

REVIEW ARTICLE (META-ANALYSIS)

Effectiveness of Ultrasound-Guided Versus Fluoroscopy or Computed Tomography Scanning Guidance in Lumbar Facet Joint Injections in Adults With Facet Joint Syndrome: A Meta-Analysis of Controlled Trials



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Abstract

Objective: To review the literature and assess the comparative effectiveness of ultrasound-guided (USG) versus computed tomography (CT)/fluoroscopy-guided lumbar facet joint injections in adults.

Data Sources: PubMed, Ovid MEDLINE, Ovid Embase, EBSCO, and Web of Science.

Study Selection: Randomized or nonrandomized controlled trials comparing the clinical effectiveness between USG and CT/fluoroscopy-guided injection techniques in patients with facet syndrome were included.

Data Extraction: Two reviewers independently screened abstracts and full texts. The results of the mean procedure duration, decreased pain score, and Modified Oswestry Disability score after treatment were extracted and presented in the form of mean \pm SD.

Data Synthesis: There were 103 records screened; 3 studies were included, with a total of 202 adults with facet joint pain. There was no statistically significant difference between the 2 groups in pain score and Modified Oswestry Disability score after injection (weighted mean difference [WMD], .07; 95% confidence interval [CI], $-.51$ to $.65$; $P=.80$; $I^2=78\%$; WMD, $-.55$; 95% CI, -1.31 to $.22$; $P=.16$; $I^2=0\%$, respectively). There was also no statistically significant difference in the mean procedure duration between the 2 groups (standardized mean difference [SMD], .97; 95% CI, -1.01 to 2.94 ; $P=.34$; $I^2=97\%$).

Conclusions: This review suggested that no significant differences in pain and functional improvement were noted between the USG and CT/fluoroscopy-guided techniques in facet joint injection. USG injection is feasible and minimizes exposure of radiation to patients and practitioners in the lumbar facet joint injection process.

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Pain emanating from the lumbar facet joints (zygapophysial joints) is a common cause of low back pain in the adult population and was first described by Goldthwaite in 1911.¹ Facet joint syndrome is defined as pain that arises from any structure of the facet joints, including the fibrous capsule, synovial membrane, hyaline cartilage, and bone.² The prevalence rate ranges between

5% and 15% of the population with axial low back pain.³ Because arthritis is a prominent cause of facet joint pain, the prevalence rate increases with age.⁴

The normative, unimpaired articular facets are covered by articular cartilage and are coated by their synovial, articular capsule.⁵ More commonly, facet joint pain is the result of repetitive stress and/or cumulative tiny trauma. This leads to inflammation, which can cause the facet joint to be filled with fluid and swell, which in turn results in stretching of the joint capsule and

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subsequent pain generation.⁶ The most frequent complaint is axial low back pain. Sometimes pain may be referred into the groin or thigh.⁷

The treatment of facet joint pain is the subject of great controversy. Facet joint injections are commonly administered to aid in determining whether the facet joint is a source of pain and/or to alleviate back pain.³ In 1963, Hirsch et al⁸ first described the technique of facet joint injections. Nowadays, injections are usually administered under fluoroscopy or computed tomography (CT) scanning guidance to ensure success and avoid complications.⁹ However, these techniques include exposure to ionizing radiation for both the patient and therapist and can only be performed in specially equipped pain clinics.¹⁰

Ultrasonography is portable, easy to access imaging which is not associated with radiation exposure. The role of ultrasound-guided (USG) spine injections has been clarified and summarized.¹¹⁻¹³ Galiano et al¹⁴ demonstrated that a USG lumbar facet joint injection is feasible and has minimal risk compared with CT-controlled injections. The Yun et al study¹⁵ also showed that USG injections in patients with lumbar facet syndrome are as effective as fluoroscopy-guided injections for pain relief and improving activities of daily living. However, there are no previous reviews to evaluate the comparative effectiveness of USG versus CT-/fluoroscopy-guided lumbar facet joint injection in adults. Also it is controversial whether the accuracy of needle placement has a significant affect on long follow-up clinical outcome in lumbar facet joint injection.

Therefore, we conducted this systematic review and meta-analysis to summarize the current evidence and evaluate the clinical effectiveness of USG lumbar facet joint injections. By reviewing the literature and performing meta-analyses of previously published studies, we aimed to assess the effectiveness of USG versus CT-/fluoroscopy-guided injections in adults with lumbar facet joint syndrome. It was the hypothesis of this study that the USG facet joint injection is as effective in clinical outcomes as CT-/fluoroscopy-guided techniques.

Methods

This systematic review was performed according to the current recommendations of the Cochrane Collaboration¹⁶ and reported using the criteria of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement.¹⁷

Search strategy

The searches were performed on PubMed, Ovid MEDLINE, Ovid Embase, EBSCO, and Web of Science from inception through August 20, 2015. Key search terms were *facet joint*, *zygapophysial joint*, *ultrasound*, *sonography*, and *injection*. Each concept used a combination of controlled vocabulary (Medical Subject Headings and Emtree) combined with text words for each database which

List of abbreviations:

CI	confidence interval
CT	computed tomography
RCT	randomized controlled trial
SMD	standardized mean difference
USG	ultrasound-guided
WMD	weighted mean difference

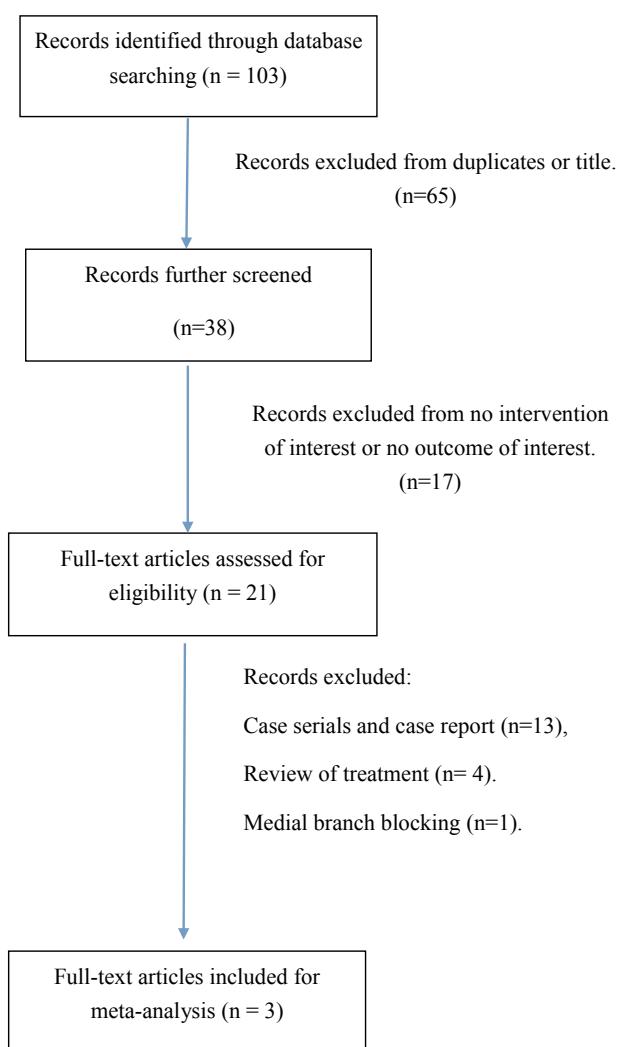


Fig 1 Flow chart of study screening.

uses subject headings (PubMed, MEDLINE, Embase, and EBSCO). Web of Science depended primarily on text words alone.

Inclusion and exclusion criteria

We included any randomized controlled trials (RCTs) or non-RCTs that compared the accuracy and/or clinical effectiveness between USG and CT-/fluoroscopy-guided injection techniques in patients with facet joint pain. Outcomes of interest included mean procedure duration, decreased pain score, and Modified Oswestry Disability score after treatment. Exclusion criteria were case reports, case series, and technical reports without control groups (CT/fluoroscopy guided) and pilot studies with no data analysis and/or power analysis.

Study selection

Once all relevant full-text articles had been gathered, the reference lists of each eligible article were scrutinized by 2 reviewers (T.W. and W.-h.Z.) for any omitted studies. Each search was imported into EndNote^a and a bibliographic database manager, and all

duplicates were removed. All conflicts were discussed and resolved with a third author (J.-h.L.).

Data collection process and outcome measures

After selection of all relevant articles, 2 authors (T.W. and W.-h.Z.) extracted all data into a preconstructed data table. The following data was extracted: author, year published, population, age, body mass index, intervention, sample size, study design, and main outcomes. The outcome measures collected were mean procedure duration, decreased pain score, and Modified Oswestry Disability score after treatment.

Statistical analysis

All analyses were performed using the generic inverse variance method (Rev Man 5.3^b). Statistical heterogeneity was quantified using the I^2 statistic and chi-square test. For continuous outcomes using the same measurement (pain score and Modified Oswestry Disability score), we pooled the weighted mean difference (WMD) using the DerSimonian and Laird random effects models. For continuous outcomes using different measurements (mean procedure duration in minutes or seconds), we pooled the standardized mean difference (SMD) using the DerSimonian and Laird random effects models. We used the Cochrane risk of bias tool to assess the methodologic quality of the included trials in terms of sequence generation, allocation concealment, blinding, incomplete outcome data, selective outcome reporting, and other sources of bias.¹⁶ The significance level was defined as $P < .05$.

Results

We screened 103 records, and 3 studies^{14,15,18} were eligible for review (fig 1), with a total of 202 adults with facet joint pain. Characteristics of the enrolled studies are described in table 1.

Clinical outcomes

Change in pain scores (visual analog scale, 0–10) after injection with USG versus CT-/fluoroscopy-guided techniques

All 3 studies^{14,15,18} assessed the difference of decreased pain score after injection between the USG and CT-/fluoroscopy-guided groups (N=202). Comparison of change in pain scores revealed that there was no statistically significant difference between the 2 groups (WMD, .07; 95% confidence interval [CI], -.51 to .65; $P = .80$, $I^2 = 78\%$) (fig 2).

Change in Modified Oswestry Disability scores after injection of USG versus CT-/fluoroscopy-guided techniques

Two studies^{15,18} assessed the difference of decreased Modified Oswestry Disability scores after injection between the USG and CT-/fluoroscopy-guided groups (N=162). Comparison of change in Modified Oswestry Disability scores revealed there was no statistically significant differences between the 2 groups (WMD, -.55; 95% CI, -1.31 to .22; $P = .16$; $I^2 = 0\%$) (fig 3).

Mean procedure duration of USG versus CT-/fluoroscopy-guided techniques

All 3 studies^{14,15,18} assessed the mean procedure duration of the USG and CT-/fluoroscopy-guided groups (N=202). Analysis

Table 1 Characteristics of the enrolled studies

Study	Population	Age (y), Mean \pm SD or Mean (Range)	Body Mass Index, Mean \pm SD	Intervention	Sample Size	Study Design	Main Evaluation Index
Galiano et al ¹⁴	Patients with facet joint pain and local pain increase over the facet joint with extension maneuvers.	49 \pm 9.9	27 \pm 4.5	USG vs CT-guided injection: 1 mL of 1% lidocaine plus 1 mL of 0.5% bupivacaine hydrochloride plus 1 mL (4-mg) of betamethasone.	40	RCT	Accuracy rate, decreased pain score after injection, mean procedure duration, and radiation doses.
Ha et al ¹⁸	Patients with spinal stenosis and low back pain showed no improvement of symptoms after medication, physical therapy, and exercise therapy for >3 months.	57.2 (45–83)	NA	USG vs fluoroscopy-guided injection: dexamethasone plus 2% lidocaine were mixed at a volume of 0.5 mL.	105	RCT	Decreased Modified Oswestry Disability score, decreased pain score after injection, and mean procedure duration.
Yun et al ¹⁵	Patients with facet syndrome of the lumbar spine of the L4-5 and L5-S1 levels.	56.4 \pm 9.2	24 \pm 2.4	USG vs fluoroscopy-guided injection: 10 mg of tramadol plus 2 mL of 1% lidocaine.	57	RCT	Decreased Modified Oswestry Disability score, decreased pain score after injection, and mean procedure duration.

Abbreviation: NA, not applicable.

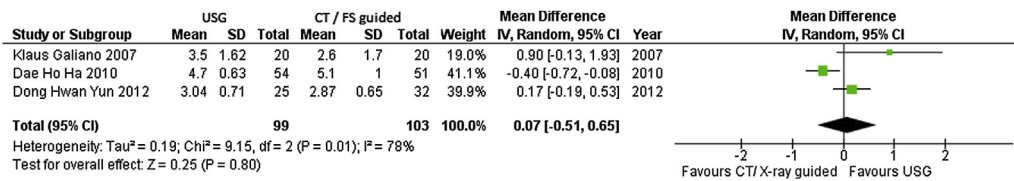


Fig 2 Change in pain score after injection: Forest plot. Abbreviation: FS, fluoroscopy.

indicated there was no statistically significant difference between the 2 groups (SMD, .97; 95% CI, -1.01 to 2.94; P = .34; I² = 97%) (fig 4).

Quality of included studies

We assessed each study’s risk of bias using the Cochrane risk of bias tool. The studies reported low risk of bias in terms of incomplete outcome data and selective outcome reporting. One study¹⁴ used a computer-generated randomization table to assign patients to different groups; therefore, the risk of randomization was assessed as low. However, 2 studies^{15,18} did not report detail of randomization of participants; therefore, the risk of randomization was unknown. Meanwhile, all 3 studies did not report detail of blinding of outcome assessment, and the risks were also unknown. Patients were not blinded to the injection technique, and this may have resulted in some bias, particularly for purely subjective assessments (eg, visual analog scale).

Discussion

Galiano et al¹⁹ recently described that the comparison of ultrasound and CT/fluoroscopy measurements demonstrated a good correlation during lumbar facet joint injection. In their study, the exact placement of the needle tip was evaluated by CT. Ultrasound and CT measurements showed the same mean depth and lateral distance to the reference point (Pearson correlation coefficient, .86; P < .0001). Therefore, ultrasound guidance might be a useful adjunct for facet joint injection in the lumbar spine. Ultrasound imaging proved to be reliable and accurate in delineating the needle tips in the facet joints compared with data obtained by means of CT/fluoroscopy.²⁰ Our systematic reviews also found that the patients who received USG facet joint injection could gain the same benefit as CT-/fluoroscopy-guided injection.

The Yun study¹⁵ demonstrated that a significant reduction of procedure duration was observed for the fluoroscopy-guided facet joint injections (248.7±6.5s) compared with ultrasound-guided

injections (263.4±5.9s) when the level of injection was limited to both the L4-5 and L5-S1 levels. The same results were also shown in the Ha et al study.¹⁸ However, Galiano¹⁴ demonstrated that an ultrasound approach to the facet joints in the lumbar spine is feasible with a significant reduction of procedure duration (USG group: 14.3±6.6min; CT-guided group: 22.3±6.3min). The different measurement of the procedure duration resulted in a converse conclusion. In the Ha study,¹⁸ the surgical time was defined as the time point at which the ultrasound or fluoroscopy images were obtained in both groups and extending to that time at which injection was completed. In the Galiano study,¹⁴ elapsed time was measured from the moment of placing the patient in the prone position. Our meta-analysis showed there was no statistically significant difference in the mean procedure duration between the 2 groups (SMD, .97; 95% CI, -1.01 to 2.94; P = .34; I² = 97%).

The sonographer classified the facet joints as clearly visible, partially visible, or not visible.¹⁴ In the Galiano study¹⁴ it was impossible to identify a lumbar approach to the facet joint via ultrasound in 2 subjects with a body mass index of 28.3 and 32.9kg/m². In these 2 patients the depth of the facet joints was >8cm. At this distance no resolution can be achieved with the ultrasound equipment used. In these 2 patients a CT-controlled procedure was performed. Therefore, body mass index was an important factor that will influence the therapeutic effects of the USG facet joint injection. In selected patients in whom the facet joint could be precisely identified and visualized under ultrasound examination, the needle placement was 100% correct.¹⁴

Studies have established the usefulness of ultrasonography for guiding local glucocorticoid injections, particularly into the facet joints.²¹ These ultrasound interventions are performed with the patient in a prone position and on a standard ultrasound device using a broadband curved 9 to 4MHz or alternatively a 5 to 1MHz array transducer depending on the patient’s body mass.¹⁹ We could identify the first to the fifth lumbar spinous process by placing the probe in a midline scan along the spinous processes. After the respective lumbar segment is defined, the transducer is rotated axially centered on the according lumbar spinous process and then moved laterally to the respective facet

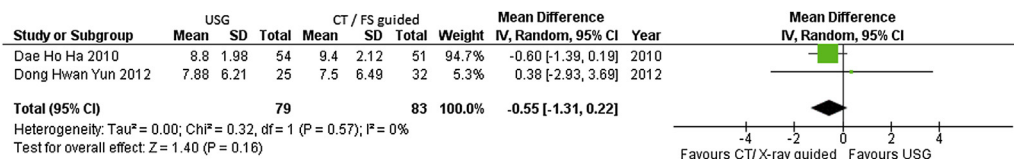


Fig 3 Change in Modified Oswestry Disability score after injection: Forest plot. Abbreviation: FS, fluoroscopy.

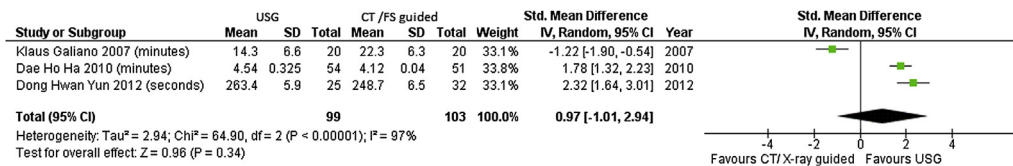


Fig 4 Mean procedure duration: Forest plot. Abbreviations: FS, fluoroscopy; Std., standard.

joint. Subsequently, 3 to 4cm laterally from the midline and lateral to the transducer, a 22-G spinal needle is inserted in an in-plane technique which enables a visualization of the complete needle path.¹⁹ The fact that in clearly visible cases ultrasound-guided facet joint injections can be rapidly performed is not surprising. Because of the immediate availability of information on the feasibility of ultrasound imaging of the target structures, once visualized, the needle can be advanced to the target structure in just a few seconds and under safe, real-time controlled conditions.

Study limitations

To our knowledge, this is the first meta-analysis to assess outcomes of lumbar facet joint injection guided by ultrasound versus CT/fluoroscopy in patients with low back pain. The limitation of this study is the relatively small sample size in each group. The results should be interpreted with some caution because of the limited number of studies and small sample sizes available for review. Therefore, adequately powered and well executed RCTs are required to confirm the benefit of USG facet joint injection.

Conclusions

USG injections in patients with lumbar facet syndrome are as effective as CT-/fluoroscopy-guided techniques for pain relief and improved Modified Oswestry Disability score. Therefore, accurate USG facet joint injection is feasible and a good treatment choice for facet syndrome of the low lumbar spine.

Suppliers

- EndNote; Thomson Reuters.
- RevMan version 5.3; The Nordic Cochrane Centre, The Cochrane Collaboration. Available at: <http://ims.cochrane.org/revman>.

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