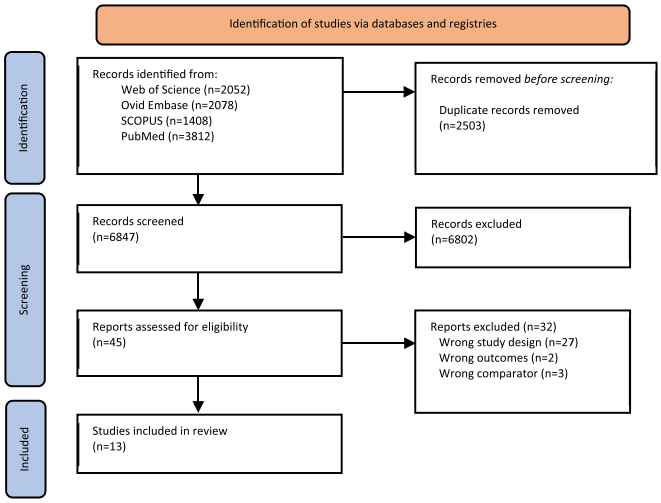

FIGURE 1. Inclusion/exclusion of studies for systematic review.

TABLE 2. Quality assessment using the Newcastle-Ottawa Quality Assessment Scale of the included studies

	Selection				Comparability	Outcome/Exposure			
Articles	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**Total Score**
Balint et al., 2002	1	1	1	1	1	1	1	1	8
Curtiss et al., 2011	1	1	1	1	1	1	1	1	8
Lundstrom et al., 2019	1	1	1	1	1	1	1	1	8

TABLE 3. Quality assessment using the revised Cochrane risk-of-bias tool for randomized trials

Articles	Domain 1	Domain 2[a]	Domain 2[b]	Domain 3	Domain 4	Domain 5	Assessment
Bum Park et al., 2011	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk of bias
Cunnington et al., 2010	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk of bias
Guermazi et al., 2022	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk of bias
Hashemi et al., 2016	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk of bias
Im et al., 2009	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk of bias
Jang et al., 2013	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk of bias
Kianmehr et al., 2018	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk of bias
Sheth et al., 2020	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk of bias
Sibbitt et al., 2012	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk of bias
Wiler et al., 2008	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk of bias
Wilmer et al., 2009	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk	Low risk of bias

[a]Effect of assignment to intervention.
[b]Effect of adhering to intervention.

better in those that undergo injections/aspirations under US guidance versus LM guidance.

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