Pain Physician 2024; 27:E169-E206 • ISSN 2150-1149

Systematic Review

Effectiveness of Facet Joint Nerve Blocks in Managing Chronic Axial Spinal Pain of Facet Joint Origin: A Systematic Review and Meta-Analysis

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Disclaimer: There was no external funding in the preparation of this manuscript.

Conflict of interest: Dr. Abdi is a consultant for OliPass Corporation and AIM Specialty Health. Dr. Soin is the founder and CEO of Soin Therapeutics. Soin Therapeutics has patents for low dose naltrexone for treatment of CRPS. Dr. Hirsch is a consultant for Medtronic, Relievant, and Sanofi. He is a grant supported Senior Affiliate Research Fellow at the Neiman Policy Institute. All other authors certify that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest,

Background: Chronic axial spinal pain is one of the major causes of disability. Literature shows that spending on low back and neck pain and musculoskeletal disorders continues to escalate, not only with disability, but also with increasing costs, accounting for the highest amount of various disease categories. Based on the current literature utilizing controlled diagnostic blocks, facet joints, nerve root dura, and sacroiliac joints have been shown as potential sources of spinal pain. Therapeutic facet joint interventional modalities of axial spinal pain include radiofrequency neurotomy, therapeutic facet joint nerve blocks, and therapeutic intraarticular injections.

Objective: The objective of this systematic review and meta-analysis is to evaluate the effectiveness of facet joint nerve blocks as a therapeutic modality in managing chronic axial spinal pain of facet joint origin.

Study Design: A systematic review and meta-analysis of randomized controlled trials (RCTs) and observational studies utilizing the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist.

Methods: The available literature on facet joint nerve blocks in axial spinal pain was reviewed. The quality assessment criteria utilized were the Cochrane review criteria to assess risk of bias, the Interventional Pain Management Techniques – Quality Appraisal of Reliability and Risk of Bias Assessment (IPM-QRB) for randomized therapeutic trials, and the Interventional Pain Management Techniques – Quality Appraisal of Reliability and Risk of Bias Assessment for Nonrandomized Studies (IPM-QRBNR) for nonrandomized studies. The evidence was graded according to Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) assessment criteria. The level of evidence was based on best evidence synthesis with modified grading of qualitative evidence from Level I to Level V.

A comprehensive literature search of multiple databases from 1966 to July 2023, including manual searches of the bibliography of known review articles was performed. Quality assessment of the included studies and best evidence synthesis were incorporated into qualitative and quantitative evidence synthesis.

Outcome Measures: The primary outcome measure was the proportion of patients with significant relief and functional improvement of greater than 50% of at least 3 months. Duration of relief was categorized as short-term (less than 6 months) and long-term (greater than 6 months).

Results: This assessment identified 8 high-quality and one moderate quality RCTs and 8 high quality and 4 moderate quality non-randomized studies with application of spinal facet joint nerve blocks as therapeutic modalities. However, based on the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) assessment, only 3 of the 21 studies showed high levels of evidence and clinical applicability, with 11 studies showing moderate levels of GRADE evidence and clinical applicability.

Limitations: Despite the availability of multiple studies, the paucity of literature is considered as the

patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.

Manuscript received: 10-23-2023
Accepted for publication: 01-17-2024

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major drawback. Based on Grading of Recommendations, Assessment Development, and Evaluations (GRADE) assessment, only 3 of the 21 studies showed high levels of evidence and clinical applicability.

Conclusion: Based on the present systematic review and meta-analysis with 9 RCTs and 12 non-randomized studies, the evidence is Level II with moderate to strong recommendation for therapeutic facet joint nerve blocks in managing spinal facet joint pain.

Key words: Facet joint pain, facet joint nerve blocks, radiofrequency neurotomy, diagnostic facet joint nerve blocks, therapeutic facet joint nerve blocks, randomized controlled trials, meta-analysis, observational studies

Pain Physician 2024: 27:E169-E206

Chronic axial spinal pain with or without extremity pain, chest wall pain, or headaches is one of the major causes of disability and healthcare costs in the United States and across the globe (1,2). Multiple publications assessing the state of US health and disability (3), spending on low back and neck pain and musculoskeletal disorders (4,5) have shown escalating disability and increasing costs in managing low back and neck pain accounting for the highest amount of the various disease categories. Despite numerous modalities of treatments available, chronic persistent spinal pain is reported in 25% to 60% of patients for at least one-year, and even longer following an initial episode (1).

Based on the current literature, utilizing controlled diagnostic blocks, the intervertebral discs, facet joints, nerve root dura, and sacroiliac joints have been shown as potential sources of spinal pain and extremity pain (1). Among the interventional modalities in managing axial spinal pain of facet joint origin, 3 modalities have been extensively utilized including therapeutic facet joint nerve blocks, radiofrequency neurotomy, and intraarticular injections (1). However, of the 3 modalities utilized for therapy, facet joint nerve blocks are also the preferred modality for the diagnosis of facet joint pain with controlled diagnostic blocks (1). Further, interventional modalities for the diagnosis and treatment of facet joint pain continue to elicit significant debate despite advances in understanding and with several publications relating to deceleration in growth patterns in the U.S. (1,6-14). Multiple publications focusing on diagnosis and effectiveness (1,7,8,15-20) and cost utility analysis have shown favorable clinical and cost utility (15-20).

Among the facet joint guidelines published, one guideline (1) systematically assessed the evidence for all interventional modalities in managing facet joint pain, including facet joint nerve blocks. For therapeutic facet joint interventions, the evidence was shown as Level II with moderate strength of recommendation for therapeutic lumbar facet joint nerve blocks with inclusion of 3 randomized controlled trials (RCTs) with long-term improvement (21-23). Level II evidence with moderate strength of recommendation was shown for therapeutic cervical facet joint nerve blocks with inclusion of one relevant RCT (24) and 3 observational studies (25-27), with long-term improvement. Finally, in the thoracic spine, also the evidence was shown as Level II with moderate strength of recommendation for thoracic therapeutic facet joint nerve blocks with inclusion of 2 RCTs (28,29) and 3 observational studies (30-32) with moderate strength of recommendation with long-term improvement. These guidelines with systematic review without meta-analysis (1) showed similar evidence of the facet joint blocks compared to radiofrequency neurotomy in cervical and lumbar spine, whereas, in the thoracic spine it was Level II for facet joint nerve blocks compared to Level III for thoracic radiofrequency ablation. Similar evidence of Level II with moderate strength of recommendation in lumbar and cervical spine.

In 2021, Baroncini et al (33) published a systematic review of management of facet joints osteoarthritis associated with chronic low back pain. In this assessment they utilized data from 487 patients, in 8 publications, with a mean follow-up of 12.4 ± 10.5 months. Utilizing methodologic quality assessment criteria of Cochrane reviews, showing overall low risk of bias, results obtained with medial branch blocks were more consistent than the ones for facet joint injections. Overall, the results showed local anesthetic, steroids, and Sarapin, alone or combined, showed improvement in pain scores and disability scores.

Mazmudar et al (34) assessed an economic value perspective of therapeutic facet joint interventions in the lumbar spine. They assessed intraarticular injections, medial branch blocks, and radiofrequency neurotomy. This 2020 publication showed limited evidence for therapeutic intraarticular facet joint injections with

moderate evidence for utilization of therapeutic medial branch blocks and radiofrequency neurotomies.

Other publications include studies by da Rocha et al (35), Liu et al (36), Manchikanti et al (19,20), van Eerd (37), and Pasuhirunnikorn et al (38). Da Rocha et al (35) evaluated medial branch blocks for the diagnosis of chronic lumbar facet joint pain. They demonstrated that after controlled diagnostic blocks, 52% of the patients reported greater than 50% improvement lasting over 3 months, indicating at a minimum of short-term effectiveness of diagnostic facet joint nerve blocks functioning as therapeutic facet joint nerve blocks. Liu et al (36) published a similar study as da Rocha (35) demonstrating therapeutic benefits of diagnostic medial branch nerve blocks. Other important studies in recent years include 2 studies by Manchikanti et al (19,20) with comparative effectiveness of radiofrequency neurotomy and therapeutic facet joint nerve blocks with assessment of cost utility in cervical and lumbar spine and van Eerd et al (37) showing the comparative value of local anesthetic blocks compared to radiofrequency neurotomy. Pasuhirunnikorn et al (38), in a recent publication, showed that lidocaine medial branch injections provided significant pain reduction up to 16 weeks and significant improvement in the neck functional outcomes up to 8 weeks compared to baseline. They also showed that bupivacaine yielded significant pain alleviation; however, up to 8 weeks only for pain upon neck mobilization and demonstrated notable improvement in neck function up to 4 weeks compared to the baseline.

Overall, the appropriate analysis of facet joint nerve blocks has not been performed by multiple authors with preconceived notions and suboptimal review of the literature. Most commonly quoted studies are extremely outdated by Marks et al (39), which was published in 1992 with extremely short-term pain relief assessment, Cohen et al (40), which showed lack of effectiveness of intraarticular injections, as well as medial branch blocks as a prognostic tool before lumbar facet joint radiofrequency neurotomy with multiple drawbacks in the conduct of the study, and a Letter to the Editor in reference to Manchikanti et al's study by Levin in 2009 (41). Further, medial branch blocks are technically easier to perform and less painful than intraarticular injections, which have a documented technical failure rate ranging between 29% and 38% per joint, and from 46% to 64% per procedure (42,43). It has been described that excessive procedure related pain is a potential cause of false-negative blocks, consequently, a less painful procedure might be associated with a lower false-positive rate (7,44). The technical failure rate for intraarticular injections has been reported to be highest at L5-S1. In contrast, lumbar medial branch blocks (less than 2%) miss the targeted nerve, even though intravascular uptake which occurs in between 4% and 19% of injections, can lead to false-negative results (7,45).

This systematic review and meta-analysis of RCTs and observational studies was undertaken to assess the efficacy and effectiveness of facet joint nerve blocks in managing chronic axial spinal pain of facet joint origin, including cervical, thoracic, and lumbar spine regions.

Methods

A systematic review and meta-analysis were performed based on methodological and reporting quality of systematic reviews as described by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (46). Methodology from other reviews was also utilized (15,16,47-49).

The objective of this systematic review and meta-analysis of RCTs and observational studies was undertaken to assess the efficacy and effectiveness of facet joint nerve blocks in managing chronic axial spinal pain of facet joint origin, including cervical, thoracic, and lumbar spine regions.

Eligibility Criteria

All RCTs and observational studies studying therapeutic facet joint nerve blocks with at least 3 months of follow-up were included in this study. The studies with appropriate diagnosis established by diagnostic blocks or clinical diagnosis were included.

Information Sources

A comprehensive literature search was conducted to include randomized control trials and observational studies published from all countries and in all languages. Searches were performed from the following sources without language restrictions.

1. PubMed from 1966 https://pubmed.ncbi.nlm.nih.gov/
2. Cochrane Library https://www.cochranelibrary.com/
3. Google Scholar https://scholar.google.com/
4. US National Guideline Clearinghouse (NGC) https://www.ahrq.gov/gam/index.html
5. Clinical Trials https://www.clinicaltrials.gov/
6. Previous systematic reviews and cross-references
7. All other sources including non-indexed journals and abstracts

The search period was from 1966 through July 2023.

Search Strategy

The search strategy included chronic axial spinal pain treated with facet joint interventions. The search terms included: ((((((spinal pain, chronic low back, neck, mid back, and upper back pain) OR chronic neck pain OR chronic low back pain OR chronic thoracic pain) OR facet joint pain) OR post lumbar surgery syndrome, post cervical surgery syndrome, post thoracic surgery syndrome) OR zygapophysial)) AND ((((facet joint) OR zygapophyseal) OR zygapophysial) OR medial branch block OR facet joint nerve block OR dorsal ramus block intraarticular injection OR radiofrequency neurotomy).

Data Selection

Two review authors independently (ADK, NNK), established the search criteria, searched the literature, and extracted data from the selected studies. Disagreements between the 2 review authors were resolved by a third author (MRS). All conflicts of interest between reviewers who have authorship of this article were resolved by assigning the dispute to other reviewers.

Study of Risk of Bias and Methodological Quality Assessment

RCTs were assessed for their quality or risk of bias methodologically utilizing Cochrane review criteria (Appendix Table 1) (50), Interventional Pain Management techniques–Quality Appraisal of reliability and Risk of Bias Assessment (IPM-QRB) (Appendix Table 2) (51), and Interventional Pain Management Techniques – Quality Appraisal of Reliability and Risk of Bias Assessment for Nonrandomized Studies (IPM-QRBNR) was utilized for observational studies, as shown in Appendix Table 3 (52).

Trials that met the inclusion criteria and scored at least 9 of 13 using the Cochrane review criteria (50) were considered high quality, while trials scoring 5-8 were considered of moderate quality. Trials that scored less than 5 were considered of low quality and were excluded from the analysis.

Trials meeting the inclusion criteria were also assessed with IPM-QRB criteria (51). Studies scoring 32-48 were considered of high quality, those scored 16-31 were of moderate quality and those that scored below 16 were considered of low quality and were excluded from the analysis.

Based on IPM-QRBNR criteria (52), studies meeting the inclusion criteria but scoring less than 16 were considered low-quality and were excluded, studies scoring from 16 to 31 were considered moderate quality; and studies scoring from 32 to 48 were considered high-quality and were included.

Assessment of Grading

The grading was conducted utilizing Grading of Recommendations, Assessment, Development and Evaluations (GRADE) system of appraisal for determining the body of evidence (53). GRADE assessment was based on 5 factors: 1) methodological limitations, 2) consistency, 3) indirectness, 4) imprecision, and 5) publication bias. They were graded high, moderate, low, or very low. Based on the study evaluation of methodologic quality, grading was applied as no change, downgraded, or upgraded. Clinical relevance and pragmatism of all studies were assessed (48,53). Applicability of the studies to real world were evaluated as described by Dal-Ré et al (54).

Methodological quality of the trials and GRADE appraisal was conducted by 2 authors (MRS and AS), independently in an unblinded manner. If a discrepancy occurred, (SA and ADK) were involved to resolve the conflict. When an issue of conflict of interest was raised in reviewing the studies (regarding authorship), the involved authors were not allowed to review those studies for quality assessment.

Outcome Measures

An outcome is considered clinically significant if a reduction of 2 points on the Visual Analog Scale (VAS) or Numeric Rating Scale (NRS), or at least 50% reduction in pain and improvement in the functional status. A positive study is said to be clinically significant and effective indicating that the primary outcome should be statistically significant at a P-value ≤ 0.05.

Analysis of Evidence

The evidence was analyzed utilizing qualitative and quantitative evidence synthesis. Quantitative evidence synthesis was performed utilizing conventional meta-analysis and a single-arm meta-analysis.

Qualitative Analysis

The qualitative analysis of the evidence was performed based on best-evidence synthesis, modified, and collated using multiple criteria, including the Cochrane Review criteria and United States Preventive Services Task Force (USPSTF) criteria as illustrated in Table 1 (55). The analysis was conducted using 5 levels of evidence ranging from strong to opinion- or consensus-based.

Meta-Analysis

Dual-Arm Meta-Analysis

For dual-arm meta-analysis, software Review Manager [Computer program] version 5.4, The Cochrane Collaboration, 2020 was used. For pain and functionality improvement data, the studies were reported as the standardized mean differences (SMD) with 95% confidence interval (CI). Data were plotted using forest plots to evaluate treatment effects using random-effects model. Heterogeneity was interpreted through I^2 statistics.

Single-Arm Meta-Analysis

For single-arm meta-analysis, software Comprehensive Meta-Analysis version 3.0 was used (Biostat Inc., Englewood, NJ). For pain and functionality improvement data, the studies were reported as the mean differences with 95% confidence intervals. Data were plotted using forest plots to evaluate treatment effects. Heterogeneity was interpreted through I^2 statistics.

At least 2 of the review authors (EK and NNK) independently, in a standardized manner, analyzed the evidence. Any disagreements between reviewers were resolved by 2 authors (SA and ADK) and consensus was attained. If there were any conflicts of interest (e.g., authorship), the reviewers of interest were recused from assessment and analysis.

Table 1. *Qualitative modified approach to grading of evidence of therapeutic effectiveness studies.*

Level I	Strong	Evidence obtained from multiple relevant high-quality randomized controlled trials
Level II	Moderate	Evidence obtained from at least one relevant high-quality randomized controlled trial or multiple relevant moderate or low-quality randomized controlled trials
Level III	Fair	Evidence obtained from at least one relevant moderate or low-quality randomized trial OR Evidence obtained from at least one relevant high-quality non-randomized trial or observational study with multiple moderate or low-quality observational studies
Level IV	Limited	Evidence obtained from multiple moderate or low-quality relevant observational studies
Level V	Consensus based	Opinion or consensus of large group of clinicians and/or scientists

Modified from: Manchikanti L, et al. A modified approach to grading of evidence. *Pain Physician* 2014; 17:E319-E325 (55).

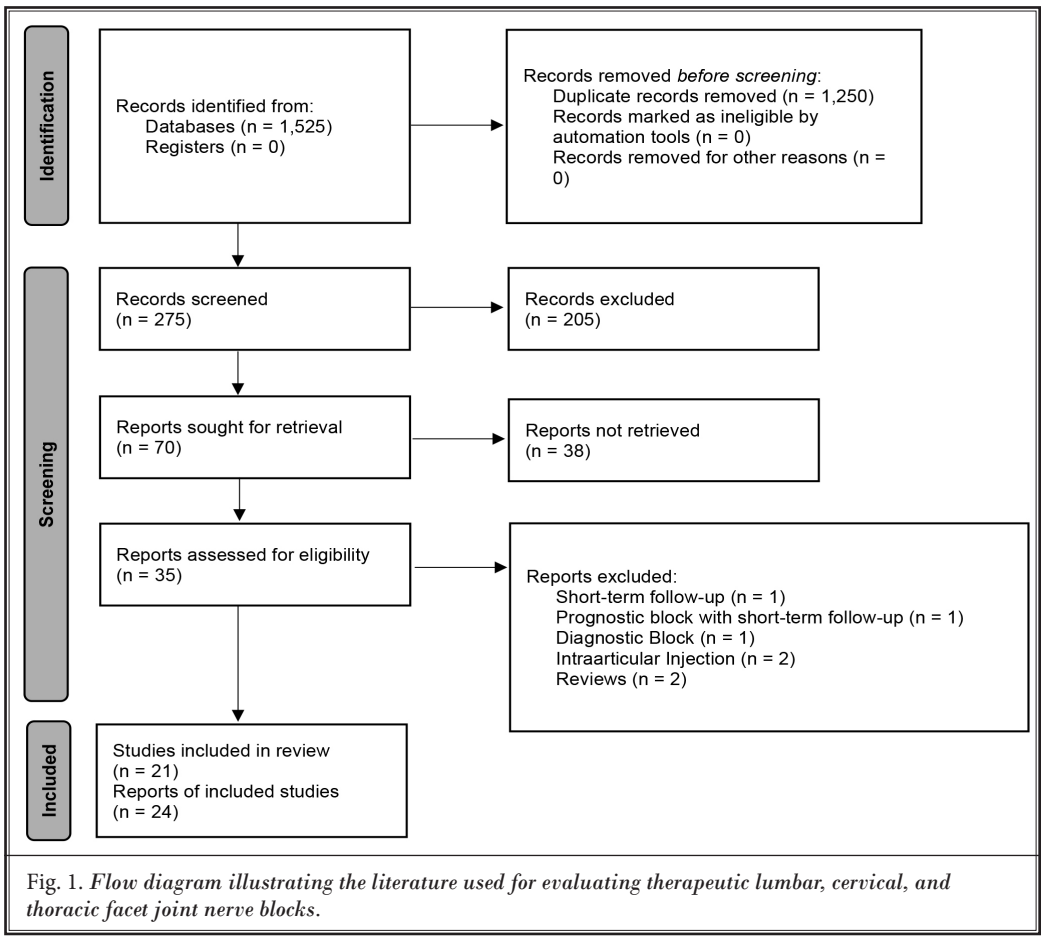


Fig. 1. *Flow diagram illustrating the literature used for evaluating therapeutic lumbar, cervical, and thoracic facet joint nerve blocks.*

Results

Study Selection

Figure 1, based on 2020 PRISMA guidance (46), shows a flow diagram

of the study selection using the PRISMA study selection process.

Based on the search criteria, 35 publications were identified and considered for inclusion (19-40,56-68) with 12 publications of RCTs (21,22,24,28,29,37,38,56-60), with inclusion of 9 trials (21,22,24,28,29,37,38,56,60). There were 16 observational studies (19,20,23,25-27,30-32,62-68), with 12 studies meeting the inclusion criteria (19,20,23,25-27,30-32,62-64).

Methodologic Quality and Risk of Bias Assessment

Tables 2 and 3 show the methodologic quality assessment and risk of bias of the 9 RCTs utilizing the Cochrane review criteria and the IPM-QRB criteria (21,22,24,28,29,37,38,56-60). Assessment by the Cochrane review criteria showed all of them as high-quality trials scoring at least 9 of 13. However, based on IPM-QRB instrument, 8 of 9 trials (22,24,28,29,37,38,56-60) scored as high with scores of above 32 of 48. One trial (21) showed moderate quality with scores above 16.

Table 4 shows methodologic quality assessment based on IPM-QRBNR criteria (52) with 8 of 12 studies showing high quality with a score above 32 (19,20,23,25,27,30,62,63). The remaining 4 studies (26,31,32,64) were shown to be of moderate quality.

Study Characteristics

Tables 5 and 6 show the characteristics and outcomes of the studies meeting inclusion criteria.

Of the 9 RCTs, none were placebo-controlled and all of

Table 2. *Methodological quality assessment of randomized trials of spinal facet joint nerve blocks utilizing Cochrane review criteria.*

	Civelek et al (21)	Manchikanti et al (22,57)	Manchikanti et al (24,58)	Manchikanti et al (28,59)	Lee et al (29)	van Eerd et al (37)	Hussain et al (56)	Abdelghaffar & Awad (60)	Pasuhirunnikorn et al (38)
Randomization adequate	Y	Y	Y	Y	Y	Y	Y	Y	Y
Concealed treatment allocation	Y	Y	Y	Y	Y	Y	Y	Y	Y
Patient blinded	N	Y	Y	Y	Y	Y	N	N	Y
Care provider blinded	N	Y	Y	Y	N	Y	N	N	Y
Outcome assessor blinded	U	N	N	N	Y	Y	N	N	Y
Drop-out rate described	Y	Y	Y	Y	Y	Y	Y	Y	Y
All randomized participants analyzed in the group	Y	Y	Y	Y	Y	Y	Y	Y	Y
Reports of the study free of suggestion of selective outcome reporting	Y	Y	Y	Y	Y	Y	Y	Y	Y
Groups similar at baseline regarding most important prognostic indicators	Y	Y	Y	N	Y	Y	Y	Y	Y
Co-intervention avoided or similar in all groups	Y	Y	Y	Y	Y	Y	Y	Y	Y
Compliance acceptable in all groups	Y	Y	Y	Y	Y	Y	Y	Y	Y
Time of outcome assessment in all groups similar	Y	Y	Y	Y	Y	Y	Y	Y	Y
Are other sources of potential bias not likely	U	Y	Y	Y	Y	Y	Y	Y	Y
SCORE	9/13	12/13	12/13	11/13	12/13	13/13	10/13	10/13	13/13

Y = yes; N = no; U = nuclear

Source: Furlan AD, et al; Editorial Board of the Cochrane Back, Neck Group. 2015 Updated Method Guideline for Systematic Reviews in the Cochrane Back and Neck Group. Spine (Phila Pa 1976) 2015; 40:1660-1673 (50).

Table 3. *Methodologic quality assessment of randomized trials of spinal facet joint nerve blocks utilizing IPM – QRB criteria.*

		Civelek et al (21)	Manchikanti et al (22,57)	Manchikanti et al (24,58)	Manchikanti et al (28,59)	Lee et al (29)	van Eerd et al (37)	Hussain et al (56)	Abdelghaffar & Awad (60)	Pasuhirunnikorn et al (38)
I.	TRIAL DESIGN AND GUIDANCE REPORTING									
1.	CONSORT or SPIRIT	2	3	3	3	2	3	2	2	3
II.	DESIGN FACTORS									
2.	Type and Design of Trial	2	2	2	2	2	2	2	2	2
3.	Setting/Physician	2	2	2	2	2	2	2	2	2
4.	Imaging	3	3	3	3	3	3	2	2	1
5.	Sample Size	1	3	3	3	1	2	1	1	3
6.	Statistical Methodology	1	1	1	1	1	1	1	1	1
III.	PATIENT FACTORS									
7.	Inclusiveness of Population									
	• For facet or sacroiliac joint interventions:	0	2	2	2	2	0	0	0	2
8.	Duration of Pain	0	2	2	2	2	2	2	2	2
9.	Previous Treatments	2	2	2	2	2	2	2	2	2
10.	Duration of Follow-up with Appropriate Interventions	2	3	3	3	2	2	2	1	2
IV.	OUTCOMES									
11.	Outcomes Assessment Criteria for Significant Improvement	2	4	4	4	2	0	2	1	2
12.	Analysis of all Randomized Participants in the Groups	2	2	2	2	2	2	2	2	2
13.	Description of Drop Out Rate	2	2	2	2	2	2	2	2	2
14.	Similarity of Groups at Baseline for Important Prognostic Indicators	2	2	2	2	2	2	2	2	2
15.	Role of Co-Interventions	1	1	1	1	1	1	2	2	2
V.	RANDOMIZATION									
16.	Method of Randomization	2	2	2	2	2	2	2	2	2
VI.	ALLOCATION CONCEALMENT									
17.	Concealed Treatment Allocation	2	2	2	2	2	2	2	2	2
VII.	BLINDING									
18.	Patient Blinding	0	1	1	1	1	1	0	0	1
19.	Care Provider Blinding	0	1	1	1	1	1	0	0	1
20.	Outcome Assessor Blinding	0	0	0	0	1	1	0	0	1

Table 3 cont. *Methodologic quality assessment of randomized trials of spinal facet joint nerve blocks utilizing IPM – QRB criteria.*

		Civelek et al (21)	Manchikanti et al (22,57)	Manchikanti et al (24,58)	Manchikanti et al (28,59)	Lee et al (29)	van Eerd et al (37)	Hussain et al (56)	Abdelghaffar & Awad (60)	Pasuhirunnikorn et al (38)
VIII.	CONFLICTS OF INTEREST									
21.	Funding and Sponsorship	0	2	2	2	2	3	2	2	2
22.	Conflicts of Interest	0	3	3	3	2	3	3	3	3
TOTAL		28	45	45	45	39	39	35	33	42

Source: Manchikanti L, et al. Assessment of methodologic quality of randomized trials of interventional techniques: Development of an interventional pain management specific instrument. Pain Physician 2014; 17:E263-E290 (51).

them were active control. Active controls included comparison of local anesthetic with steroid and local anesthetic without steroids in 4 RCTs (21,22,24,28), local anesthetic and radiofrequency neurotomy (37), trigger point injections in one study (56), intraarticular facet joint injections (29), retrolaminar approach in cervical spine (60), and comparison of 2 local anesthetics (38). Regionally, 2 trials were performed in the lumbar spine (21,22), 5 trials were performed in the cervical spine (24,37,38,58,60), and 2 trials were performed in the thoracic spine (28,29). All the trials were performed under fluoroscopy except one trial by Pasuhirunnikorn et al (38).

In reference to nonrandomized studies, of the 12 observational studies, 3 studies were performed in the lumbar spine (19,23,62), 6 studies were performed in the cervical spine (20,25-27,63,64), and 3 studies were performed in the thoracic spine (30-32). In nonrandomized studies, comparators were available with conventional radiofrequency in 2 studies (19,37), local anesthetic with steroids compared to local anesthetic alone in one study (23), and multiple studies had no comparator. All the studies were performed under fluoroscopy.

Diagnostic Blocks

Controlled Diagnostic Blocks

There were 9 studies utilizing controlled dual diagnostic blocks (19,20,22-25,27,28,30). In one study, diagnostic blocks were performed utilizing a single block with criterion standard of > 75% pain relief (38). In one study, descriptions were not clear (62). Thus, only 10 of 21 studies used single or dual diagnostic blocks.

Table 7 shows assessment of the GRADE criteria utilizing 5 levels of evidence and assessing 5 factors: methodologic limitation, consistency, indirectness, imprecision and publication bias with grading of high, moderate, low, or very low. Overall, 3 studies showed high level according to GRADE assessment (22,24,28), whereas 11 studies showed moderate (19-21,23,25,26,29,30,37,38,56) and 7 studies showed low grading (27,31,32,60,62-64).

Table 8 shows effectiveness of RCTs and observational studies.

Qualitative Analysis

The evidence in this study was analyzed qualitatively using a best-evidence synthesis approach, which incorporated various criteria such as the Cochrane Review and the USPSTF criteria outlined in Table 1 (55). The analysis utilized five levels of evidence, ranging from strong to opinion or consensus-based, and the results were graded according to the GRADE system (48,69). Dal-Ré et al (54) described for pragmatic and real-world studies, they should fulfill at least 2 fundamental features, including conduct of the study, which should resemble usual clinical practice, and the applicability of the results to multiple other settings (i.e., real world), not only the one where the trial was conducted. Table 8 shows qualitative analysis.

Quantitative Analysis

Pain-Conventional Dual-Arm Analysis

There were 3 trials (22,24,28) with 320 patients that compared control (local anesthetic) vs. local anesthetic and steroid group in a dual-arm meta-analysis for 3 months. Results did not show a statistically significant difference in pain levels between these 2 groups [SMD 0.03 (-0.19, 0.25), $P = 0.78$] (Fig. 2A).

Table 4. *Assessment of nonrandomized or observational studies of spinal facet joint nerve blocks utilizing IPM-QRBNR.*

		Manchikanti et al (19)	Manchikanti et al (20)	Manchikanti et al (23)	Manchikanti et al (25)	Manchikanti et al (30)	Hahn et al (26)	Lee & Huston (27)	Park et al (31)	Chang (32)	Han et al (62)	Park et al (63)	Klessinger (64)
I.	STUDY DESIGN AND GUIDANCE REPORTING												
1.	STROBE or TREND GUIDANCE	3	3	3	3	3	2	2	2	2	3	3	2
II.	DESIGN FACTORS												
2.	Study Design and Type	4	4	4	4	4	2	2	2	2	4	4	2
3.	Setting/Physician	2	2	2	2	2	2	2	2	2	2	2	2
4.	Imaging	2	2	2	3	3	3	3	3	3	2	2	2
5.	Sample Size	2	2	2	2	1	2	2	1	1	2	2	2
6.	Statistical Methodology	2	2	2	2	2	2	2	1	1	2	2	2
III.	PATIENT FACTORS												
7.	Inclusiveness of Population												
	For facet or sacroiliac joint interventions:	4	4	4	4	4	4	4	4	4	2	4	0
8.	Duration of Pain	2	2	2	2	2	2	2	2	2	2	2	2
9.	Previous Treatments	2	2	2	2	2	2	2	2	2	2	2	2
10.	Duration of Follow-up with Appropriate Interventions	3	3	3	3	3	1	3	2	2	2	2	2
IV.	OUTCOMES												
11.	Outcomes Assessment Criteria for Significant Improvement	3	3	3	4	4	2	3	1	3	2	2	2
12.	Description of Drop Out Rate	1	1	1	1	1	1	1	1	1	1	1	1
13.	Similarity of Groups at Baseline for Important Prognostic Indicators	2	2	2	0	0	0	0	0	0	2	2	0
14.	Role of Co-Interventions	2	2	2	2	2	2	2	2	2	2	2	1
V.	ASSIGNMENT												
15.	Method of Assignment of Participants	2	2	2	2	2	2	2	2	2	2	2	0
VI.	CONFLICTS OF INTEREST												
16.	Funding and Sponsorship	2	2	2	2	2	2	2	2	2	2	2	2
TOTAL		38	38	38	36	37	31	34	29	31	34	36	24

Source: Manchikanti L, et al. Development of an interventional pain management specific instrument for methodologic quality assessment of nonrandomized studies of interventional techniques. Pain Physician 2014; 17:E291-E317 (52).

Table 5. *Study characteristics of randomized controlled trials assessing spinal facet joint nerve blocks.*

Study Study Characteristic Methodological Quality Scoring	Number of Patients & Selection Criteria	Facet Joint Nerve Blocks	Comparator	Outcome Measures and Time of Measurement	Results	Strengths	Weaknesses	Conclusions
LUMBAR FACET JOINT NERVE BLOCKS								
Civelek et al, 2012 (21) RA, AC Quality Scores: Cochrane = 9/13 IPM-QRB = 28/48	100 patients with chronic low back pain with failed conservative therapy and strict selection criteria; however, without diagnostic blocks	50 patients were treated with facet joint nerve blocks	50 patients were treated with conventional radiofrequency neurotomy at 80°C for 120 seconds in combination with high dose local anesthetic and steroids	Visual NRS, NASS, patient satisfaction questionnaire, Euro-Qol in 5 dimensions and ≥ 50% relief One month, 6 months, 12 months	At one year, 90% of patients in the radiofrequency group and 69% of the patients in the facet joint nerve block group showed significant improvement compared to 92% and 75% at 6-month follow-up	Randomized with 50 patients in each group	No diagnostic blocks were performed. High dose steroids and local anesthetics were utilized in both groups	Positive long-term results Efficacy was shown even without diagnostic blocks, both for facet joint nerve blocks and radiofrequency neurotomy
Manchikanti et al, 2008, 2010 (22,57) RA, DB, AC Quality Scores: Cochrane = 12/13 IPM-QRB = 45/48	120 patients with chronic low back pain of facet joint origin treated with therapeutic lumbar facet joint nerve blocks Controlled dual diagnostic blocks with a criterion standard of 80% pain relief	60 patients were treated with facet joint nerve blocks utilizing local anesthetic and steroids. These patients were also divided into 2 groups with 30 patients in each with or without the addition of Sarapin.	60 patients were treated with facet joint nerve blocks utilizing local anesthetic only. These patients were also divided into 2 groups with 30 patients in each with or without the addition of Sarapin.	NRS, ODI, employment status, and opioid intake 3, 6, 12, 18, and 24 months	Significant pain relief was shown in 85% in local anesthetic group and 90% in local anesthetic with steroids group at the end of the 2-year study period in both groups, with an average of 5-6 total treatments	Randomized trial with relatively large proportion of patients with 2-year follow-up, with inclusion of patients diagnosed with controlled diagnostic blocks	Lack of placebo group	Positive study with long-term effects. Effectiveness demonstrated with facet joint nerve blocks with local anesthetic with or without steroids
CERVICAL FACET JOINT NERVE BLOCKS								
Manchikanti et al, 2008, 2010 (24,58) RA, DB, AC, F Quality Scores: Cochrane = 12/13 IPM-QRB = 45/48	120 patients with axial neck pain treated with therapeutic cervical facet joint nerve blocks Controlled dual diagnostic blocks with a criterion standard of 80% pain relief	Cervical medial branch nerve blocks with fluoroscopy were performed utilizing local anesthetic with Sarapin	Cervical medial branch nerve blocks with fluoroscopy were performed utilizing local anesthetic with Sarapin	Measured numeric pain scores, NDI, opioid intake, and employment status at baseline. The procedures were repeated upon the return of pain and deterioration in functional status to less than 50% 3, 6, 12, 18, and 24 months	85% of the patients with local anesthetic only and 92% of the patients with steroid reported significant pain relief at 12 months, whereas the statistics were 85% in local anesthetic group and 93% in local anesthetic with steroid group at the end of 2 years. Functional status improvement of 50% or more by NDI was seen in 63% and 68% at 12 months and 70% and 75% at 24 months in local anesthetic group and local anesthetic with steroid group	Randomized trial with relatively large proportion of patients with 2-year follow-up, with inclusion of patients diagnosed with controlled diagnostic blocks	Lack of placebo group	This is the first study conducted evaluating therapeutic medial branch blocks in a randomized double-blind fashion, with effectiveness of facet joint nerve blocks with or without steroids

Table 5 cont. *Study characteristics of randomized controlled trials assessing spinal facet joint nerve blocks.*

Study Study Characteristic Methodological Quality Scoring	Number of Patients & Selection Criteria	Facet Joint Nerve Blocks	Comparator	Outcome Measures and Time of Measurement	Results	Strengths	Weaknesses	Conclusions
van Eerd et al, 2021 (37) RA, AC Quality Scores: Cochrane = 13/13 IPM-QRB = 39/48	79 patients with chronic cervical facet joint pain were included on the basis of the diagnosis with clinical criteria No diagnostic blocks were performed	Facet joint nerve block group, described as the control group, received nerve blocks with bupivacaine injection 0.5 mL, 0.25% at each nerve These patients also underwent sham radiofrequency denervation	The comparator group or intervention group received radiofrequency denervation and bupivacaine injection, 0.25% at each level	The primary outcome at 3 months and 6 months consisted of: • Pain intensity • Self-reported treatment effect • NDI • Use of pain medication • PGIC Duration of effect was determined using telephone interviews 6 weeks, 3 months, 6 months 6-month follow-up measure was defined as primary endpoint	Patient Global Impression of Change (PGIC) significant improvement Facet joint nerve blocks with bupivacaine group, 61.1% Denervation plus bupivacaine, 61.1% Facet joint nerve blocks with bupivacaine alone, 51.3% vs. radiofrequency neurotomy, 55.6% 3 months: bupivacaine only group, 51.4% RF denervation + bupivacaine, 57.1% 6 months: bupivacaine only group, 41% radiofrequency denervation + bupivacaine, 50%	Randomized active control trial comparing clinically relevant treatments commonly provided in managing patients with axial neck pain	The diagnosis was made based on clinical diagnosis. There were no diagnostic blocks performed	Positive short and long-term improvement 6 months or longer This study showed that local anesthetics are long-acting, at least equivalent to radiofrequency neurotomy in patients with clinically diagnosed facet joint pain with some decline, though statistically not significant at 6 months
Pasuhirunnikorn et al, 2023 (38) RA, DB, AC, US-guided Quality Scores: Cochrane = 13/13 IPM-QRB = 42/48	Randomized 62 patients diagnosed with chronic cervical facet syndrome diagnosed with a single diagnostic block with lidocaine were randomized into either lidocaine or bupivacaine groups Single diagnostic blocks with 75% pain relief as the criterion standard	31 patients Facet joint nerve blocks Injection of 2% lidocaine under ultrasound guidance with 0.5 to 1 mL per level according to the patients' pain symptoms	31 patients Injection of bupivacaine, 0.5%, with a volume of 0.5 to 1 mL per level according to the patients' pain symptoms	NRS, NDI At least 50% relief was the primary outcome. 75% pain relief and neck functional outcomes was the secondary outcome 2 weeks, 1 month, 3 months and 6 months	• There was no significant difference in the duration of 50% and 75% pain reduction and NDI between the lidocaine and bupivacaine groups • Lidocaine provided significant pain reduction up to 16 weeks and significant improvement neck functional outcomes up to 8 weeks compared to the baseline • Bupivacaine provided significant pain relief for up to 8 weeks and demonstrated notable improvement in neck function up to 4 weeks compared to the baseline	A randomized, double-blind, controlled study with appropriate sample size calculation utilizing 2 separate local anesthetics	A single diagnostic block was performed	Positive short-term results of 16 weeks Effectiveness demonstrates efficacy of local anesthetics to provide long-term improvement with 16 weeks with lidocaine and 8 weeks with bupivacaine in patients with cervical facet joint syndrome with the diagnosis of a single diagnostic block

Table 5 cont. *Study characteristics of randomized controlled trials assessing spinal facet joint nerve blocks.*

Study Study Characteristic Methodological Quality Scoring	Number of Patients & Selection Criteria	Facet Joint Nerve Blocks	Comparator	Outcome Measures and Time of Measurement	Results	Strengths	Weaknesses	Conclusions
Hussain et al, 2020 (56) RA, DB, AC, F Quality Scores: Cochrane = 10/13 IPM-QRB = 35/48	In this study, 60 patients with chronic neck pain were included to compare cervical medial branch nerve blocks with trigger point injections. Selection criteria included clinical symptoms and signs No diagnostic blocks	Facet joint nerve blocks 30 patients were treated with cervical medial branch blocks. The procedure was performed under fluoroscopic guidance. Each medial branch nerve was infiltrated with 1 mL of levobupivacaine, 0.25%, and triamcinolone Kenacort, 20 mg, at 2 levels	Comparator group included trigger point injections with 20 mg of triamcinolone and 0.25% levobupivacaine at 2 levels	NRS, NDI score subject to evaluation of pain, requirement of analgesics, and complications 3, 6, and 12 weeks	NRS scores decreased with medial branch block from baseline of 8 ± 1 to 2 ± 1.8 compared to reduction of 7.57 ± 1.47 to 6.96 ± 2.37 with trigger point injections with significant difference NDI was reduced with cervical medial branch blocks from 31.36 ± 8.197 to 8.2 ± 3.3 compared to 33 ± 8.65 to 32.3 ± 11.6 in the trigger point group with significant difference	A randomized controlled study with appropriate sample calculations	No diagnostic blocks were performed	Positive short-term results comparing cervical medial branch blocks with trigger point injections with significant difference with pain relief and disability index
Abdelghaffar & Awad, 2022 (60) RA, AC Quality Scores: Cochrane = 10/13 IPM-QRB = 33/48	Randomized, active control, open comparative study of 60 patients not responding to conservative treatments No diagnostic blocks The study was based on provocative testing for diagnosing facet joint pain with combined extension and rotation of the cervical spine and imaging of the cervical spine No diagnostic blocks	Cervical medial branch blocks were performed at the affected dermatomal level and one level above using 0.5 mL dexamethasone, 8 mg per 2 mL, and 0.5 mL of 1% lidocaine at each level	Retrolaminar block was utilized as comparator Comparator group was performed with cervical retrolaminar block with 2 mL of dexamethasone, 4 mg per 1 mL and 3 mL of 1% lidocaine for each affected dermatomal level	NRS, NDI, the timings of the monitoring, and monitoring of complications Follow ups were 2 months and 3 months	NRS scores in medial branch blocks were 6.40 ± 1.376 at baseline and 3.09 ± 1.245 at 3-month interval compared to retrolaminar group of 6.26 ± 1.462 to 3.23 ± 1.416 with no significant differences. Neck disability decreased significantly in both groups with no significant difference between the groups	Randomized controlled trial comparing 2 technical aspects	There were no diagnostic blocks. Some study participants had pain > 4 which may be less than required by guidelines. The volume of injection was significantly different with 1 mL of lidocaine in medial branch block group and 3 mL of lidocaine in retrolaminar group	Positive trial results in patients without diagnostic nerve blocks with both techniques of medial branch blocks and retrolaminar blocks

Table 5 cont. *Study characteristics of randomized controlled trials assessing spinal facet joint nerve blocks.*

Study Study Characteristic Methodological Quality Scoring	Number of Patients & Selection Criteria	Facet Joint Nerve Blocks	Comparator	Outcome Measures and Time of Measurement	Results	Strengths	Weaknesses	Conclusions
THORACIC FACET JOINT NERVE BLOCKS								
Manchikanti et al 2010, 2012 (28,59) RA, DB, AC Quality Scores: Cochrane = 11/13 IPM-QRB = 45/48	100 patients were included with 50 patients in each of the local anesthetic and steroid groups. Controlled dual diagnostic blocks with a criterion standard of 80% pain relief	Patients received thoracic medial branch blocks with bupivacaine	Patients received thoracic medial branch blocks with bupivacaine and non-particulate betamethasone	Numeric pain scores, ODI, opioid intake, and return to work status. Significant pain relief was defined as > 50% relief. Significant functional improvement was > 40% reduction of ODI All outcomes were assessed at baseline, 6 months, 12 months, and 24 months.	In local anesthetic group, 80% of patients showed significant pain relief and functional improvement at 12 and 24 months. In local anesthetic with steroid group, 84% of patients showed significant pain relief and functional improvement at 12 months and 24 months. The majority of patients experienced significant pain relief for 46 to 47 weeks, requiring approximately 3 to 4 treatments with an average relief of 14 to 16 weeks per episode of a treatment	Significant pain relief was shown in 85% in local anesthetic group and 90% in local anesthetic with steroids group at the end of the 2-year study period an average of 5 - 6 total treatments in both groups	Randomized trial with relatively large proportion of patients with 2-year follow-up, with inclusion of patients diagnosed with controlled diagnostic blocks	The majority of patients in both groups experienced significant pain relief and improvement in functional status. Therapeutic thoracic medial branch blocks, with or without steroid
Lee et al, 2018 (29) RA, AC Quality Scores: Cochrane = 12/13 IPM-QRB = 34/48	40 patients with thoracic facet joint pain were recruited and randomly assigned into 1 of the 2 groups, with intraarticular steroid injection or medial branch blocks, each with 20 patients No diagnostic blocks	Thoracic medial branch blocks The selection criteria was determined by positive response to a single thoracic medial branch block with 0.5 mL of 1% lidocaine	Intraarticular thoracic facet joint steroid injection. Intraarticular injection was performed with injection of 0.3 mL of contrast material into the thoracic facet joint space followed by 1 mg, 0.25 mL of dexamethasone, mixed with 0.5 mL of 0.25% bupivacaine. For the medial branch blocks, 0.5 mL of 0.25% bupivacaine, mixed with 10 mg, 0.25 mL of dexamethasone was injected	NRS, successful treatment was defined as more than 50% reduction in the NRS score at 6 months, when compared to the pre-treatment NRS score. Patient GPE 6 months	In both groups, the NRS scores at follow-up periods, 1, 3, and 6 months were significantly lower than the pre-treatment scores. Changes in the NRS scores over a time were not significantly different between groups. 6 months after treatment, 65% of the patients in the intraarticular steroid group and 8 patients (40%) in the medial branch block group reported successful pain relief. No significant differences were observed in the areas of successful pain relief at 6 months after the procedure. The rates of patient satisfaction between the 2 groups were not statistically significant	First randomized, double-blind controlled trial comparing intraarticular thoracic facet joint steroid injections and thoracic medial branch blocks	First randomized, double-blind controlled trial comparing intraarticular thoracic facet joint steroid injections and thoracic medial branch blocks. Small study with short-term follow-up	This study reinforces the importance of therapeutic medial branch blocks and also therapeutic intraarticular injections in the thoracic spine with both modalities being effective in patients who are diagnosed with facet joint pain with diagnostic blocks

RA = randomized; AC = active controlled; DB = double-blind; F = Fluoroscopy; US = Ultrasound; ODI = Oswestry Disability Index; IPM-QRB = Interventional Pain Management techniques–Quality Appraisal of reliability and Risk of Bias Assessment; NRS = Numeric Rating Scale; NDI = Neck Disability Index; NASS = North American Spine Society; GPE = global perceived effect; Patient Global Impression of Change (PGIC)

Table 6. *Study characteristics of non-randomized and observational studies assessing spinal facet joint nerve blocks.*

Study **Study Characteristic** **Methodological Quality Scoring**	**Number of Patients & Selection Criteria**	**Facet Joint Nerve Blocks**	**Comparator**	**Outcome Measures and Time of Measurement**	**Results**	**Strengths**	**Weaknesses**	**Conclusions**
LUMBAR FACET JOINT NERVE BLOCKS								
Manchikanti et al, 2022 (19) Observational study Quality Scores: IPM-QRBNR = 38/48	A total of 326 patients met the inclusion criteria with 99 patients receiving lumbar facet joint nerve blocks and 227 receiving lumbar radiofrequency neurotomy The inclusion criteria was based on the positive results with controlled comparative local anesthetic blocks with 80% pain relief	Facet joint nerves were blocked with injection of 1.5 mL of bupivacaine, 0.25% at each level, for each nerve, with most commonly 3 nerves involving 2 joints, L4/5, L5/S1 and bilaterally	Conventional radiofrequency neurotomy was performed for 120 seconds at 90° preceded by injection of 1.5 mL mixture of local anesthetic	Pain relief, significant of at least 50%, cost utility analysis 3, 6, and 12 months	At 3-month follow-up, 100% of patients showed significant improvement in both groups, whereas 96% of the patients in facet joint nerve block group and 74% in radiofrequency group showed significant pain relief, followed by 79% in facet joint nerve group, and 65% in radiofrequency group with significant pain relief at 12 months	Clinically applicable study with controlled diagnostic blocks. Facet joint nerve blocks were only performed in patients where radiofrequency was not performed or was considered as ineffective	Observational study	Positive study This study shows appropriate improvement with lumbar facet joint nerve blocks which is similar to the relief provided by radiofrequency neurotomy with 2 procedures of radiofrequency vs. 4 procedures of facet joint nerve blocks. Cost utility was also favorable with $4,664 for QALY per year compared to $5,446 for radiofrequency neurotomy
Manchikanti et al, 2001 (23) Prospective observational study Quality Scores: IPM-QRBNR = 38/48	73 patients were diagnosed with facet joint pain based on controlled dual diagnostic blocks with a criterion standard of 80% pain relief	A mixture of bupivacaine 0.25% and Sarapin with 1 to 1.5 mL with 1 mg of methylprednisolone	Facet joint nerve blocks with a mixture of bupivacaine 0.25%, Sarapin 1.5 mL per each nerve	Pain relief, NRS, significant pain relief of > 50%, change in pain status, physical and mental health, employment status 3 months, 6 months, 12 months	Significant improvements were noted in both groups with or without steroids. Similar improvements were seen in both groups. Average pain decreased from 7.7 ± 0.09 to 3.4 ± 0.14 with functional status improving from 3.6 ± 0.11 to 5.5 ± 0.14	Clinically relevant study procedures and evaluation with active control group in a practical setting.	Prospective study without randomization. Similar treatment modalities in 2 groups. Multiple procedures performed which are more than recommended procedures based on the standards after publication of this study	Positive study Overall, the results of this study demonstrate that medial branch blocks with local anesthetic and Sarapin with or without steroids are clinically and cost effective modality of treatment

Table 6 cont. *Study characteristics of non-randomized and observational studies assessing spinal facet joint nerve blocks.*

Study **Study Characteristic** **Methodological Quality Scoring**	**Number of Patients & Selection Criteria**	**Facet Joint Nerve Blocks**	**Comparator**	**Outcome Measures and Time of Measurement**	**Results**	**Strengths**	**Weaknesses**	**Conclusions**
Han et al, 2017 (62) Retrospective comparative study Quality Scores: IPM-QRBNR = 34/48	The study included treatment with facet joint nerve blocks either performed with ultrasound guidance (n= 68) or fluoroscopy (n=78) All patients had pain of at least 3 months Diagnostic blocks were performed, presumably with criterion standard of 80% pain relief	Facet joint nerve blocks were performed utilizing a volume of 1 mL mixture of 1% lidocaine 0.5 mL and dexamethasone 5 mg per mL at 0.5 mL at each level with all patients receiving blocks of 3 nerves Patients also received 2 consecutive therapeutic injections at a 2-week interval	None	vNRS, ODI, successful outcome > 50% pain relief and > 40% functional status improvement 1, 3 and 6 months after the last injections	74.4% of patients showed successful treatment outcome in fluoroscopy group and 63.2% of patients showed successful outcome in ultrasound group at 3-month follow-up At 6-month follow-up, 51.4% of the patients in ultrasound group and 52.5% of the patients in fluoroscopy group showed successful outcome with > 50% pain relief and 40% improvement in functionality with ODI	Clinically applicable study, performed in a practical setting	A retrospective study Authors essentially compared ultrasound imaging vs. fluoroscopy. The diagnostic criteria were not clearly defined. Outcomes are also not clearly defined with confusing data of re-injection Large number of withdrawals after the first therapeutic injection	A positive study The study shows therapeutic effectiveness of injection of xylocaine with Decadron up to 6 months with 2 injections
CERVICAL FACET JOINT NERVE BLOCKS								
Manchikanti et al, 2022 (20) Observational study Quality Scores: IPM-QRBNR = 38/48	In this study, 295 patients meeting inclusion criteria were included with 132 patients receiving cervical medial branch blocks and 163 patients receiving cervical radiofrequency neurotomy. Inclusion criteria were based on dual diagnostic blocks with a criterion standard of 80% pain relief	Each nerve was infiltrated with 1.5 mL of 0.25% preservative free Marcaine with 2 nerves infiltrated for each joint	After infiltration with local anesthetic of 1.5 mL with a mixture of long-acting and short-acting local anesthetic. Radiofrequency neurotomy was performed for 60 seconds at 90°	NRS and significant improvement of 50% in pain relief 3, 6, and 12 months	Significant improvement in both groups from baseline to 12 months with pain relief and proportion of patients with > 50% pain relief Significant pain relief was recorded 100%, 94%, and 81% of the patients in the medial branch blocks group, compared to 100%, 69%, and 64% in radiofrequency neurotomy group at 3-, 6-, and 12-month follow-up, with significant difference at 6 and 12 months Average relief of each procedure for cervical medial branch blocks was 13 to 14 weeks, whereas for radiofrequency neurotomy, it was 20 to 25 weeks	A practical clinical study comparing 2 commonly utilized modalities in clinic population in the real world data analysis	Nonrandomized observational study	Positive study This study shows appropriate improvement with cervical medial branch blocks which is similar to the relief provided by radiofrequency neurotomy with 2 procedures of radiofrequency vs. 4 procedures of facet joint nerve blocks. Cost utility was also favorable with $4,994 for QALY per year compared to $5,364 for radiofrequency neurotomy.

Table 6 cont. *Study characteristics of non-randomized and observational studies assessing spinal facet joint nerve blocks.*

Study **Study Characteristic** **Methodological Quality Scoring**	**Number of Patients & Selection Criteria**	**Facet Joint Nerve Blocks**	**Comparator**	**Outcome Measures and Time of Measurement**	**Results**	**Strengths**	**Weaknesses**	**Conclusions**
Manchikanti et al, 2004 (25) Prospective Quality Score: IPM-QRBNR = 37/48	100 consecutive patients diagnosed with facet joint pain utilizing controlled diagnostic blocks with 80% pain relief as the criterion standard	Cervical medial branch blocks with bupivacaine and methylprednisolone Patients had repeat blocks as clinically indicated	None	Pain relief, ODI, psychological status, work status 3 months, 6 months, and 12 months	Significant pain relief at 3, 6, and 12 months, compared to baseline measurements. There was also significant improvement in disability status, psychological status, and return to work. Significant pain relief was observed at 92% at 3 months, 82% at 6 months, and 56% at 12 months	First study available – a practical clinical study	Non-randomized	Positive study This was the first evaluation ever published in the cervical spine evaluating the role of therapeutic cervical medial branch blocks
Hahn et al, 2018 (26) A retrospective practice audit Quality Scores: IPM-QRBNR = 31/48	178 patients were included No diagnostic blocks	Medial branch blocks were performed utilizing 1 mL of bupivacaine 0.25% and 20 mg of triamcinolone at each level Patients with positive outcomes received a second block if required	None	The study was related to vertigo at each examination Modified McNabb outcome criteria were used: 1 = gone, 2 = better, 3 = the same, 4 = worse. Ratings of 1 and 2 were considered to be positive outcomes and ratings of 3 and 4 were considered to be negative outcomes The data was collected and patients were followed on a long-term basis	62.4% of the patients experienced significant improvement of the vertigo In 26.4% or 47 patients no information about the vertigo was available at follow-up and were included in the worst case scenario Median relief of the vertigo was 2 months	This is the first evaluation utilizing cervical medial branch blocks to manage cervicogenic vertigo with successful result in 62.4% of the patients. This also gives a prevalence of cervicogenic headache responding to therapeutic medial branch blocks.	Observational study and study for vertigo	Positive study This is the first study utilizing therapeutic medial branch blocks to manage and treat cervicogenic headache with positive results

Table 6 cont. *Study characteristics of non-randomized and observational studies assessing spinal facet joint nerve blocks.*

Study **Study Characteristic** **Methodological Quality Scoring**	**Number of Patients & Selection Criteria**	**Facet Joint Nerve Blocks**	**Comparator**	**Outcome Measures and Time of Measurement**	**Results**	**Strengths**	**Weaknesses**	**Conclusions**
Lee & Huston, 2018 (27) Observational study Quality Scores: IPM-QRBNR = 34/48	118 patients were screened and 51 of them were positive for cervical facet joint pain The diagnosis was established utilizing controlled comparative local anesthetic blocks with a criterion standard of 80% pain relief	These 51 patients underwent therapeutic medial branch blocks under fluoroscopic guidance using 0.5 mL of 2% lidocaine at each level for the first block and 0.5% bupivacaine for the second block. If the pain returned patients were offered therapeutic medial branch blocks. In fact, only 11 patients required therapeutic injections	None	Pain, pain relief, patient reported improvement, opioid use One year follow-up	Patients responsive to controlled diagnostic blocks showed significant improvement almost for a year with therapeutic medial branch blocks. 44 patients (59 joints) were surveyed after one year. 34 of 59 joints showed reduction of pain over 50% overall symptomatic improvement after one year. 24 of 44 patients ceased narcotic use	First long-term follow-up of patients with diagnostic blocks only with 80% of patients showing significant improvement after one-year and 22% requiring repeat blocks	This is observational case series	The important finding in this study is that diagnostic blocks are prognostic and therapeutic providing longer-term relief than suspected
Park et al, 2017 (63) Retrospective comparative study Quality Scores: IPM-QRBNR = 36/48	Patients with chronic cervical facet joint pain who received medial branch blocks were included in this retrospective study. The number of patients were 68 in the ultrasound group and 58 in the fluoroscopy group Inclusion criteria was pain of at least 3 months and positive response to cervical facet joint nerve blocks with comparative local anesthetic blocks The criterion standard was not described	Cervical medial branch blocks were performed with injection of 1 mL mixture of 1% lidocaine, 0.5 mL, and dexamethasone 5 mg Patients received 2 consecutive injections at 2 week intervals The second injection was omitted if initial injection resulted in significant improvement	None	NRS, NDI Successful outcome was more than 50% improvement in pain scores and more than 40% improvement of NDI score	3-month outcomes were with a treatment success rate of 64.7% in US-guided group and 62.1% in the fluoroscopy guided group At 6-month follow-up, the success rate was 55.9% in US group and 51.7% in fluoroscopy group There were no significant differences in the success rate between the 2 groups	A retrospective comparative study performed in a clinical setting	Large proportion of after the first injection There was no comparator except for 2 imaging modalities Number of patients was relatively small	Positive study This study shows effectiveness of therapeutic facet joint nerve blocks in cervical spine Controleld diagnostic blocks were performed; however, the criterion standard of pain relief was not described

Table 6 cont. *Study characteristics of non-randomized and observational studies assessing spinal facet joint nerve blocks.*

Study **Study Characteristic** **Methodological Quality Scoring**	**Number of Patients & Selection Criteria**	**Facet Joint Nerve Blocks**	**Comparator**	**Outcome Measures and Time of Measurement**	**Results**	**Strengths**	**Weaknesses**	**Conclusions**
Klessinger, 2010 (64) Retrospective study IPM-QRBNR = 24/48	The study determined the benefit of therapeutic medial branch blocks after cervical operations. Three hundred and twelve operations were performed and 87 patients, or 33.3%, of the patients reported persistent neck pain after the surgery Diagnostic blocks were performed with 1 mL of combination of triamcinolone 5 mg and bupivacaine 0.5% with 80% pain relief as the criterion for positive diagnosis	Cervical facet joint nerve blocks were performed with a combination of triamcinolone 5 mg and bupivacaine 0.5%. 1 mL of fluid was injected at each level Only the diagnostic blocks were performed with 1 mL mixture of 5 mg of triamcinolone and 0.25% bupivacaine	None	80% reduction of pain or patient was sufficiently satisfied with the relief Pain relief and movements of the neck Follow-up: Between 6 and 49 months	At 6-month follow-up, success rate was 56.7%. At one year follow-up, success rate was 52.9%	Represents a clinical scenario. Shows the value of diagnostic blocks with therapeutic effect in post surgery patients.	This is a retrospective evaluation. No functional outcomes were assessed. There were no second blocks for follow-up in patients without significant relief	Positive study with diagnostic blocks providing long-term relief
THORACIC FACET JOINT NERVE BLOCKS								
Manchikanti et al, 2006 (30) Prospective observational study Quality Scores: IPM-QRBNR = 37/48	55 consecutive patients meeting the diagnostic criteria of thoracic facet joint pain by means of comparative, controlled diagnostic blocks were included in this evaluation. Patients underwent dual diagnostic blocks with a criterion standard of 80% pain relief	Thoracic facet joint nerve blocks were performed with injection of 1.5 mL of bupivacaine, with or without Sarapin, and 1 mg of depo methylprednisolone per 1 to 1.5 mL solution per nerve. A minimum of 2 nerves were blocked. Repeat blocks were provided as needed with average relief per procedure of 6.7 ± 11.2 weeks	None	Outcome measures: NRS, significant pain relief above 50%, ODI, work status, P-3 3 months, 6 months, 12 months, 24 months and 36 months	Numeric pain scores at baseline were 7.7 ± 0.91 with scores of 3.3 ± 0.68 at 3 months, 3.3 ± 0.65 at 6 months, 3.2 ± 0.66 at 1 year, and 3.2 ± 0.75 at 3 years Proportion of patients with > 50% relief was 71% at 3 months and 6 months, 76% at 1 year, 71% at 2 years, and 69% at 3 years Significant improvement in ODI scores from 24.7 ± 3.66 at baseline to 14.2 ± 2.56 at 3 months, 13.8 ± 2.78 at 6 months, 13.4 ± 3.15 at 1 year, and 13.2 ± 3.5 at 3 years	Diagnostic blocks were performed long-term follow-up of 3 years Clinically relevant outcomes monitored over a long period with significant pain relief and improvement in functional status	Non-randomized observational study, no control group	Positive study showing effectiveness of thoracic medial branch blocks on a long-term basis when appropriately repeated with over 16 weeks of relief with each procedure

Table 6 cont. *Study characteristics of non-randomized and observational studies assessing spinal facet joint nerve blocks.*

Study **Study Characteristic** **Methodological Quality Scoring**	**Number of Patients & Selection Criteria**	**Facet Joint Nerve Blocks**	**Comparator**	**Outcome Measures and Time of Measurement**	**Results**	**Strengths**	**Weaknesses**	**Conclusions**
Park et al, 2013 (31) Observational study Quality Score: IPM-QRBNR = 29/48	53 patients with axial back pain with chronic facet joint pain for osteoporotic compression fractures in thoracolumbar region. Majority of the patients included osteoporotic fractures at T12 and L1 No diagnostic blocks were performed	Facet blocks of the T11 and T12 medial branches and L1 and L2 medial branches were performed utilizing 1% lidocaine, 0.5 mL onto the target nerve. Repeated medial branch blocks were performed if the pain ratings measured before injection increased 50% or more. In patients with return of pain and who responded, repeat blocks were performed	None	vNRS, ODI 2 weeks, 3 months, and 12 months	VAS and ODI improved 2 weeks after the injection and continued to improve until 12 months. Significant improvement with significant pain relief (>40%), functional improvement (>20%), and the patient satisfaction level excellent or good at 12 months after the first injection were observed in 78.9% of the patients	This is the first systematically performed study of the effectiveness of diagnostic and therapeutic medial branch blocks in managing chronic facet joint pain with positive results.	Observational study with 53 patients	Positive study This study shows the effectiveness of medial branch blocks as a therapeutic modality in thoracic facet joint pain
Chang, 2018 (32) Retrospective, observational data collected from 72 patients Quality Score: IPM-QRBNR = 31/48	2 patients treated with facet joint nerve blocks Of these, 20 patients underwent PRF on the thoracic medial branch to manage thoracic facet joint pain to refractory thoracic medial branch blocks All the patients underwent single diagnostic facet joint nerve blocks with a criterion standard of 80% pain relief	Therapeutic medial branch blocks with 0.5 mL of 2% lidocaine mixed with 0.5 mL of 0.25% bupivacaine to treat pain of thoracic facet joints.	Pulsed radiofrequency treatment was carried out for 360 seconds at 40°	NRS scores 12 months	The results showed that 73% of the patients were treated successfully with therapeutic medial branch blocks	This is one of the first studies to report initially successful treatment with therapeutic medial branch blocks and subsequently with pulsed radiofrequency. This provides information on the value of therapeutic medial branch blocks and also pulsed radiofrequency treatment leading the way for conventional radiofrequency treatment	Observational study. The base results of effectiveness of therapeutic medial branch blocks were not published	Positive study This study shows the effectiveness of pulsed radiofrequency in managing thoracic facet joint pain refractory to therapeutic medial branch blocks after the diagnosis was established with diagnostic facet joint blocks

IPM-QRBNR = Interventional Pain Management Techniques – Quality Appraisal of Reliability and Risk of Bias Assessment for Nonrandomized Studies; NRS = Numeric Rating Scale; ODI = Oswestry Disability Index; vNRS = verbal Numeric Rating Scale; NDI = Neck Disability Index; P-3 = Pain Patient Profile; QALY = quality adjusted life year; VAS = visual analog scale

Table 7. *GRADE assessment of randomized and observational studies evaluating effectiveness of facet joint nerve blocks.*

Article	Methodologic Limitation	Consistency	Indirectness	Imprecision	Publication Bias	Total
Civelek et al (21)	High	Moderate	Moderate	Moderate	Very low	Moderate
Manchikanti et al (22,57)	Very low	High	High	Low	Very low	High
Manchikanti et al (24,58)	Very low	High	High	Low	Very low	High
van Eerd et al (37)	High	High	High	Moderate	Very low	Moderate
Pasuhirunnikorn et al (38)	Low	High	High	Low	Very low	Moderate
Hussain et al (56)	High	Moderate	High	Moderate	Very low	Moderate
Abdelghaffar & Awad (60)	High	Moderate	High	Moderate	Very low	Low
Manchikanti et al (28,59)	Very low	High	High	Low	Very low	High
Lee et al (29)	High	Moderate	Moderate	Moderate	Very low	Moderate
Manchikanti et al (19)	Moderate	High	Moderate	Moderate	Very low	Moderate
Manchikanti et al (20)	Moderate	High	Low	Low	Very low	Moderate
Manchikanti et al (23)	Moderate	High	Low	Low	Very low	Moderate
Manchikanti et al (25)	Moderate	High	Low	Low	Very low	Moderate
Hahn et al (26)	High	Low	Low	High	Very low	Moderate
Lee & Huston (27)	High	Low	Low	High	Very low	Low
Han et al (62)	High	Low	Low	Moderate	Very low	Low
Park et al (63)	High	Low	Low	Moderate	Very low	Low
Klessinger (64)	High	Low	Low	High	Very low	Low
Manchikanti et al (30)	Low	High	High	Low	Very low	Moderate
Park et al (31)	High	Low	Low	High	Very low	Low
Chang (32)	Very high	Low	Low	High	Very low	Low

There were 3 trials (22,24,28) with 320 patients that compared control (local anesthetic) vs. local anesthetic and steroid group in a dual-arm meta-analysis for 6 months. Results showed a statistically significant difference in pain levels between these 2 groups [SMD 0.13 (-0.21, 0.46), $P = 0.45$] (Fig. 2B).

There were 3 trials (22,24,28) with 320 patients that compared control (local anesthetic) vs. local anesthetic and steroid group in a dual-arm meta-analysis for 12 months. Results showed a statistically significant difference in pain levels between these 2 groups [SMD -0.11 (-0.32, 0.11), $P = 0.33$] (Fig. 2C).

Functionality – Conventional Dual-Arm Analysis

There were 3 trials (22,24,28) with 320 patients that compared control vs. steroid group functionality in a dual-arm meta-analysis at 3 months. Results showed a statistically significant difference in functionality levels between these 2 groups [SMD -0.18 (-0.48, 0.11), $P = 0.22$] (Fig. 3A).

There were 3 trials (22,24,28) with 320 patients that compared control vs. steroid group functionality in a dual-arm meta-analysis at 6 months. Results showed a statistically significant difference in functionality levels between these 2 groups [SMD -0.98 (-2.10, 0.14), $P = 0.09$] (Fig. 3B).

There were 3 trials (22,24,28) with 320 patients that compared control vs. steroid group functionality in a dual-arm meta-analysis at 12 months. Results did not show a statistically significant difference in functionality levels between these 2 groups [SMD -0.28 (-1.36, 0.79), $P = 0.61$] (Fig. 3C).

Pain – Single Arm Meta-Analysis

Figure 4A shows the results of a single meta-analysis utilizing medial branch blocks. There were 4 studies (29,38,62,63) used to assess pain scores at 1 month using NRS. As shown in Fig. 4A, the pooled mean difference of pain scores from the baseline to 1-month follow-up was 2.784 points decreased (95% CI: -2.863 to -2.705, $P < 0.0001$).

Figure 4B shows the results of a single meta-analysis utilizing medial branch blocks. There were 13 studies (20,25,28-31,56,58-60,62,63) used to assess pain scores at 3 months using NRS. As shown in Fig. 4B, the pooled mean difference of pain scores from the baseline to

Table 8. *Effectiveness of randomized controlled trials and observational studies of spinal facet joint nerve blocks.*

Study **Study Characteristic** **Methodological Quality Scoring**	**Number of Patients & Selection Criteria**	**Interventions**	**Pain Relief and Function**			**Results**			**GRADE Criteria Assessment**	**Clinical Applicability**	**Comments/ Conclusions**
			3 months	**6 months**	**1-year**	**Short-Term ≤ 6 mos.**	**Long-Term**				
							6 months	**1-year**			
LUMBAR FACET JOINT NERVE BLOCKS											
Civelek et al, 2012 (21) RA, AC Quality Scores: Cochrane = 9/13 IPM-QRB = 28/48	100 patients Selection Criteria: Failed conservative therapy Clinical Criteria: No diagnostic blocks	LA with steroid = 50 Conventional radiofrequency = 50	NA	75% vs. 92%	69% vs. 90%	NA	P	P	Moderate	Moderate	Long-term effectiveness Moderate level of evidence and clinical applicability
Manchikanti et al, 2008, 2010 (22,57) RA, DB, AC Quality Scores: Cochrane = 12/13 IPM-QRB = 45/48	120 patients 120 chronic axial low back pain patients were positive for facet joint pain diagnosed with controlled dual diagnostic blocks with 80% pain relief as the criterion standard were included	LA with steroid = 60 LA = 60	82% vs. 83%	93% vs. 83%	85% vs. 84%	P	P	P	High	High	Short- and long-term effectiveness High level of evidence and clinical applicability
Manchikanti et al, 2022 (19) Observational study Quality Scores: IPM-QRBNR = 38/48	326 patients Selection by positive controlled comparative local anesthetic blocks with 80% pain relief as the criterion standard	Facet joint nerve blocks with bupivacaine 1.5 mL, 0.25% per level vs. bupivacaine injection, followed by conventional radiofrequency neurotomy for 120 seconds at 90°	100% vs. 100%	96% facet joint nerve block group vs. 74% radiofrequency group	79% facet joint nerve blocks group vs. 65% radiofrequency group	P	P	P	Moderate	Moderate	Short and long-term effectiveness Moderate level of evidence and clinical applicability

Table 8 cont. *Effectiveness of randomized controlled trials and observational studies of spinal facet joint nerve blocks.*

Study Study Characteristic Methodological Quality Scoring	Number of Patients & Selection Criteria	Interventions	Pain Relief and Function			Results			GRADE Criteria Assessment	Clinical Applicability	Comments/ Conclusions
			3 months	6 months	1-year	Short-Term ≤ 6 mos.	Long-Term 6 months	Long-Term 1-year			
Manchikanti et al, 2001 (23) Prospective observational study Quality Scores: IPM-QRBNR = 38/48	73 patients Selection by positive dual controlled comparative diagnostic blocks of 80% pain relief as the criterion standard	LA with steroid = 41 LA = 32	100% vs 100%	75% vs 80%	75% vs 80%	P	P	P	Moderate	Moderate	Positive short and long-term results Moderate level of evidence and moderate clinical applicability
Han et al, 2017 (62) Retrospective comparative study Quality Scores: IPM-QRBNR = 34/48	The study included treatment with facet joint nerve blocks either performed with ultrasound guidance (n= 68) or fluoroscopy (n=78) All patients had pain of at least 3 months Diagnostic blocks were performed, presumably with criterion standard of 80% pain relief	Facet joint nerve blocks were performed utilizing a volume of 1 mL mixture of 1% lidocaine 0.5 mL and dexamethasone 5 mg per mL at 0.5 mL at each level with all patients receiving blocks of 3 nerves Patients also received 2 consecutive therapeutic injections at a 2-week interval	74.4% vs. 63.2%	51.4% vs. 52.5%	NA	P	P	NA	Low	Low	A positive study Low level of evidence and clinical applicability Noninferior to radiofrequency ablation
CERVICAL FACET JOINT NERVE BLOCKS											
Manchikanti et al, 2008, 2010 (24,58) RA, DB, AC, F Quality Scores: Cochrane = 12/13 IPM-QRB = 45/48	120 patients Selection criteria: Positive diagnostic blocks of 80% pain relief as the criterion standard Diagnostic criteria: Dual controlled diagnostic blocks with 80% pain relief as the criterion standard	Local anesthetic = 60 Local anesthetic with steroid = 60	83% versus 85%	87% versus 95%	85% versus 92%	P	P	P	High	High	Short- and long-term effectiveness High level of evidence and clinical applicability

Table 8 cont. *Effectiveness of randomized controlled trials and observational studies of spinal facet joint nerve blocks.*

Study Study Characteristic Methodological Quality Scoring	Number of Patients & Selection Criteria	Interventions	Pain Relief and Function			Results			GRADE Criteria Assessment	Clinical Applicability	Comments/ Conclusions
			3 months	6 months	1-year	Short-Term ≤ 6 mos.	Long-Term 6 months	Long-Term 1-year			
Pasuhirunnikorn et al, 2023 (38) RA, DB, AC, US-guided Quality Scores: Cochrane = 13/13 IPM-QRB = 42/48	62 patients diagnosed with a single diagnostic block were randomized into 2 groups of 31 each and were treated with either 2% lidocaine or 0.5% bupivacaine Diagnostic blocks were performed utilizing 2% lidocaine with criterion standard of 75% pain relief with a single block	Lidocaine group: Facet joint nerve blocks were performed with injection of 2% lidocaine with a volume of 0.5 to 1 mL per level according to the patients' pain symptoms Comparator group received injection of 0.5% bupivacaine with a volume of 0.5 to 1 mL per level based on the patients' pain symptoms	• Lidocaine provided significant pain reduction up to 16 weeks and significant improvement in neck functional outcomes up to 8 weeks compared to the baseline • Bupivacaine provided significant pain relief for up to 8 weeks for pain and demonstrated notable improvement in neck function up to 4 weeks compared to the baseline	NA	NA	P	NA	NA	Moderate	High	Positive trial with short term effectiveness High level of evidence and clinical applicability
van Eerd et al, 2021 (37) RA, AC Quality Scores: Cochrane = 13/13 IPM-QRB = 39/48	79 patients were included on the basis of the diagnosis with clinical criteria. No diagnostic blocks were performed	Facet joint nerve block group followed by sham radiofrequency neurotomy vs. facet joint nerve blocks, followed by conventional radiofrequency neurotomy Comparator group received radiofrequency denervation following bupivacaine injection as in control group	61.1% facet joint nerve block vs. 61.1% denervation group	51.3% facet joint nerve block vs. 55.6% denervation group	NA	P	P	NA	Moderate	Moderate	Positive study with short and long-term effectiveness Moderate level of evidence and clinical applicability Noninferior to radiofrequency ablation

Table 8 cont. *Effectiveness of randomized controlled trials and observational studies of spinal facet joint nerve blocks.*

Study Study Characteristic Methodological Quality Scoring	Number of Patients & Selection Criteria	Interventions	Pain Relief and Function			Results			GRADE Criteria Assessment	Clinical Applicability	Comments/ Conclusions
			3 months	6 months	1-year	Short-Term ≤ 6 mos.	Long-Term				
							6 months	1-year			
Hussain et al, 2020 (56) RA, DB, AC, F Quality Scores: Cochrane = 10/13 IPM-QRB = 35/48	55 patients Diagnosis by clinical signs and symptoms No diagnostic blocks were performed	Facet joint nerve blocks vs. trigger point injections	NRS scores 8 ± 1 in facet joint group vs. 7.57 ± 1.47 in trigger point group with reductions significantly at 12-weeek follow-up to 2.2 ± 1.8 in medial branch group and 6.96 ± 2.37 in trigger point group with significant difference. NDI also showed similar improvements	NA	NA	P	NA	NA	Moderate	Moderate	Positive study with short-term effectiveness Moderate level of evidence and clinical applicability
Abdelghaffar & Awad (60) RA, AC Quality Scores: Cochrane = 10/13 IPM-QRB = 33/48	60 patients Diagnosis by clinical criteria No diagnostic blocks were performed	Medial branch blocks vs. retrolaminar blocks	Significant improvement in both groups with no significant differences among the groups with reductions in pain and disability scores	NA	NA	P	NA	NA	Low	Low	Positive study with short-term effectiveness Low level of evidence and clinical applicability
Klessinger, 2010 (64) Retrospective study IPM-QRBNR = 24/48	87 patients A single diagnostic block with 80% pain relief as the criterion standard	Diagnostic blocks Therapeutic medial branch blocks were performed with a combination of bupivacaine 0.25% and triamcinolone 5 mg with a total volume of approximately 1 mL at each level	NA	Success rate was 56.7%	Success rate was 52.9%	NA	P	P	Low	Low	Positive study with diagnostic blocks providing long term relief Low level of evidence and clinical applicability

Table 8 cont. *Effectiveness of randomized controlled trials and observational studies of spinal facet joint nerve blocks.*

Study **Study Characteristic** **Methodological Quality Scoring**	**Number of Patients & Selection Criteria**	**Interventions**	**Pain Relief and Function**			**Results**			**GRADE Criteria Assessment**	**Clinical Applicability**	**Comments/ Conclusions**
			3 months	**6 months**	**1-year**	**Short-Term ≤ 6 mos.**	**Long-Term**				
							6 months	**1-year**			
Manchikanti et al, 2022 (20) Observational study Quality Scores: IPM-QRBNR = 38/48	132 patients Selection by positive with controlled dual diagnostic blocks with 80% pain relief as the criterion standard	Therapeutic medical branch blocks	100%	94%	81%	P	P	P	Moderate	Moderate	Long-term effectiveness Moderate level of evidence and clinical applicability
Manchikanti et al, 2004 (25) Prospective Quality Score: IPM-QRBNR = 37/48	100 patients Selection by positive with controlled diagnostic blocks with 80% pain relief as the criterion standard	Therapeutic medical branch blocks	92%	82%	56%	P	P	P	Moderate	Moderate	Long-term effectiveness Moderate level of evidence and clinical applicability
Hahn et al, 2018 (26) A retrospective practice audit Quality Score: IPM-QRBNR = 31/48	178 patients were included.	Medial branch blocks	62.4%	62.4%	62.4%	P	P	P	Moderate	Moderate	Long-term effectiveness Moderate level of evidence and clinical applicability
Lee & Huston, 2018 (27) Observational study Quality Score: IPM-QRBNR = 34/48	51 patients were positive for controlled diagnostic blocks	Therapeutic medical branch blocks	86%	86%	86%	P	P	P	Low	Low	Long-term effectiveness Low level of evidence and clinical applicability

Table 8 cont. *Effectiveness of randomized controlled trials and observational studies of spinal facet joint nerve blocks.*

Study Study Characteristic Methodological Quality Scoring	Number of Patients & Selection Criteria	Interventions	Pain Relief and Function			Results			GRADE Criteria Assessment	Clinical Applicability	Comments/ Conclusions
			3 months	6 months	1-year	Short-Term ≤ 6 mos.	Long-Term				
							6 months	1-year			
Park et al, 2017 (63) Retrospective comparative study Quality Scores: IPM-QRBNR = 36/48	Patients with chronic cervical facet joint pain who received medial branch blocks were included in this retrospective study. The number of patients were 68 in the ultrasound group and 58 in the fluoroscopy group Inclusion criteria was pain of at least 3 months and positive response to cervical facet joint nerve blocks with comparative local anesthetic blocks The criterion standard was not described	Cervical medial branch blocks were performed with injection of 1 mL mixture of 1% lidocaine, 0.5 mL, and dexamethasone 5 mg Patients received 2 consecutive injections at 2 week intervals The second injection was omitted if initial injection resulted in significant improvement	62.1% fluoroscopy 64.7% ultrasound	51.7% fluoroscopy 55.9% ultrasound	NA	P	P	NA	Low	Low	Low level of effective results with low level of clinical applicability
THORACIC FACET JOINT NERVE BLOCKS											
Manchikanti et al 2010, 2012 (28,59) RA, DB, AC Quality Scores: Cochrane = 11/13 IPM-QRB = 45/48	100 patients Selection by positive with controlled dual diagnostic blocks with 80% pain relief as the criterion standard	Local anesthetic = 50 Local anesthetic with steroid = 50	79% vs 83%	79% vs 81%	80% vs 83%	P	P	P	High	High	Short- and long-term effectiveness High level of evidence and clinical applicability

Table 8 cont. *Effectiveness of randomized controlled trials and observational studies of spinal facet joint nerve blocks.*

Study **Study Characteristic** **Methodological Quality Scoring**	**Number of Patients & Selection Criteria**	**Interventions**	**Pain Relief and Function**			**Results**			**GRADE Criteria Assessment**	**Clinical Applicability**	**Comments/ Conclusions**
			3 months	**6 months**	**1-year**	**Short-Term ≤ 6 mos.**	**Long-Term**				
							6 months	**1-year**			
Lee et al, 2018 (29) RA, AC Quality Scores: Cochrane = 12/13 IPM-QRB = 34/48	40 patients • Intraarticular steroid injection = 20 patients • Medial branch blocks = 20 patients.	Thoracic facet joint nerve blocks	NA	40%	NA	P	NA	NA	Moderate	Moderate	Short- and long-term effectiveness Moderate level of evidence and clinical applicability
Manchikanti et al, 2006 (30) Prospective observational study Quality Scores: IPM-QRBNR = 37/48	55 consecutive patients, all meeting diagnostic criteria for thoracic facet joint pain Selection by positive with controlled dual diagnostic blocks with 80% pain relief as the criterion standard	Thoracic facet joint nerve blocks	71%	71%	76%	P	P	P	Moderate	Moderate	Short- and long-term effectiveness High level of evidence and clinical applicability
Park et al, 2013 (31) Observational study Quality Score: IPM-QRBNR = 29/48	53 patients with axial back pain with chronic facet joint pain for osteoporotic compression fractures in thoracolumbar region. Majority of the patients included osteoporotic fractures at T12 and L1.	Facet blocks of the T11 and T12 medial branches and L1 and L2 medial branches	78.9%	78.9%	78.9%	P	P	P	Low	Low	Positive study Low level of evidence and clinical applicability

Table 8 cont. *Effectiveness of randomized controlled trials and observational studies of spinal facet joint nerve blocks.*

Study Study Characteristic Methodological Quality Scoring	Number of Patients & Selection Criteria	Interventions	Pain Relief and Function			Results			GRADE Criteria Assessment	Clinical Applicability	Comments/ Conclusions
			3 months	6 months	1-year	Short-Term ≤ 6 mos.	Long-Term				
							6 months	1-year			
Chang, 2018 (32) Retrospective, observational data collected from 72 patients Quality Score: IPM-QRBNR = 31/48	20 patients underwent pulsed radiofrequency thoracic medial branch blocks	Pulsed radiofrequency treatment	73%	73%	73%	P	P	P	Low	Low	Positive study Short- and long-term improvement Low level of evidence and clinical applicability

RA = randomized; AC = active controlled; DB = double-blind; F = Fluoroscopy; US = Ultrasound; IPM-QRB = Interventional Pain Management techniques–Quality Appraisal of reliability and Risk of Bias Assessment; IPM-QRBNR = Interventional Pain Management Techniques – Quality Appraisal of Reliability and Risk of Bias Assessment for Nonrandomized Studies; LA = local anesthetic; NA = not applicable; P = positive; NRS = Numeric Rating Scale; NDI = Neck Disability Index

3-month follow-up was 4.091 points decreased (95% CI: -4.136 to -4.047, $P < 0.0001$).

Figure 4C shows the results of a single meta-analysis utilizing medial branch blocks. There were 10 studies (20,24,25,28-30,58,59,62,63) used to assess pain scores at 6 months using NRS. As shown in Fig. 4C, the pooled mean difference of pain scores from the baseline to 6-month follow-up was 4.666 points decreased (95% CI: -4.715 to -4.617, $P < 0.0001$).

Figure 4D shows the results of a single meta-analysis utilizing medial branch blocks. There were 8 studies (20,24,25,28,30,31,58,59) used to assess pain scores at 12 months using NRS. As shown in Fig. 4D, the pooled mean difference of pain scores from the baseline to 12-month follow-up was 4.604 points decreased (95% CI: -4.658 to -4.551, $P < 0.0001$).

Figure 4E shows the results of a single meta-analysis utilizing radiofrequency ablation. There were 2 studies (24,28) used to assess pain scores at 18 months using NRS. As shown in Fig. 4E, the pooled mean difference of pain scores from the baseline to 18-month follow-up was 4.777 points decreased (95% CI: -4.904 to -4.651, $P < 0.0001$).

Figure 4F shows the results of a single meta-analysis utilizing radiofrequency ablation. There were 3 studies (24,28,30) used to assess pain scores at 24 months using NRS. As shown in Fig. 4F, the pooled mean difference of pain scores from the baseline to 24-month follow-up was 4.698 points decreased (95% CI: -4.817 to -4.578, $P < 0.0001$).

Functionality – Single Arm Meta-Analysis

Figure 5A shows the results of a single meta-analysis utilizing radiofrequency ablation. There were 5 studies (28,31,59,62,63) used to assess functionality scores at 3 months using NRS. As shown in Fig. 5A, the pooled mean difference of pain scores from the baseline to 3-month follow-up was 14.880 points decreased (95% CI: -15.324 to -14.436, $P < 0.0001$).

Figure 5B shows the results of a single meta-analysis utilizing radiofrequency ablation. There were 4 studies (28,59,62,63) used to assess functionality scores at 6 months using NRS. As shown in Fig. 5B, the pooled mean difference of pain scores from the baseline to 6-month follow-up was 13.752 points decreased (95% CI: -14.197 to -13.307, $P < 0.0001$).

Figure 5C shows the results of a single meta-analysis utilizing radiofrequency ablation. There were 3 studies (28,31,59) used to assess functionality scores at 12 months using NRS. As shown in Fig. 5C, the pooled

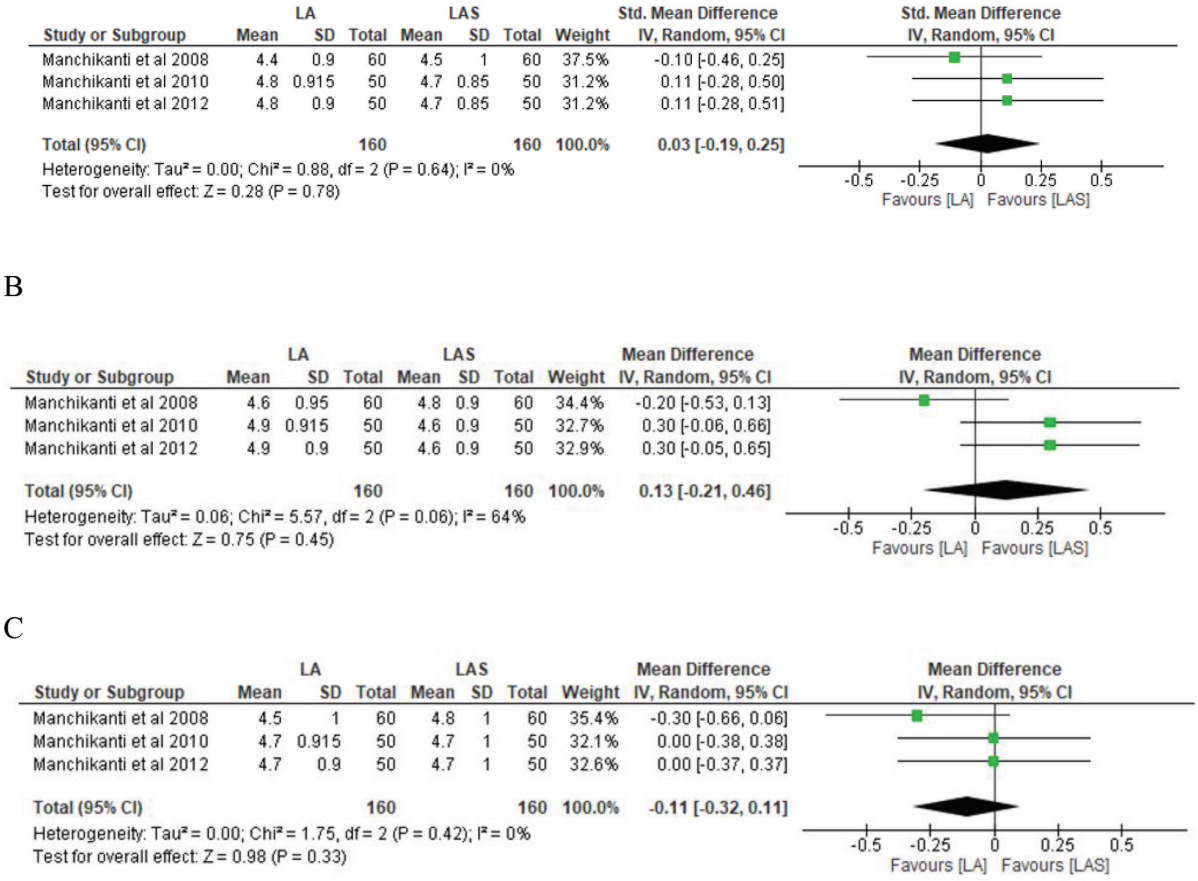


Fig. 2. *Results of conventional dual-arm meta-analysis of NRS with local anesthetics and local anesthetics with steroids at 3, 6, and 12-month follow-up. A. 3 Months NRS local anesthetic (LA) vs. local anesthetic and steroid (LAS). B. 6 Months NRS local anesthetic (LA) vs. local anesthetic and steroid (LAS). C. 12 Months NRS local anesthetic (LA) vs. local anesthetic and steroid (LAS).*

mean difference of pain scores from the baseline to 12-month follow-up was 16.072 points decreased (95% CI: -16.670 to -15.474, $P < 0.0001$).

Discussion

The present systematic review with meta-analysis of facet joint nerve blocks or medial branch blocks and L5 dorsal ramus blocks shows Level II evidence with moderate to strong recommendation as a therapeutic modality in managing chronic axial spinal pain. In this analysis, we have utilized a total of 21 studies, of which 9 were RCTs and 12 were observational studies. All of the studies underwent appropriate quality analysis with Cochrane review criteria and IPM-QRB, as well as IPM-QRBNR. Utilizing best evidence synthesis with qualitative and quantitative analysis with application of GRADE and clinical applicability criteria, the evidence demonstrated is valuable, relevant, and clinically applicable. In this analysis, we identified 8 high quality and one moderate quality RCT, and 8 high quality and 4 moderate quality non-randomized studies with application of spinal facet joint nerve blocks as therapeutic modalities. In addition, based on GRADE assessment, only 3 of the 21 studies showed high levels of evidence and clinical applicability, with 11 studies showing moderate levels of GRADE evidence and clinical applicability. Based on the qualitative and quantitative analysis of 9 RCTs and 12 non-randomized studies, the evidence is Level II with moderate to strong recommendation for therapeutic facet joint nerve blocks in managing spinal facet joint pain. The meta-analysis utilizing a conventional dual-arm analysis showed no significant differ-

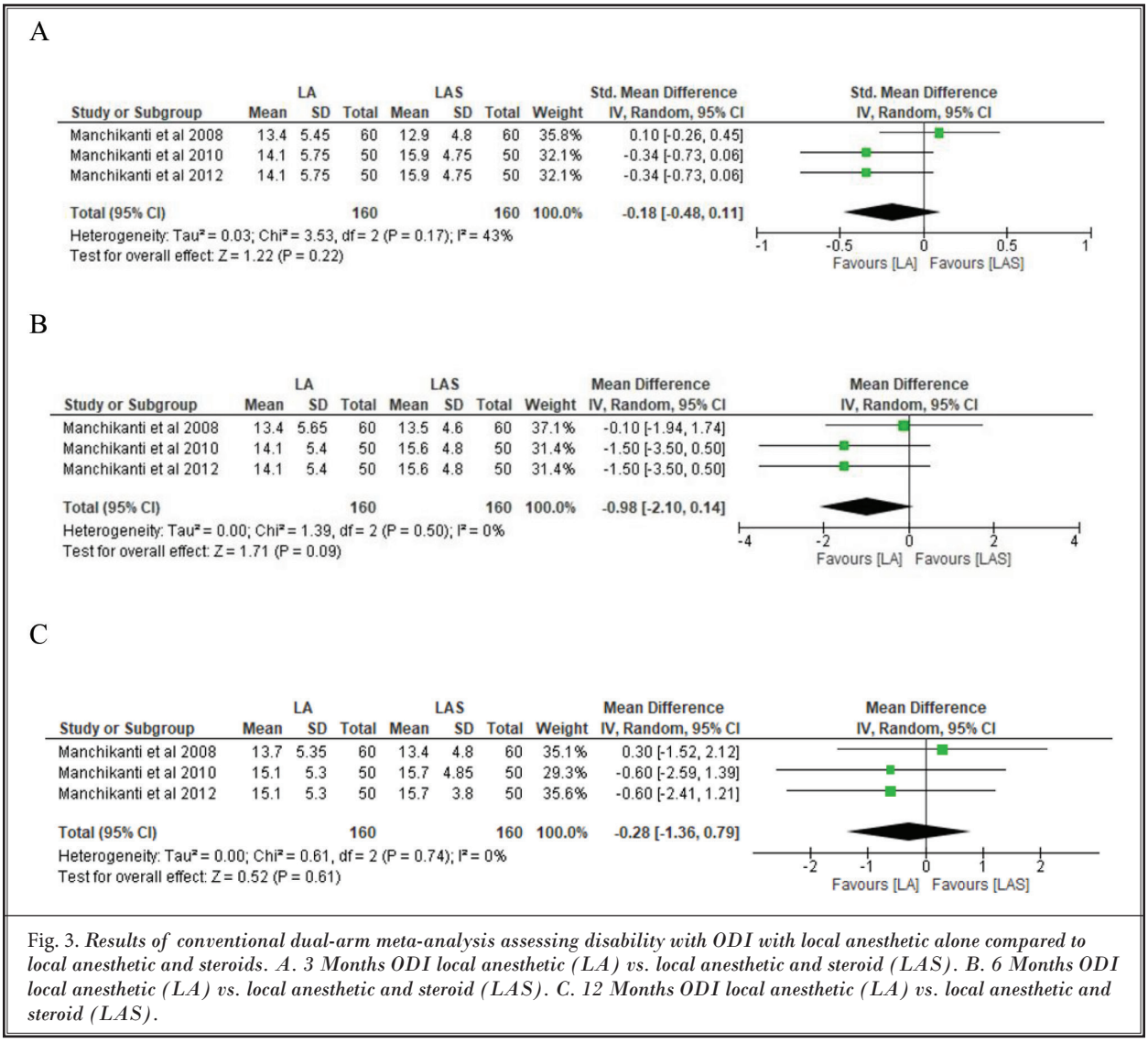


Fig. 3. *Results of conventional dual-arm meta-analysis assessing disability with ODI with local anesthetic alone compared to local anesthetic and steroids. A. 3 Months ODI local anesthetic (LA) vs. local anesthetic and steroid (LAS). B. 6 Months ODI local anesthetic (LA) vs. local anesthetic and steroid (LAS). C. 12 Months ODI local anesthetic (LA) vs. local anesthetic and steroid (LAS).*

ence in utilizing 3 studies (22,24,28) which compared local anesthetic versus local anesthetic and steroid at 3 months and significant difference in favor of steroids at 6-months, and significant difference in favor of local anesthetic alone group at 12-month follow-up. Functionality analysis showed a significant difference between these 2 groups in favor of local anesthetic alone group at 3 months, 6 months, and 12 months. However, single-arm meta-analysis utilizing all of the available studies showed mean decrease of pain scores of 2.784 (95% CI, -2.863 to -2.705, $P < 0.0001$) at one month, 4.091 points decrease of NRS (95% CI: -4.136 to -4.047, $P < 0.0001$) at 3 months, 4.666 point decrease (95% CI: -4.715 to -4.617, $P < 0.0001$) at 6 months, and 4.604 point decrease of NRS (95% CI: -4.658 to -4.551, $P < 0.0001$) at 12 months. Beyond 12 months, only 2 studies (24,28) met the inclusion criteria showing 4.777 point decrease of NRS (95% CI: -4.904 to -4.651, $P < 0.0001$) at 18 months and 4.698 point decrease of NRS (95% CI: -4.817 to -4.578, $P < 0.0001$) at 24 months. In reference to the functionality, single-arm meta-analysis at 3 months showed a decrease of 14.880 point decrease in Oswestry Disability Index (ODI) scores with (95% CI: -15.324 to -14.436, $P < 0.0001$) at 3 months, decrease of 13.752 points at 6 months (95% CI: -14.197 to -13.307, $P < 0.0001$), and 16.072 point decrease at 12 months (95% CI: -16.670 to -15.474, $P < 0.0001$).These outcomes were robust though in a single-arm analysis with over 4 point decrease except at one-month follow-up with narrow 95% CI and very low P values of < 0.0001 and functional

A

Study name	Difference in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Park et al. 2017 US LAS	-3.920	0.149	0.022	-4.212	-3.628	-26.309	0.000
Park et al 2017 FL LAS	-3.640	0.191	0.036	-4.014	-3.266	-19.058	0.000
Han et al. 2017 US LAS	-3.690	0.158	0.025	-4.000	-3.380	-23.354	0.000
Han et al. 2017 FL LAS	-3.800	0.151	0.023	-4.096	-3.504	-25.166	0.000
Lee et al. 2018 LAS	-2.200	0.369	0.136	-2.923	-1.477	-5.962	0.000
Pasuhirunnikorn et al. 2023 L	-2.500	0.055	0.003	-2.608	-2.392	-45.455	0.000
Pasuhirunnikorn et al. 2023 B	-2.300	0.092	0.008	-2.480	-2.120	-25.000	0.000
	-2.784	0.040	0.002	-2.863	-2.705	-68.902	0.000

Statistics for each study

Difference in means and 95% CI

-5.00 -2.50 0.00 2.50 5.00

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
213.211	6	0.000	97.186	0.517	0.415	0.172	0.719

B

Study name	Difference in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Manchikanti et al. 2022 MBB	-4.800	0.048	0.002	-4.894	-4.706	-100.000	0.000
Manchikanti et al. 2022 RFN	-4.400	0.074	0.005	-4.545	-4.255	-59.459	0.000
Manchikanti et al. 2004 LA/LAS	-4.600	0.085	0.007	-4.767	-4.433	-54.118	0.000
Pasuhirunnikorn et al. 2023 L	-2.000	0.073	0.005	-2.143	-1.857	-27.397	0.000
Pasuhirunnikorn et al. 2023 B	-0.500	0.165	0.027	-0.823	-0.177	-3.030	0.002
Hussain et al. 2020	-6.000	0.256	0.066	-6.502	-5.498	-23.438	0.000
Manchikanti et al. 2008 LA	-4.400	0.116	0.013	-4.627	-4.173	-37.931	0.000
Manchikanti et al. 2008 LAS	-4.500	0.129	0.017	-4.753	-4.247	-34.884	0.000
Abdelghaffar et al. 2022	-3.310	0.222	0.049	-3.745	-2.875	-14.910	0.000
Park et al. 2017 US LAS	-3.740	0.167	0.028	-4.067	-3.413	-22.395	0.000
Park et al. 2017 FL LAS	-3.730	0.152	0.023	-4.028	-3.432	-24.539	0.000
Manchikanti et al. 2012 LA	-4.800	0.127	0.016	-5.049	-4.551	-37.795	0.000
Manchikanti et al. 2012 LAS	-4.700	0.120	0.014	-4.935	-4.465	-39.167	0.000
Lee et al. 2018 LAS	-2.200	0.369	0.136	-2.923	-1.477	-5.962	0.000
Manchikanti et al. 2006 LA/LAS	-4.400	0.107	0.011	-4.610	-4.190	-41.121	0.000
Park et al. 2013	-3.750	0.059	0.003	-3.866	-3.634	-63.559	0.000
Han et al. 2017 US LAS	-3.690	0.158	0.025	-4.000	-3.380	-23.354	0.000
Han et al. 2017 FL LAS	-3.800	0.151	0.023	-4.096	-3.504	-25.166	0.000
Manchikanti et al. 2010 LA	-4.800	0.129	0.017	-5.053	-4.547	-37.209	0.000
Manchikanti et al. 2010 LAS	-4.700	0.120	0.014	-4.935	-4.465	-39.167	0.000
	-4.091	0.023	0.001	-4.136	-4.047	-180.912	0.000

Statistics for each study

Difference in means and 95% CI

-8.00 -4.00 0.00 4.00 8.00

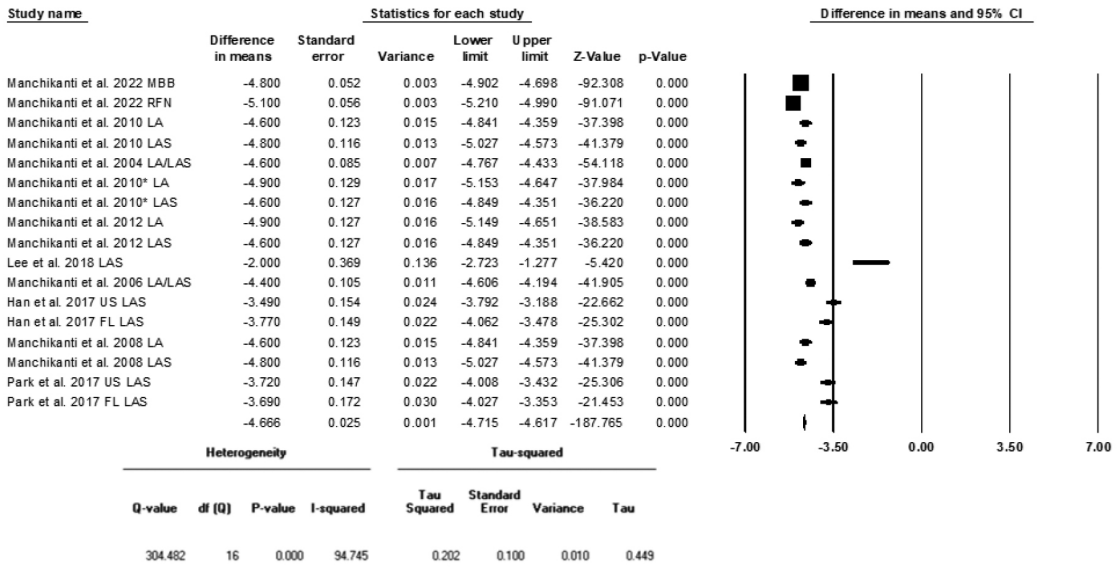
Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
1851.834	19	0.000	98.974	1.047	0.479	0.229	1.023

Fig. 4. *Results of single-arm meta-analysis of NRS at 1-month, 3 months, 6 months, and 12 months with local anesthetic alone and local anesthetic and steroid. A. Single-arm meta-analysis on NRS at 1 month.* (US = ultrasound, FL = fluoroscopic, L = lidocaine, B = bupivacaine) *B. Single-arm meta-analysis on NRS at 3 months.* (US = ultrasound, FL = fluoroscopic, L = lidocaine, B = bupivacaine, MBB = medial branch block, RFN = radiofrequency neurotomy, LA = local anesthetic, LAS = local anesthetic and steroid)

improvement of 13.752 point decrease from 50 points, up to 16.072 at 12-month follow-up with narrow 95% CI with a highly significant *P* value of 0.0001.

The results of the present systematic review and meta-analysis are similar to multiple previously reported systematic reviews incorporated into guidelines (1). Further, a recent article published after the completion of this evaluation evaluated intraarticular facet joint injection with injection versus medial branch block in patients with low back pain in a RCT (70). In this trial with evaluation of 60 patients, authors showed significant improvement in pain scores after injection in both groups. The mean pain scores in both groups remained less than 2 at all time intervals throughout the study

C



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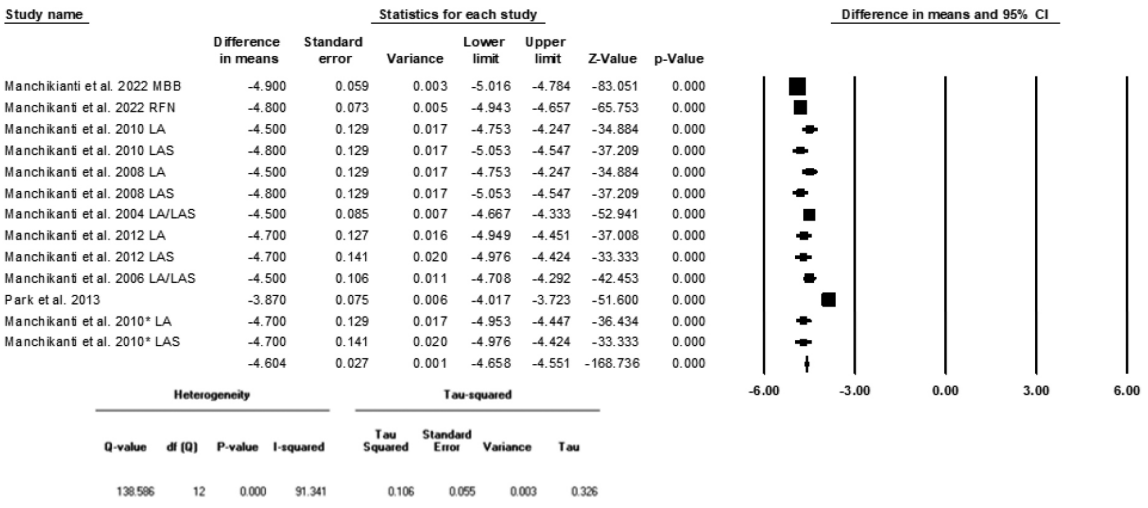
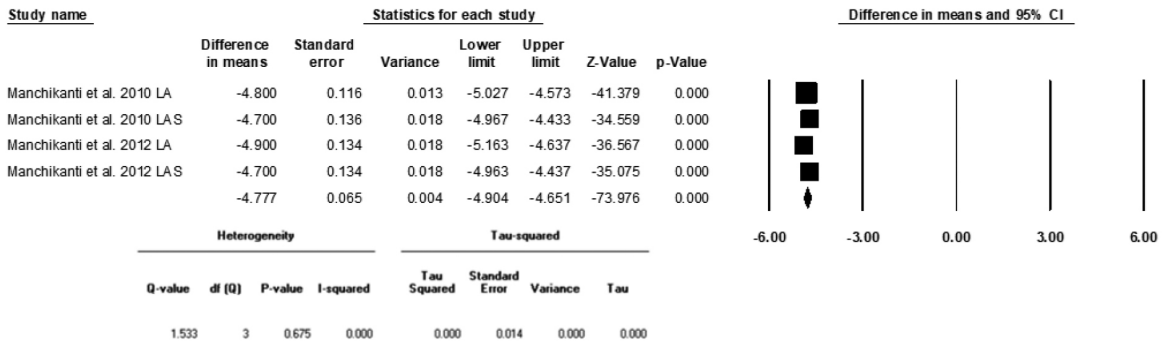


Fig. 4 continued. *Results of single-arm meta-analysis of NRS at 1-month, 3 months, 6 months, and 12 months with local anesthetic alone and local anesthetic and steroid. C. Single-arm meta-analysis on NRS at 6 months.* (US = ultrasound, FL = fluoroscopic, MBB = medial branch block, RFN = radiofrequency neurotomy, LA = local anesthetic, LAS = local anesthetic and steroid) *D. Single-arm meta-analysis on NRS at 12 months.* (MBB = medial branch block, RFN = radiofrequency neurotomy, LA = local anesthetic, LAS = local anesthetic and steroid)

period or 6 months. There was also significant improvement in functional status in both groups.

However, these are also in contradiction to consensus practice guidelines (7,8). Despite describing ease in performing the procedure and better results with numerous technical difficulties with intraarticular injections and associated risks in the cervical spine with spinal cord damage, some authors described lack of therapeutic role for medial branch blocks. Cohen et al and others described technical difficulties, false-neg-

E



Study name	Difference in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Manchikanti et al. 2010 LA	-4.800	0.116	0.013	-5.027	-4.573	-41.379	0.000
Manchikanti et al. 2010 LAS	-4.700	0.136	0.018	-4.967	-4.433	-34.559	0.000
Manchikanti et al. 2012 LA	-4.900	0.134	0.018	-5.163	-4.637	-36.567	0.000
Manchikanti et al. 2012 LAS	-4.700	0.134	0.018	-4.963	-4.437	-35.075	0.000
	-4.777	0.065	0.004	-4.904	-4.651	-73.976	0.000

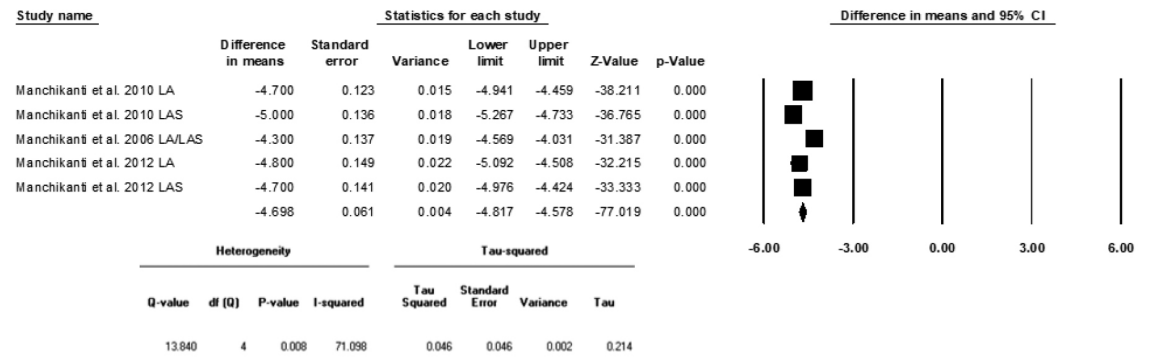
Statistics for each study

Difference in means and 95% CI

-6.00 -3.00 0.00 3.00 6.00

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
1.533	3	0.675	0.000	0.000	0.014	0.000	0.000

F



Study name	Difference in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Manchikanti et al. 2010 LA	-4.700	0.123	0.015	-4.941	-4.459	-38.211	0.000
Manchikanti et al. 2010 LAS	-5.000	0.136	0.018	-5.267	-4.733	-36.765	0.000
Manchikanti et al. 2006 LA/LAS	-4.300	0.137	0.019	-4.569	-4.031	-31.387	0.000
Manchikanti et al. 2012 LA	-4.800	0.149	0.022	-5.092	-4.508	-32.215	0.000
Manchikanti et al. 2012 LAS	-4.700	0.141	0.020	-4.976	-4.424	-33.333	0.000
	-4.698	0.061	0.004	-4.817	-4.578	-77.019	0.000

Statistics for each study

Difference in means and 95% CI

-6.00 -3.00 0.00 3.00 6.00

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
13.840	4	0.008	71.098	0.046	0.046	0.002	0.214

Fig. 4 continued. *Results of single-arm meta-analysis of NRS at 1-month, 3 months, 6 months, and 12 months with local anesthetic alone and local anesthetic and steroid. E. Single-arm meta-analysis on NRS at 18 months.* (LA = local anesthetic, LAS = local anesthetic and steroid) *F. Single-arm meta-analysis on NRS at 24 months.* (LA = local anesthetic, LAS = local anesthetic and steroid)

atives are crucial in managing the patients as a false-negative essentially means the medicine not reaching the targeted area and not being effective (7,43-45).

This systematic review and meta-analysis of RCTs and observational studies of the effectiveness of therapeutic facet joint nerve blocks for chronic axial spinal pain demonstrated Level II evidence for long-term effectiveness of 6 months or longer with moderate recommendation.

Of importance, multiple studies have been published showing clinical effectiveness and cost utility of therapeutic facet joint nerve blocks with ease of administration and lesser complications. Further, there are also indications for therapeutic facet joint nerve blocks in patients with implants, pseudoarthritis, fusion with hardware, morbid obesity, and inability to be positioned for radiofrequency neurotomy procedures. Thus, it is crucial to consider appropriate studies comparing the effectiveness of therapeutic facet joint nerve blocks with other modalities such as radiofrequency neurotomy and more recent publications.

Among the notable publications, van Eerd et al (37) showed pain treatment success of 61.1% in both groups, either with local anesthetic alone or with local anesthetic and radiofrequency neurotomy with a single lesion at 3 months, 55.6% in the denervation group, and 51.3% in the bupivacaine alone group at 6-month follow-up with no significant difference among the groups, in clinically diagnosed cervical facet joint pain, reinforcing long-term relief of local anesthetic injections. Manchikanti et al (19,20) assessed the comparative effectiveness of radiofrequency neurotomy with

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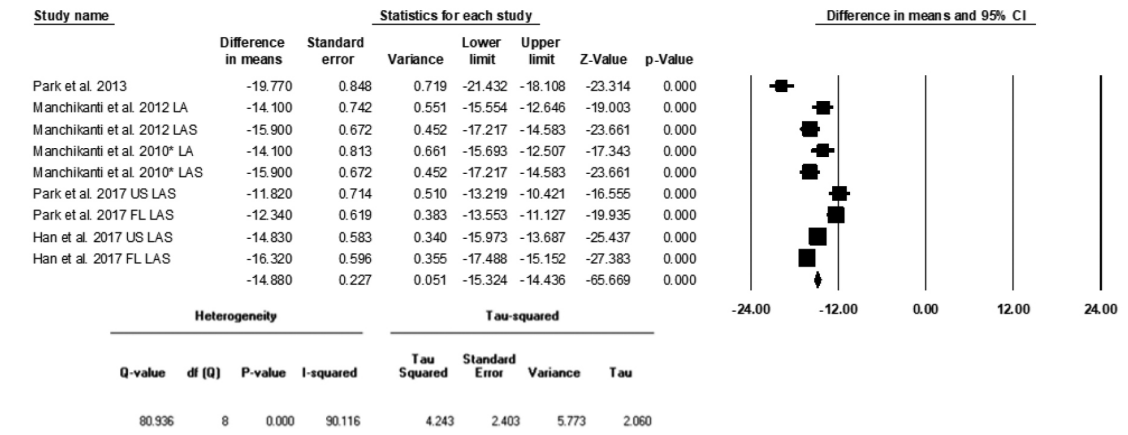

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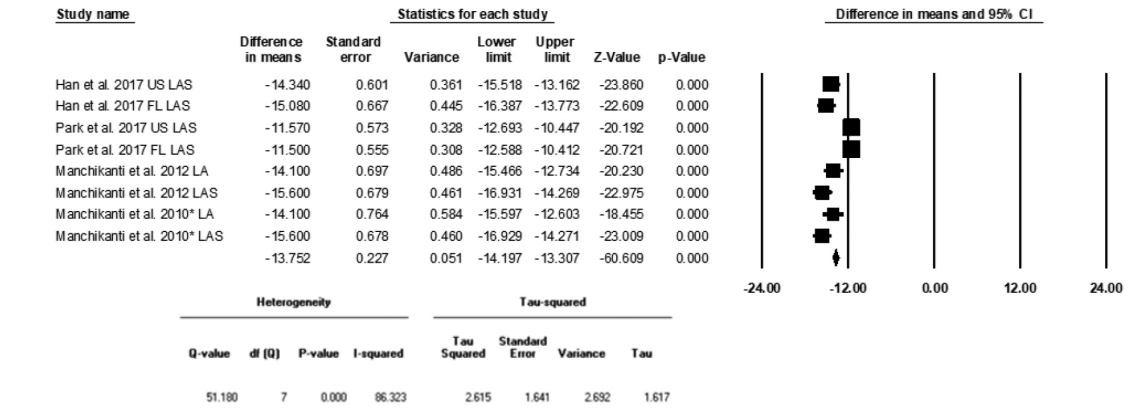

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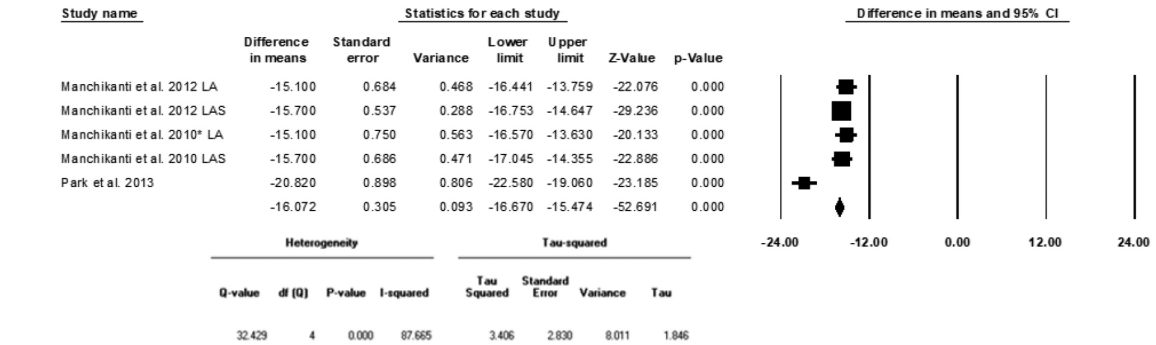

Fig. 5. *Results of single-arm meta-analysis of functionality at 3-, 6-, and 12-month follow-up. A. Single-arm meta-analysis on functionality at 3 months.* (LA = local anesthetic, LAS = local anesthetic and steroid, US = ultrasound, FL = fluoroscopic) *B. Single-arm meta-analysis on functionality at 6 months.* (LA = local anesthetic, LAS = local anesthetic and steroid, US = ultrasound, FL = fluoroscopic) *C. Single-arm meta-analysis on functionality at 12 months.* (LA = local anesthetic, LAS = local anesthetic and steroid, US = ultrasound, FL = fluoroscopic)

facet joint nerve blocks in a similar group of population in both cervical and lumbar spine. In a lumbar facet joint pain study of outcomes and cost utility analysis (19), 326 patients were assessed with 99 patients receiving lumbar facet joint nerve blocks and 227 receiving lumbar radiofrequency neurotomy. Significant improvement was seen in both groups from baseline to 12-months, at 3, 6, and 12-month follow-up, with significant difference at 6 months with 99% of patients showing improvement in nerve block group compared to 74% in radiofrequency group. Further, at one-year the significant improvement was 79% in nerve block group and 65% in the radiofrequency group. The cost utility was similar with some benefit with facet joint nerve blocks USD $4,664 compared to USD $5,446 for quality adjusted life year (QALY). There was also a higher side effect rate in radiofrequency neurotomy. Similar results were shown in cervical spine (20) with inclusion of total of 295 patients, of which 132 patients received cervical medial branch blocks and 163 patients received cervical radiofrequency neurotomy. Similar differences as in lumbar spine were observed with significant difference in the outcomes at 6 months and 12 months with better outcomes of facet joint nerve blocks with lower cost utility of USD $5,364 for cervical radiofrequency neurotomy and $4,994 for medial branch blocks for QALY.

In a recent publication, Pasuhirunnikorn et al (38) compared outcomes of lidocaine versus bupivacaine for cervical medial branch blocks in chronic cervical facet joint arthropathy in a randomized double-blind trial. The patient selection was without diagnostic blocks. Even then, they showed significant pain reduction up to 16 weeks and function up to 8 weeks with lidocaine compared to baseline and 8 weeks of pain relief and 4 weeks of function with bupivacaine compared to baseline.

In addition, as shown in this evaluation with a total of 9 RCTs and 12 observational studies with inclusion of the 2 above studies, the evidence is Level II with moderate to strong recommendation.

In comparison to other modalities of treatments, based on the available systematic reviews and RCTs, these procedures provide similar and at times, superior, pain relief based on the duration of pain relief of 13 to 16 weeks when performed following diagnostic blocks.

The present investigation, therefore, is the first systematic review with meta-analysis focused on determining the effectiveness of therapeutic facet joint nerve blocks in managing axial spinal pain. The results of this study provide appropriate clinical application and generalizable to therapeutic facet joint nerve blocks when indicated, specifically with relative contraindications to radiofrequency neurotomy procedures.

The strengths of this evaluation include rigorous methodologic quality assessment, qualitative and quantitative analysis, application of GRADE and clinical applicability criteria. This evaluation also showed the application in real-world settings. However, the weaknesses include lack of placebo-controlled trials and variations in selection criteria.

Conclusion

In conclusion, the present systematic and meta-analysis of therapeutic facet joint nerve blocks in managing chronic axial spinal pain shows Level II evidence, with moderate to strong recommendation, based on 9 relevant high quality RCTs and 12 relevant moderate to high quality observational studies, and with 3 of 21 studies showing high levels of evidence and clinical applicability, with 11 studies showing moderate levels of GRADE evidence and clinical applicability.

Acknowledgements

The authors wish to thank Tonie M. Hatton and Diane E. Neihoff, transcriptionists, for their assistance in preparation of this manuscript. We would like to thank the editorial board of *Pain Physician* for review and criticism in improving the manuscript.

Compliance with Ethics Guidelines

This article is based on previously conducted studies and does not contain any new studies with human participants or animals performed by any of the authors.

Author Contribution

The concept and study was designed by LM, NNK, and JAH.

Statistical analysis was performed by EK and NNK.

Manuscript preparation was performed by LM, MRS, ADK, SA, AS, and JAH.

All authors contributed to preparation of the manuscript, reviewed, and approved the content with final version.

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Appendix Table 1. *Sources of risk of bias and Cochrane Review rating system.*

Bias Domain	**Source of Bias**		**Possible Answers**
Selection	(1) Was the method of randomization adequate?	A random (unpredictable) assignment sequence. Examples of adequate methods are coin toss (for studies with 2 groups), rolling a dice (for studies with 2 or more groups), drawing of balls of different colors, drawing of ballots with the study group labels from a dark bag, computer-generated random sequence, preordered sealed envelopes, sequentially-ordered vials, telephone call to a central office, and preordered list of treatment assignments.	Yes/No/Unsure
		Examples of inadequate methods are: alternation, birth date, social insurance/security number, date in which they are invited to participate in the study, and hospital registration number.	
Selection	(2) Was the treatment allocation concealed?	Assignment generated by an independent person not responsible for determining the eligibility of the patients. This person has no information about the persons included in the trial and has no influence on the assignment sequence or on the decision about eligibility of the patient.	Yes/No/Unsure
Performance	(3) Was the patient blinded to the intervention?	Index and control groups are indistinguishable for the patients or if the success of blinding was tested among the patients and it was successful.	Yes/No/Unsure
Performance	(4) Was the care provider blinded to the intervention?	Index and control groups are indistinguishable for the care providers or if the success of blinding was tested among the care providers and it was successful.	Yes/No/Unsure
Detection	(5) Was the outcome assessor blinded to the intervention?	Adequacy of blinding should be assessed for each primary outcome separately. This item should be scored "yes" if the success of blinding was tested among the outcome assessors and it was successful or:	Yes/No/Unsure
		• for patient-reported outcomes in which the patient is the outcome assessor (e.g., pain, disability): the blinding procedure is adequate for outcome assessors if participant blinding is scored "yes"	
		• for outcome criteria assessed during scheduled visit and that supposes a contact between participants and outcome assessors (e.g., clinical examination): the blinding procedure is adequate if patients are blinded, and the treatment or adverse effects of the treatment cannot be noticed during clinical examination	
		• for outcome criteria that do not suppose a contact with participants (e.g., radiography, magnetic resonance imaging): the blinding procedure is adequate if the treatment or adverse effects of the treatment cannot be noticed when assessing the main outcome	
		• for outcome criteria that are clinical or therapeutic events that will be determined by the interaction between patients and care providers (e.g., cointerventions, hospitalization length, treatment failure), in which the care provider is the outcome assessor: the blinding procedure is adequate for outcome assessors if item "4" (caregivers) is scored "yes"	
		• for outcome criteria that are assessed from data of the medical forms: the blinding procedure is adequate if the treatment or adverse effects of the treatment cannot be noticed on the extracted data	
Attrition	(6) Was the drop-out rate described and acceptable?	The number of participants who were included in the study but did not complete the observation period or were not included in the analysis must be described and reasons given. If the percentage of withdrawals and drop-outs does not exceed 20% for short-term follow-up and 30% for long-term follow-up and does not lead to substantial bias a "yes" is scored (N.B. these percentages are arbitrary, not supported by literature).	Yes/No/Unsure
Attrition	(7) Were all randomized participants analyzed in the group to which they were allocated?	All randomized patients are reported/analyzed in the group they were allocated to by randomization for the most important moments of effect measurement (minus missing values) irrespective of noncompliance and cointerventions.	Yes/No/Unsure

Appendix Table 1 cont. *Sources of risk of bias and Cochrane Review rating system.*

Bias Domain	**Source of Bias**		**Possible Answers**
Reporting	(8) Are reports of the study free of suggestion of selective outcome reporting?	All the results from all prespecified outcomes have been adequately reported in the published report of the trial. This information is either obtained by comparing the protocol and the report, or in the absence of the protocol, assessing that the published report includes enough information to make this judgment.	Yes/No/Unsure
Selection	(9) Were the groups similar at baseline regarding the most important prognostic indicators?	Groups have to be similar at baseline regarding demographic factors, duration and severity of complaints, percentage of patients with neurological symptoms, and value of main outcome measure(s).	Yes/No/Unsure
Performance	(10) Were cointerventions avoided or similar?	If there were no cointerventions or they were similar between the index and control groups.	Yes/No/Unsure
Performance	(11) Was the compliance acceptable in all groups?	The reviewer determines if the compliance with the interventions is acceptable, based on the reported intensity, duration, number and frequency of sessions for both the index intervention and control intervention(s). For example, physiotherapy treatment is usually administered for several sessions; therefore it is necessary to assess how many sessions each patient attended. For single-session interventions (e.g., surgery), this item is irrelevant.	Yes/No/Unsure
Detection	(12) Was the timing of the outcome assessment similar in all groups?	Timing of outcome assessment should be identical for all intervention groups and for all primary outcome measures.	Yes/No/Unsure
Other	(13) Are other sources of potential bias unlikely?	Other types of biases. For example: • When the outcome measures were not valid. There should be evidence from a previous or present scientific study that the primary outcome can be considered valid in the context of the present. • Industry-sponsored trials. The conflict of interest (COI) statement should explicitly state that the researchers have had full possession of the trial process from planning to reporting without funders with potential COI having any possibility to interfere in the process. If, for example, the statistical analyses have been done by a funder with a potential COI, usually "unsure" is scored.	Yes/No/Unsure

Adapted and modified from: Furlan AD, et al; Editorial Board of the Cochrane Back, Neck Group. 2015 Updated method guideline for systematic reviews in the Cochrane Back and Neck Group. *Spine (Phila Pa 1976)* 2015; 40:1660-1673 (50).

Appendix Table 2. *Item checklist for assessment of randomized controlled trials of IPM techniques utilizing IPM – QRB.*

		Scoring
I.	TRIAL DESIGN AND GUIDANCE REPORTING	
1.	CONSORT or SPIRIT	
	Trial designed and reported without any guidance	0
	Trial designed and reported utilizing minimum criteria other than CONSORT or SPIRIT criteria or trial was conducted prior to 2005	1
	Trial implies it was based on CONSORT or SPIRIT without clear description with moderately significant criteria for randomized trials or the trial was conducted before 2005	2
	Explicit use of CONSORT or SPIRIT with identification of criteria or trial conducted with high level reporting and criteria or conducted before 2005	3
II.	DESIGN FACTORS	
2.	Type and Design of Trial	
	Poorly designed control group (quasi selection, convenient sampling)	0
	Proper active-control or sham procedure with injection of active agent	2
	Proper placebo control (no active solutions into active structures)	3
3.	Setting/Physician	
	General setting with no specialty affiliation and general physician	0
	Specialty of anesthesia/PMR/neurology/radiology/ortho, etc.	1
	Interventional pain management with interventional pain management physician	2
4.	Imaging	
	Blind procedures	0
	Ultrasound	1
	CT	2
	Fluoro	3
5.	Sample Size	
	Less than 50 participants in the study without appropriate sample size determination	0
	Sample size calculation with less than 25 patients in each group	1
	Appropriate sample size calculation with at least 25 patients in each group	2
	Appropriate sample size calculation with 50 patients in each group	3
6.	Statistical Methodology	
	None or inappropriate	0
	Appropriate	1
III.	PATIENT FACTORS	
7.	Inclusiveness of Population	
7a.	For epidural procedures:	
	Poorly identified mixed population	0
	Clearly identified mixed population	1
	Disorders specific trials (i.e. well defined spinal stenosis and disc herniation, disorder specific, disc herniation or spinal stenosis or post surgery syndrome)	2
7b.	For facet or sacroiliac joint interventions:	
	No diagnostic blocks	0
	Selection with single diagnostic blocks	1
	Selection with placebo or dual diagnostic blocks	2
8.	Duration of Pain	
	Less than 3 months	0
	3 to 6 months	1

Appendix Table 2 cont. *Item checklist for assessment of randomized controlled trials of IPM techniques utilizing IPM – QRB.*

		Scoring
	> 6 months	2
9.	Previous Treatments	
	Conservative management including drug therapy, exercise therapy, physical therapy, etc.	
	Were not utilized	0
	Were utilized sporadically in some patients	1
	Were utilized in all patients	2
10.	Duration of Follow-up with Appropriate Interventions	
	Less than 3 months or 12 weeks for epidural or facet joint procedures, etc. and 6 months for intradiscal procedures and implantables	0
	3 to 6 months for epidural or facet joint procedures, etc., or 1 year for intradiscal procedures or implantables	1
	6 months to 17 months for epidurals or facet joint procedures, etc., and 2 years or longer for discal procedures and implantables	2
	18 months or longer for epidurals and facet joint procedures, etc., or 5 years or longer for discal procedures and implantables	3
IV.	OUTCOMES	
11.	Outcomes Assessment Criteria for Significant Improvement	
	No descriptions of outcomes OR < 20% change in pain rating or functional status	0
	Pain rating with a decrease of 2 or more points or more than 20% reduction OR functional status improvement of more than 20%	1
	Pain rating with decrease of ≥ 2 points AND ≥ 20% change or functional status improvement of ≥ 20%	2
	Pain rating with a decrease of 3 or more points or more than 50% reduction OR functional status improvement with a 50% or 40% reduction in disability score	2
	Significant improvement with pain and function ≥ 50% or 3 points and 40% reduction in disability scores	4
12.	Analysis of all Randomized Participants in the Groups	
	Not performed	0
	Performed without intent-to-treat analysis without inclusion of all randomized participants	1
	All participants included with or without intent-to-treat analysis	2
13.	Description of Drop Out Rate	
	No description of dropouts, despite reporting of incomplete data or ≥ 20% withdrawal	0
	Less than 20% withdrawal in one year in any group	1
	Less than 30% withdrawal at 2 years in any group	2
14.	Similarity of Groups at Baseline for Important Prognostic Indicators	
	Groups dissimilar with significant influence on outcomes with or without appropriate randomization and allocation	0
	Groups dissimilar without influence on outcomes despite appropriate randomization and allocation	1
	Groups similar with appropriate randomization and allocation	2
15.	Role of Co-Interventions	
	Co-interventions were provided but were not similar in the majority of participants	0
	No co-interventions or similar co-interventions were provided in the majority of the participants	1
V.	RANDOMIZATION	
16.	Method of Randomization	
	Quasi randomized or poorly randomized or not described	0
	Adequate randomization (coin toss, drawing of balls of different colors, drawing of ballots)	1

Appendix Table 2 cont. *Item checklist for assessment of randomized controlled trials of IPM techniques utilizing IPM – QRB.*

		Scoring
	High quality randomization (Computer generated random sequence, pre-ordered sealed envelopes, sequentially ordered vials, telephone call, pre-ordered list of treatment assignments, etc.)	2
VI.	ALLOCATION CONCEALMENT	
17.	Concealed Treatment Allocation	
	Poor concealment of allocation (open enrollment) or inadequate description of concealment	0
	Concealment of allocation with borderline or good description of the process with probability of failure of concealment	1
	High quality concealment with strict controls (independent assignment without influence on the assignment sequence)	2
VII.	BLINDING	
18.	Patient Blinding	
	Patients not blinded	0
	Patients blinded adequately	1
19.	Care Provider Blinding	
	Care provider not blinded	0
	Care provider blinded adequately	1
20.	Outcome Assessor Blinding	
	Outcome assessor not blinded or was able to identify the groups	0
	Performed by a blinded independent assessor with inability to identify the assignment-based provider intervention (i.e., subcutaneous injection, intramuscular distant injection, difference in preparation or equipment use, numbness and weakness, etc.)	1
VIII.	CONFLICTS OF INTEREST	
21.	Funding and Sponsorship	
	Trial included industry employees	-3
	Industry employees involved; high levels of funding with remunerations by industry or an organization funded with conflicts	-3
	Industry or organizational funding with reimbursement of expenses with some involvement	0
	Industry or organization funding of expenses without involvement	1
	Funding by internal resources only with supporting entity unrelated to industry	2
	Governmental funding without conflict such as NIH, NHS, AHRQ	3
22.	Conflicts of Interest	
	None disclosed with potential implied conflict	0
	Marginally disclosed with potential conflict	1
	Well disclosed with minor conflicts	2
	Well disclosed with no conflicts	3
	Hidden conflicts with poor disclosure	–1
	Misleading disclosure with conflicts	–2
	Major impact related to conflicts	–3
TOTAL		48

Source: Manchikanti L, et al. Assessment of methodologic quality of randomized trials of interventional techniques: Development of an interventional pain management specific instrument. *Pain Physician* 2014; 17:E263-E290 (51).

Appendix Table 3. *IPM checklist for assessment of nonrandomized or observational studies of IPM techniques utilizing IPM-QRBNR.*

		Scoring
I.	STUDY DESIGN AND GUIDANCE REPORTING	
1.	STROBE or TREND Guidance	
	Case Report/Case Series	0
	Study designed without any guidance	1
	Study designed with minimal criteria and reporting with or without guidance	2
	Study designed with moderately significant criteria or implies it was based on STROBE or TREND without clear description or the study was conducted before 2011 or similar criteria utilized with study conducted before 2011	3
	Designed with high level criteria or explicitly uses STROBE or TREND with identification of criteria or conducted prior to 2011	4
II.	DESIGN FACTORS	
2.	Study Design and Type	
	Case report or series (uncontrolled – longitudinal)	0
	Retrospective cohort or cross-sectional study	1
	Prospective cohort case-control study	2
	Prospective case control study	3
	Prospective, controlled, nonrandomized	4
3.	Setting/Physician	
	General setting with no specialty affiliation and general physician	0
	Specialty of anesthesia/PMR/neurology, etc.	1
	Interventional pain management with interventional pain management physician	2
4.	Imaging	
	Blind procedures	0
	Ultrasound	1
	CT	2
	Fluoro	3
5.	Sample Size	
	Less than 100 participants without appropriate sample size determination	0
	At least 100 participants in the study without appropriate sample size determination	1
	Sample size calculation with less than 50 patients in each group	2
	Appropriate sample size calculation with at least 50 patients in each group	3
	Appropriate sample size calculation with 100 patients in each group	4
6.	Statistical Methodology	
	None	0
	Some statistics	1
	Appropriate	2
III.	PATIENT FACTORS	
7.	Inclusiveness of Population	
7a.	For epidural procedures:	
	Poorly identified mixed population	1
	Poorly identified mixed population with large sample (≥ 200)	2
	Clearly identified mixed population	3
	Disorders specific trials (i.e. well defined spinal stenosis and disc herniation, disorder specific, disc herniation or spinal stenosis or post-surgery syndrome)	4

Appendix Table 3 cont. ***IPM checklist for assessment of nonrandomized or observational studies of IPM techniques utilizing IPM-QRBNR.***

7b.	For facet or sacroiliac joint interventions:	
	No specific selection criteria	1
	No diagnostic blocks based on clinical symptomatology	2
	Selection with single diagnostic blocks	3
	Selection with placebo or dual diagnostic blocks	4
8.	Duration of Pain	
	Less than 3 months	0
	3 to 6 months	1
	> 6 months	2
9.	Previous Treatments	
	Conservative management including drug therapy, exercise therapy, physical therapy, etc.	
	Were not utilized	0
	Were utilized sporadically in some patients	1
	Were utilized in all patients	2
10.	Duration of Follow-up with Appropriate Interventions	
	Less than 3 months or less for epidural or facet joint procedures, etc., and 6 months for intradiscal procedures and implantables	1
	3-6 months for epidural or facet joint procedures, etc., or one year for intradiscal procedures or implantables	2
	6-12 months for epidurals or facet joint procedures, etc., and 2 years or longer for discal procedures and implantables	3
	18 months or longer for epidurals and facet joint procedures, etc., or 5 years or longer for discal procedures and implantables	4
IV.	OUTCOMES	
11.	Outcomes Assessment Criteria for Significant Improvement	
	No descriptions of outcomes OR < 20% change in pain rating or functional status	0
	Pain rating with a decrease of 2 or more points or more than 20% reduction OR functional status improvement of more than 20%	1
	Pain rating with decrease of ≥ 2 points AND ≥ 20% change or functional status improvement of ≥ 20%	2
	Pain rating with a decrease of 3 or more points or more than 50% reduction OR functional status improvement with a 50% or 40% reduction in disability score	2
	Significant improvement with pain and function ≥ 50% or 3 points and 40% reduction in disability scores	4
12.	Description of Drop Out Rate	
	No description despite reporting of incomplete data or more than 30% withdrawal	0
	Less than 30% withdrawal in one year in any group	1
	Less than 40% withdrawal at 2 years in any group	2
13.	Similarity of Groups at Baseline for Important Prognostic Indicators	
	No groups or groups dissimilar with significant influence on outcomes	0
	Groups dissimilar without significant influence on outcomes	1
	Groups similar	2
14.	Role of Co-Interventions	
	Dissimilar co-interventions or similar co-interventions in some of the participants	1
	No co-interventions or similar co-interventions in majority of the participants	2

Appendix Table 3 cont. ***IPM checklist for assessment of nonrandomized or observational studies of IPM techniques utilizing IPM-QRBNR.***

V.	ASSIGNMENT	
15.	Method of Assignment of Participants	
	Case report/case series or selective assignment based on outcomes or retrospective evaluation based on clinical criteria	1
	Prospective study with inclusion without specific criteria	2
	Retrospective method with inclusion of all participants or random selection of retrospective data	3
	Prospective, well-defined assignment of methodology and inclusion criteria (quasi randomization, matching, stratification, etc.)	4
VI.	CONFLICTS OF INTEREST	
16.	Funding and Sponsorship	
	Trial included industry employees with or without proper disclosure	-3
	Industry employees involved; high levels of funding with remunerations by industry or an organization funded with conflicts	-3
	Industry or organizational funding with reimbursement of expenses with some involvement or no information available	0
	Industry or organization funding of expenses without involvement	1
	Funding by internal resources only	2
	Governmental funding without conflict such as NIH, NHS, AHRQ	3
TOTAL MAXIMUM		48

Source: Manchikanti L, et al. Development of an interventional pain management specific instrument for methodologic quality assessment of non-randomized studies of interventional techniques. *Pain Physician* 2014; 17:E291-E317 (52).