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# A Scoping Review of the Effectiveness, Safety, and Technical Considerations of Hydrodissection in Lumbar Facet Joint Interventions

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## Abstract

**Background:** Chronic low back pain affects 15% - 45% of adults, with facet joint pathology contributing substantially to this burden. Current interventional treatments—including intra-articular corticosteroid injections and medial branch blocks—demonstrate highly variable success rates (13% - 74% for ≥50% pain relief). Hydrodissection, a technique using larger volumes of injectate (5 - 30 mL) to mechanically release entrapped nerves from adhesions, has shown promising results for peripheral nerve entrapments and select spinal applications. However, its application to lumbar facet joint interventions remains unexplored. **Objective:** To map and characterize the existing evidence base regarding the application of hydrodissection to lumbar facet joint interventions and medial branch blocks, identify the extent, range, and nature of available evidence (or its absence), and establish a research agenda to address identified gaps, following established scoping review methodology (PRISMA-ScR/JBI framework). **Methods:** A comprehensive literature search was conducted across PubMed, Embase, Cochrane Library, and Web of Science databases from inception through January 2026. Search terms included hydrodissection, lumbar facet joint, medial branch block, and related terminology. Two independent reviewers screened titles, abstracts, and full texts. Reference lists of relevant articles were manually searched. **Results:** No published studies—randomized controlled trials, observational studies, or case series—specifically applied hydrodissection technique to lumbar facet joint injections or medial branch blocks. While extensive literature exists for standard facet interventions (Levels I - II evidence from multiple systematic reviews and guidelines), and hydrodissection has been successfully applied to related structures (superior cluneal nerve with 80% response rates, caudal epidural space, cervical

nerve roots), the translation to facet joint interventions represents a complete evidence gap. Technical challenges include ultrasound visualization accuracy (11% - 13% incorrect needle placement versus fluoroscopy) and volume considerations that may compromise diagnostic specificity. **Conclusions:** The complete absence of evidence for hydrodissection in lumbar facet joint interventions represents a significant research opportunity. Given the theoretical mechanistic rationale (nervi nervorum release, vasa nervorum restoration), successful applications in anatomically related structures, and limitations of current treatments, systematic investigation is warranted. We propose a staged research pathway: 1) cadaveric feasibility studies establishing ultrasound visualization parameters, 2) pilot case series documenting technical success and short-term outcomes, and 3) randomized controlled trials comparing hydrodissection to standard approaches in selecting patient populations.

## Keywords

Hydrodissection, Lumbar Facet Joint, Medial Branch Block, Chronic Low Back Pain, Interventional Pain Management, Evidence Gap

## 1. Introduction

Chronic low back pain (LBP) affects approximately 15% - 45% of adults and represents a leading cause of disability worldwide, with substantial socioeconomic burden [1]-[3]. Among the various anatomical sources of LBP, the lumbar facet joints (zygapophyseal joints) contribute to 15% - 45% of cases [4] [5]. These synovial joints, innervated by medial branch nerves from the dorsal rami, become pain generators through degenerative changes, inflammation, and capsular distension.

Current interventional treatments for facet joint pain include intra-articular corticosteroid injections and medial branch blocks, followed by radiofrequency ablation for sustained relief in positive responders. However, treatment outcomes remain highly variable. A 2025 systematic review of fluoroscopically guided lumbar facet steroid injections reported success rates (≥50% pain relief) ranging from 13% - 74%, with functional improvement (≥30% reduction in Oswestry Disability Index) achieved in only 29% of patients at one month or longer [6]. The American Society of Interventional Pain Physicians (ASIPP) 2020 guidelines rated the overall quality of evidence for therapeutic facet joint interventions as "low" to "moderate" using GRADE criteria [7].

These modest success rates suggest that current small-volume injection techniques (typically 0.5 - 2 mL) may inadequately address certain pain mechanisms. Standard approaches focus on anti-inflammatory effects (corticosteroids) and temporary neural blockade (local anesthetics), but may not address mechanical factors such as perineural adhesions, fascial entrapment, or vascular compression—all of which can generate persistent neuropathic pain [8] [9].

### 1.1. Hydrodissection: Principles and Mechanisms

Hydrodissection refers to the injection of fluid under hydrostatic pressure to mechanically separate nerves from surrounding structures, releasing adhesions and restoring normal tissue planes [10]. Unlike standard nerve blocks that use small volumes (0.5 - 2 mL) primarily for pharmacological effect, hydrodissection employs larger volumes (5 - 30 mL) to achieve mechanical tissue separation visualized in real-time under ultrasound guidance.

The technique operates through multiple complementary mechanisms:

- **Mechanical release of adhesions:** Hydrostatic pressure physically separates scar tissue and fascial adhesions that may entrap nerves following injury, inflammation, or surgery [10] [11].
- **Restoration of nerve gliding:** Cadaveric studies demonstrate that hydrodissection reduces nerve gliding resistance, potentially restoring normal neural mechanics [12].
- **Decompression of nervi nervorum:** Peripheral nerves possess their own innervation (nervi nervorum)—free nerve endings within and surrounding the epineurium. Compression of these fibers generates neuropathic pain; their release may explain rapid symptom improvement following hydrodissection [13].
- **Vascular decompression:** Relief of pressure on vasa nervorum (intraneural blood vessels) improves neural nutrition and reduces metabolite accumulation, both implicated in chronic neuropathic pain [14].
- **Pharmacological mechanisms (when using dextrose):** Five percent dextrose in water (D5W), commonly used for hydrodissection, may downregulate TRPV1 ion channels associated with chronic neuropathic pain and correct perineural glycopenia [15] [16].

These mechanisms differ fundamentally from standard corticosteroid injections, which rely primarily on anti-inflammatory effects with minimal mechanical tissue separation at the small volumes used.

### 1.2. Evidence for Hydrodissection in Peripheral and Spinal Applications

Hydrodissection has demonstrated efficacy across multiple peripheral nerve entrapment syndromes. For carpal tunnel syndrome, randomized controlled trial evidence shows D5W hydrodissection provides superior outcomes compared to corticosteroid injections, with greater reductions in symptom severity scores and nerve conduction improvements at 6-month follow-up. Similar success has been reported for ulnar nerve entrapment at the elbow, tarsal tunnel syndrome, and meralgia paresthetica [10] [17].

Within the spine, hydrodissection has been successfully applied to anatomically related structures. Superior cluneal nerve entrapment—a cause of low back pain where nerves become trapped between the thoracolumbar fascia and iliac crest—showed approximately 80% positive response rates following ultrasound-guided

dextrose hydrodissection [18]. Caudal epidural hydrodissection with D5W demonstrated superior outcomes to saline for chronic low back and leg pain, with 52% pain improvement on numerical rating scale and 42% improvement on Oswestry Disability Index at 12-month follow-up [19].

For cervical radicular pain, a retrospective cohort study of 74 patients receiving ultrasound-guided cervical nerve root hydrodissection showed significant numerical rating scale improvements at 1 week, 1 month, 3 months, and final follow-up, with only 5.4% experiencing transient complications.

These successful applications in both peripheral nerves and spinal structures provide proof-of-concept for hydrodissection's therapeutic potential. However, the anatomical transition to lumbar facet joint interventions introduces unique technical and conceptual challenges that have not been systematically investigated.

### 1.3. Study Objective

The primary objective of this scoping review was to systematically identify and synthesize existing evidence comparing hydrodissection to standard injection techniques for lumbar facet joint blocks and medial branch blocks. Secondary objectives included characterizing the current evidence landscape for both approaches, identifying technical and conceptual barriers to translation, and proposing a research agenda to address identified gaps.

## 2. Methods

### 2.1. Search Strategy

A comprehensive literature search was conducted in PubMed, Embase, Cochrane Central Register of Controlled Trials, and Web of Science databases from inception through January 31, 2026. The search strategy combined terms related to:

1) hydrodissection techniques,

2) lumbar facet joints and medial branch nerves, and

3) interventional procedures.

The search was restricted to English-language publications due to resource constraints for translation; this restriction is acknowledged as a limitation. No publication type restrictions were applied.

For the purposes of this review, "hydrodissection" was operationally defined as the injection of a fluid volume of ≥5 mL (of any injectate, including normal saline, dextrose solutions, or local anesthetic) under real-time imaging guidance with the explicit intent to mechanically separate a nerve or periarticular structure from surrounding tissue. Studies using standard diagnostic volumes (≤2 mL) were not classified as hydrodissection regardless of terminology. The complete PubMed search string was: (hydrodissection OR "nerve hydrodissection" OR "perineural injection" OR "high-volume injection" OR "perineural injection therapy" OR "interfascial plane injection" OR "high-volume medial branch block" OR "dextrose perineural injection" OR "epineural injection" OR "perineural saline separation"

OR "neural prolotherapy") AND ("lumbar facet" OR "zygapophyseal joint" OR "medial branch" OR "facet joint" OR "posterior spinal nerve" OR "dorsal ramus") AND (injection OR block OR "nerve block" OR intervention OR procedure). Analogous searches were adapted for each database; the complete adapted search strings for Embase, Cochrane, and Web of Science are provided in **Appendix 1**. Additional searches were conducted for:

1) hydrodissection in related lumbar structures (superior cluneal nerve, middle cluneal nerve, iliolumbar ligament),

2) standard facet joint interventions to characterize the existing evidence base, and

3) ultrasound-guided versus fluoroscopy-guided facet interventions to understand imaging-related technical considerations.

Reference lists of all relevant systematic reviews, guidelines, and primary studies were manually searched for additional citations. Grey literature sources including conference proceedings and clinical trial registries (ClinicalTrials.gov, WHO ICTRP) were searched for ongoing or unpublished studies.

## 2.2. Study Selection

Two independent reviewers screened all titles and abstracts identified by the search strategy. Full texts of potentially relevant articles were obtained and assessed against the following inclusion criteria:

- Studies reporting hydrodissection technique applied to lumbar facet joints or medial branch nerves.
- Any study design (randomized controlled trials, observational studies, case series, case reports, technical descriptions).
- Adult patients (≥18 years) with chronic lumbar facet joint pain.
- English language publications (due to resource constraints for translation).

Studies were excluded if they:

1) described standard facet joint injections or medial branch blocks without hydrodissection technique,

2) applied hydrodissection to other lumbar structures (e.g., epidural space, nerve roots) without facet joint involvement, or

3) were animal studies, cadaveric studies without clinical outcomes, or review articles without primary data.

## 2.3. Data Extraction and Synthesis

For any identified studies meeting inclusion criteria, we planned to extract: study design and setting, participant characteristics, intervention details (injectate composition, volume, imaging guidance), comparator interventions, outcome measures (pain scores, functional assessments, duration of effect), adverse events, and author conclusions.

Given the anticipated heterogeneity of study designs and outcome measures, we planned to synthesize findings narratively rather than through meta-analysis.

Risk of bias assessment would be conducted using appropriate tools based on study design (Cochrane Risk of Bias tool for RCTs, Newcastle-Ottawa Scale for observational studies).

To characterize the broader context, we also synthesized existing evidence for:

1) standard lumbar facet joint interventions,

2) hydrodissection in related anatomical structures, and

3) imaging guidance considerations relevant to potential hydrodissection applications.

## 3. Results

### 3.1. Literature Search Results

The comprehensive database search identified 1247 unique records after deduplication. Title and abstract screening excluded 1198 records that clearly did not meet inclusion criteria. Full-text review of the remaining 49 articles revealed zero studies applying hydrodissection technique to lumbar facet joint injections or medial branch blocks.

The 49 full-text reviewed articles fell into three categories: 1) studies of standard facet joint interventions without hydrodissection (n = 31), 2) hydrodissection studies in other anatomical locations (n = 15), and 3) technical descriptions of ultrasound-guided lumbar interventions mentioning but not implementing hydrodissection for facet joints (n = 3). No ongoing or unpublished studies were identified in clinical trial registries. The primary reasons for full-text exclusion were: a) injectate volume ≤ 2 mL without hydrodissection intent (n = 26); b) hydrodissection applied to non-facet lumbar structures such as epidural space, nerve roots, or cluneal nerves without medial branch or intra-articular facet joint targeting (n = 14); c) narrative review or technical commentary without primary outcome data (n = 6); and d) no extractable clinical outcomes related to facet pain (n = 3). Notably, none of the excluded studies used the term "hydrodissection" in relation to medial branch nerves or intra-articular facet joint targets, confirming that the evidence gap is not an artefact of terminology alone.

This complete absence of evidence represents a critical gap warranting detailed characterization of the existing evidence landscape for both standard approaches and hydrodissection in related applications.

### 3.2. Current Evidence for Standard Lumbar Facet Joint Interventions

#### *Diagnostic Medial Branch Blocks*

The ASIPP 2020 comprehensive guidelines provide Levels I - II evidence supporting diagnostic medial branch blocks with moderate-to-strong recommendations. The prevalence of facetogenic pain among chronic low back pain patients ranges from 15% - 45% based on controlled diagnostic blocks [4] [20].

However, single diagnostic blocks have false-positive rates of 17% - 47%, necessitating dual comparative blocks (using anesthetics of different durations) to im-

prove specificity to approximately 88%. Standard volumes for diagnostic blocks are 0.3 - 0.5 mL of local anesthetic per nerve, with larger volumes risking spread to adjacent structures and increased false-positive rates [7].

***Therapeutic Intra-Articular Injections***

Therapeutic intra-articular facet joint injections typically employ 1 - 2 mL of corticosteroid mixed with local anesthetic. A 2025 systematic review found highly variable success rates for ≥50% pain relief ranging from 13% - 74%, with functional improvement (≥30% ODI reduction) achieved in only 29% of patients at one month or longer. The ASIPP guidelines rate the evidence quality as Level IV (weak) with weak recommendations for therapeutic use [7].

Duration of benefit is limited, with most studies reporting median relief durations of 1 - 3 months. Multiple systematic reviews have concluded that while therapeutic facet injections may provide short-term relief, evidence for sustained functional improvement remains limited [21] [22].

***Radiofrequency Ablation***

For patients with positive diagnostic medial branch blocks, radiofrequency ablation demonstrates Level II evidence with moderate recommendations. A 2024 meta-analysis of 8 randomized controlled trials showed significant pain reduction over placebo at short-term (mean difference −1.01, $p = 0.04$) and medium-term (mean difference −1.42, $p = 0.005$) follow-up [23].

However, radiofrequency ablation requires expensive equipment, carries risks of neuritis and motor weakness, and success depends critically on accurate diagnostic block responses—which, as noted, have substantial false-positive rates [24] [25].

***Safety Profile***

Standard facet joint interventions demonstrate an excellent safety profile. Manchikanti *et al.* documented 0% major complications across 7500 episodes involving 43,000 nerve blocks. Kim *et al.* reported overall adverse events of only 0.84% per procedure with major complications at 0.07% in a study of 11,980 intra-articular facet joint injections [26].

## 3.3. Hydrodissection in Related Lumbar Structures

While no studies have applied hydrodissection to facet joints specifically, several reports document its use in anatomically related lumbar structures, providing proof-of-concept for the technique's feasibility in this region.

***Superior Cluneal Nerve***

The superior cluneal nerves, medial branches of the dorsal rami of L1 - L3, can become entrapped where they cross the iliac crest—a recognized cause of low back pain. Chang *et al.* conducted a randomized study (NCT04478344) of ultrasound-guided dextrose hydrodissection for superior cluneal nerve entrapment, demonstrating approximately 80% positive response rates. Their protocol used 1 mL of 50% dextrose, 4 mL of 1% lidocaine, and 5 mL of normal saline (total 10 mL) delivered via in-plane, medial-to-lateral ultrasound-guided approach.

This is particularly relevant as the superior cluneal nerves share embryological origin with the medial branch nerves innervating facet joints, and both involve dorsal ramus anatomy. The successful hydrodissection of superior cluneal nerves demonstrates feasibility of the technique in the lumbar posterior compartment.

#### *Caudal Epidural Space*

Maniquis-Smigel *et al.* conducted prospective studies comparing caudal epidural injections of 10 mL D5W versus normal saline for chronic low back and buttock/leg pain. At 12-month follow-up, the D5W group showed 52% pain improvement on numerical rating scale and 42% improvement on Oswestry Disability Index, significantly superior to saline controls. While not directly targeting facet joints, this demonstrates that dextrose-based hydrodissection in the lumbar spine can produce sustained functional improvements.

#### *Middle Cluneal Nerve and Iliolumbar Ligament*

The middle cluneal nerves and iliolumbar ligament have also been targeted with hydrodissection techniques for low back pain, with multiple case reports describing symptom improvement [27] [28]. However, these reports lack controlled comparisons and standardized outcome measures, limiting definitive conclusions about efficacy.

### 3.4. Imaging Guidance Considerations

A fundamental distinction between standard facet interventions and potential hydrodissection applications involves imaging guidance requirements. Professional guidelines mandate fluoroscopy or CT for standard facet interventions based on Level I evidence demonstrating superior accuracy [7]. Hydrodissection, by contrast, inherently requires ultrasound guidance to visualize real-time injectate spread and tissue separation.

Ashmore *et al.* conducted a systematic review comparing imaging modalities, finding ultrasound-guided medial branch blocks carry an 11% risk difference for incorrect needle placement versus fluoroscopic confirmation ($p < 0.0009$), and ultrasound-guided facet joint injections show 13% risk difference versus CT confirmation ($p < 0.0001$). Accuracy decreases further in obese patients (BMI > 30), with only 62% correct placement achieved [29].

However, clinical outcome studies show no significant differences in pain relief between modalities. Wu *et al.*'s meta-analysis of 3 randomized controlled trials found a weighted mean difference of only 0.07 (95% CI: −0.51 to 0.65) in pain scores between ultrasound and fluoroscopy guidance. Nisolle *et al.*'s non-inferiority RCT demonstrated ultrasound-guided lumbar medial branch blocks were not inferior to fluoroscopy-guided procedures for pain relief outcomes [30].

This creates a technical paradox: hydrodissection's mechanism requires ultrasound visualization, yet ultrasound has demonstrated accuracy limitations for targeting the small-caliber medial branch nerves. Resolving this tension—whether through technical refinements, patient selection, or acceptance of broader tissue effects—represents a key challenge in translating hydrodissection to facet joint

applications.

## 4. Discussion

This scoping review, conducted in accordance with PRISMA-ScR guidance, reveals a finding that simultaneously represents a significant limitation of current clinical practice and a substantial opportunity for innovative research. The evidence gap is particularly striking given the extensive literature supporting both standard facet interventions and hydrodissection in related anatomical applications.

### 4.1. Mechanistic Rationale for Translation

The theoretical basis for applying hydrodissection to facet joint pain rests on established pain mechanisms that standard small-volume injections may inadequately address. Medial branch nerves, like all peripheral nerves, possess nervi nervorum—free nerve endings within and surrounding the epineurium that, when mechanically compressed, generate neuropathic pain independent of the nerve's primary sensory function.

Bennett *et al.*'s seminal research demonstrated that even minimal nerve compression produces rapid morphological changes to vasa nervorum and subsequent neuropathic pain behavior in animal models. In the lumbar spine, medial branch nerves traverse dense fascial planes, cross bony prominences, and may develop adhesions following inflammation or surgery—all scenarios where mechanical compression could perpetuate pain despite anti-inflammatory treatment.

Standard corticosteroid injections (1 - 2 mL volume) primarily target inflammatory mechanisms and provide temporary neural blockade. While effective for many patients, the 13% - 74% success rate variability suggests a substantial subset may have pain mechanisms—such as mechanical entrapment—that require alternative approaches.

Hydrodissection's larger volumes (5 - 30 mL) mechanically separate adhesions and restore tissue planes, potentially addressing these mechanical factors. The successful application to superior cluneal nerves—which share dorsal ramus anatomy with medial branch nerves—provides anatomical proof-of-concept [18].

### 4.2. Technical Challenges and Considerations

**Ultrasound Visualization Limitations.** The most significant technical challenge involves ultrasound's demonstrated accuracy limitations for lumbar medial branch blocks. With 11% - 13% incorrect needle placement rates compared to fluoroscopic confirmation, and further degradation in obese patients, ultrasound guidance appears less reliable for targeting these small-caliber nerves.

However, this limitation may be less critical for hydrodissection than for diagnostic blocks. Diagnostic procedures require pinpoint accuracy to ensure specificity; therapeutic interventions may benefit from broader perineural spread. If

hydrodissection's mechanism operates primarily through releasing regional fascial adhesions and decompressing nervi nervorum, precise nerve targeting may be less essential than achieving adequate tissue separation in the correct anatomical compartment.

**Volume and Specificity Trade-offs.** Standard medial branch blocks use 0.3 - 0.5 mL per nerve to maintain diagnostic specificity; larger volumes risk spread to adjacent structures and false-positive results. Hydrodissection protocols typically employ 5 - 10 mL per site for peripheral nerves—volumes that would clearly spread beyond a single medial branch nerve's territory.

This volume difference is not a design flaw but reflects fundamentally different therapeutic mechanisms. Standard blocks aim for pharmacological neural blockade and anti-inflammatory effects at precise anatomical sites. Hydrodissection aims for mechanical tissue separation across a broader anatomical region. The appropriate volume depends on the intended mechanism.

One resolution: reserve hydrodissection for therapeutic applications in patients who have already had positive diagnostic blocks using standard techniques and volumes. This maintains diagnostic specificity while allowing mechanical intervention for confirmed responders who may benefit from adhesion release.

**Injectate Selection.** Multiple injectate options exist for hydrodissection. Five percent dextrose in water has shown superior outcomes to corticosteroids for carpal tunnel syndrome and demonstrated efficacy for caudal epidural injection and superior cluneal nerve entrapment. D5W offers potential advantages including TRPV1 channel modulation, correction of perineural glycopenia, and absence of steroid-related side effects [15] [16].

However, normal saline or dilute local anesthetic solutions could also be used for purely mechanical hydrodissection. Comparative studies would be needed to determine optimal injectate composition, potentially through initial dose-finding and safety studies before larger comparative trials. High-volume injections (5 - 30 mL) in the posterior lumbar compartment introduce specific safety considerations that early-phase studies must prospectively monitor. Adverse events of particular concern include: 1) inadvertent epidural or intrathecal spread due to the proximity of the medial branch nerves to the intervertebral foramina and dural sleeve, potentially causing transient neurological deficit or spinal headache; 2) vascular injection or hematoma formation given the vascularity of the posterior paraspinal compartment; 3) inadvertent nerve root compression secondary to high-volume injectate tracking along fascial planes toward the neural foramen; 4) infection risk, which, although low with standard aseptic technique, may be elevated with repeated high-volume procedures; and 5) local anaesthetic systemic toxicity (LAST) if large volumes of dilute local anaesthetic are used as the carrier. Early-phase feasibility and case series studies should incorporate standardized adverse event reporting forms, neurological assessment at 24 hours and 1 week post-procedure, and mandatory reporting of any procedural complications to enable robust safety characterization before larger trials proceed.

### 4.3. Patient Selection Considerations

Not all patients with facet joint pain would necessarily benefit equally from hydrodissection. Several subpopulations appear particularly promising:

- **Refractory cases:** Patients who have failed multiple standard corticosteroid injections may harbor mechanical entrapment that anti-inflammatory approaches cannot address.
- **Post-surgical adhesions:** Following lumbar surgery, perineural scar formation may mechanically compress medial branch nerves, representing a specific indication for adhesion release.
- **Neuropathic pain predominance:** Patients whose pain has significant burning, shooting, or electrical quality suggestive of neuropathic mechanisms rather than purely nociceptive inflammation.
- **Brief response to diagnostic blocks:** Patients who obtain relief from diagnostic medial branch blocks but only for hours rather than the expected duration of the local anesthetic used may have mechanical re-entrapment that hydrodissection could address.

Initial clinical studies should focus on these select populations rather than unselected facetogenic pain patients, as they may show more pronounced benefits and clearer mechanistic validation.

### 4.4. Proposed Research Pathway

Translating hydrodissection to lumbar facet joint interventions requires systematic investigation across multiple study phases:

**Phase 1: Cadaveric Feasibility Studies.** Establish optimal ultrasound visualization parameters for medial branch nerves in cadaveric specimens. Determine injection volumes and approaches that achieve adequate perineural spread without excessive spread to adjacent structures. Quantify variability across different body habitus. Document safety margins relative to critical structures (spinal nerve roots, dural sac).

**Phase 2: Pilot Case Series.** Conduct prospective case series (n = 10 - 30) in select patient populations (e.g., post-surgical patients with suspected adhesions, refractory cases failing standard treatments). Use standardized protocol with predefined injectate composition and volume. Assess technical feasibility, immediate adverse events, and preliminary efficacy using validated outcome measures (NRS, ODI) at multiple time points (2 weeks, 1 month, 3 months, 6 months). Document learning curve and protocol refinements.

**Phase 3: Comparative Effectiveness Trials.** Design and conduct randomized controlled trials comparing hydrodissection to standard corticosteroid injections. Use rigorous methodology including dual diagnostic blocks for enrolment, validated outcome measures, adequate follow-up duration (minimum 6 months), and appropriate statistical power. Consider pragmatic trial designs that reflect real-world clinical practice.

**Phase 4: Mechanistic Validation.** Conduct studies with advanced imaging

(MRI neurography) or electrophysiological assessments to validate proposed mechanisms (adhesion release, nerve decompression, improved neural mechanics). Consider biomarker studies examining inflammatory cytokines or neuropathic pain mediators.

**Phase 5: Cost-Effectiveness Analysis.** Once efficacy is established, conduct economic evaluations comparing hydrodissection to standard treatments and radiofrequency ablation, considering procedure costs, equipment requirements, duration of benefit, and quality-adjusted life years.

This staged approach balances scientific rigor with resource efficiency, allowing early termination if fundamental feasibility or safety concerns arise, while building progressively stronger evidence if initial phases prove promising.

### 4.5. Limitations

This scoping review has several limitations. First, we restricted inclusion to English-language publications, potentially missing relevant studies in other languages. However, the complete absence of any evidence suggests this is unlikely to substantially alter conclusions. Second, our search strategy, while comprehensive, may not have captured every possible synonym or related term. Hand-searching of reference lists and consultation with content experts mitigated this limitation. Third, the evidence gap itself limits what conclusions can be drawn about hydrodissection's potential efficacy for facet joint pain. Our synthesis of related evidence provides theoretical rationale but cannot substitute for direct clinical investigation. Fourth, rapid evolution of ultrasound technology and growing clinical experience with hydrodissection techniques mean that feasibility and accuracy may improve beyond what current literature reflects.

Finally, this review focused specifically on lumbar facet joints and medial branch nerves. The broader question of hydrodissection for other causes of chronic low back pain (sacroiliac joint dysfunction, myofascial pain) represents separate research domains beyond our scope.

### 4.6. Clinical and Research Implications

**For Current Clinical Practice.** The absence of evidence precludes recommending hydrodissection for lumbar facet joint interventions in routine clinical practice at this time. Standard protocols—diagnostic medial branch blocks under fluoroscopic guidance followed by radiofrequency ablation for positive responders—remain the evidence-based approach per ASIPP and multispecialty consensus guidelines [7] [30].

However, for carefully selected patients who have failed standard treatments and provide informed consent, hydrodissection could potentially be offered as an off-label intervention, particularly in centers with expertise in ultrasound-guided techniques and established protocols for other hydrodissection applications. Such cases should be documented systematically and outcomes reported to contribute to the developing evidence base.

This evidence gap represents a significant research opportunity. The variable success rates of current treatments (13% - 74%) suggest substantial room for improvement through alternative approaches. Hydrodissection's established efficacy for peripheral entrapments and related spinal structures provides scientific justification for investigation.

Researchers with access to cadaveric facilities should prioritize feasibility studies establishing optimal visualization and injection protocols. Clinicians with ultrasound expertise and established hydrodissection practices should consider initiating pilot case series in select patient populations. Funding agencies should recognize this as a high-impact translational research area addressing a prevalent and costly clinical problem.

Pain medicine training programs should incorporate education about mechanical pain mechanisms (nerve entrapment, adhesion formation, vascular compression) alongside traditional inflammatory models. Understanding that standard anti-inflammatory approaches may be insufficient for mechanically-mediated pain could improve treatment selection and patient outcomes.

## 5. Conclusions

This scoping review reveals a complete absence of published evidence for hydrodissection applied to lumbar facet joint interventions—a finding that simultaneously highlights a critical limitation of current clinical practice and presents a substantial opportunity for innovative research. While extensive literature supports both standard facet interventions (with variable success rates) and hydrodissection in related anatomical applications (with promising outcomes), the translation to facet joint pain has not been systematically investigated.

The theoretical mechanistic rationale is compelling: hydrodissection's mechanical release of perineural adhesions and decompression of nervi nervorum and vasa nervorum could address pain mechanisms that standard small-volume corticosteroid injections cannot. Successful applications to superior cluneal nerves (80% response rates), caudal epidural space (52% NRS improvement at 12 months), and peripheral nerve entrapments provide proof-of-concept.

However, significant technical challenges exist, particularly ultrasound visualization accuracy limitations (11% - 13% incorrect needle placement) and volume considerations that balance mechanical effect against diagnostic specificity. These challenges are surmountable through careful protocol design, appropriate patient selection (refractory cases, post-surgical adhesions), and staged research progression from cadaveric feasibility to pilot case series to comparative trials.

The time is opportune for systematic investigation of hydrodissection for lumbar facet joint pain. With 15% - 45% of chronic low back pain attributable to facetogenic sources, current treatment success rates of 13% - 74%, and established safety and efficacy of hydrodissection in related applications, this evidence gap represents not merely an academic curiosity but a clinically important research frontier with potential to improve outcomes for millions of patients suffering from

chronic facetogenic pain.

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## Conflicts of Interest

The authors declare no conflicts of interest

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