Ultrasound-guided lumbar facet injections. Technique and literature review

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Summary

This review examines the current state-of-the-art of ultrasound-guided lumbar facet joint injections (FJI), highlighting its emergence as a novel and increasingly successful approach. The literature underscores its growing popularity owing to practical advantages such as low cost, absence of radiation, real-time needle visualisation and tracking, and a low rate of complications.

The procedure serves a dual purpose: as a diagnostic test for facet joint syndrome-related low back pain and as a therapeutic intervention for pain alleviation. Ultrasound guidance is particularly advantageous when coupled with needle guidance systems, ensuring precise needle direction for deep structure penetration with heightened accuracy.

In conclusion, ultrasound-guided lumbar FJI is a non-invasive, cost-effective, and radiation-free alternative to intrarticular injections guided by fluoroscopy and computed tomography. This comprehensive review aims to serve as an insightful resource for practitioners, providing valuable insights into the procedural nuances and clinical benefits of this procedure.

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Introduction

Facet joint injection (FJI) is a common interventional pain management technique used to alleviate chronic pain arising from the facet joints. Traditionally, fluoroscopy and computed tomography (CT) have been the most commonly used imaging techniques to guide the needle into the facet joint during FJI. Fluoroscopy uses continuous X-ray imaging to visualise the position of the needle in real time, while CT provides high-resolution images of the spine and surrounding structures, allowing for accurate needle placement [1].

However, ultrasound guidance is becoming increasingly popular as an alternative imaging technique for FJI. Ultrasound is non-invasive, does not use ionising radiation, and can provide real-time visualisation of the needle as it is advanced toward the facet joint. This can help to minimise the risk of complications, such as accidental injection into surrounding structures or nerve damage. In addition, ultrasound guidance can be performed quickly and easily at the bedside, making it a convenient option for both patients and healthcare providers [1]. Needle guidance systems are needle guides or tracking devices that attach to the ultrasound probe and help to stabilise the needle and maintain its trajectory towards the target, reducing the risk of accidental puncture of adjacent structures and improving the accuracy of needle placement [1].

This review aims to provide a detailed description of the procedural steps involved in performing ultrasound-guided FJI, emphasising the practical aspects including indications, contraindications, and potential complications, with an overview of the anatomy, aetiology, clinical manifestations, and diagnosis of facet joint pain syndrome.

Anatomy

The facet joints (zygapophyseal joints) are synovial joints located in the posterior aspect of the vertebral column, which are responsible for providing stability and mobility to the spine. They are formed by the articular processes between two adjacent vertebrae. The inferior articular process is provided by the superior vertebrae, while the inferior vertebrae provide the superior articular process[1]. Other characteristics include articular cartilage overlying each articular process's facet, followed by a layer of the synovial membrane and a tough outer fibrous layer overlying the membrane [2].

The joints are innervated by the medial branches of the dorsal rami of spinal nerves. Sensory information is provided by each facet joint via dual innervation from the spinal nerve at the same level and one level above.

Facet joints vary in size and shape based on the vertebral level. At the L1-L2 level, the facet joints are oriented obliquely, with the superior articular process facing posteromedial and the inferior articular process facing anterolateral. Moving down the lumbar spine, the orientation of the facet joints becomes more sagittal, with the superior articular process facing more posteriorly and the inferior articular process facing more anteriorly. By the L5-S1 level, the facet joints are nearly sagittal in orientation, with the superior articular process facing almost directly posteriorly and the inferior articular process facing almost directly anteriorly.

Facet joints have several functions, including limiting excessive motion, distributing axial load, and preventing displacement from intervertebral joint forward and rotational movements.

Facet joint pain is thought to be the source of pain in up to 67% of patients with neck pain, 48% of patients with thoracic pain, and 45% of patients with low back pain[1]. Because of the synovia's rich innervation, it is thought that pain from the facet joint stems from injury or inflammation caused by degenerative arthritis, capsular distension or defects, instability, and impinged nerves caused by osteophytes.

Aetiology

The facet joints can become a source of pain due to various reasons, such as spinal arthritis, back injuries, or mechanical stress to the back. The narrowing of the intervertebral space caused by the thinning of the spinal discs due to daily wear and tear and aging can increase pressure on the facet joints [3]. Moreover, a back injury in early life, such as fractures, torn ligaments, or disc problems, can cause abnormal movement and alignment of the spine, leading to excessive strain on the facet joint surfaces.

In response to this added pressure, the body may develop bone spurs around the facet joints, leading to their enlargement, also known as hypertrophy. As the cartilage covering the joint surfaces degenerates, the underlying bone rubs against other bones, causing inflammation, swelling and pain. Osteoarthritis of the facet joints develops gradually over time, and symptoms usually manifest later in the disease. However, sudden movements, heavy twisting, or backward bending in the lower back can damage a facet joint, causing immediate symptoms.

Clinical manifestations

Facet joint osteoarthritis typically worsens after rest or sleep and can cause pain on the same side of the affected joint when bending the trunk sideways or backward. This is due to the increased pressure on the facet joints, resulting in mechanical pain caused by abnormal movement in the spine. The pain is often felt in the center of the lower back and may spread to one or both buttocks. While the pain may sometimes spread to the thighs, it rarely goes below the knee [1].

Diagnosis

The definitive diagnosis of facet joint syndrome poses a challenge, given the absence of specific diagnostic markers. History and clinical examination may reveal unilateral or bilateral back pain radiating to one or both buttocks, sides of the groin, and thighs, and stopping above the knee [4]. Imaging studies (radiographs, MRI, CT, single-photon emission computerised tomography (SPECT), although often performed, lack specificity and correlation between clinical symptoms and degenerative spinal changes [5].

Currently, the gold standard for diagnosing lower back pain from a facet joint syndrome is intra-articular facet joint injection with local anaesthetic. This procedure not only provides immediate pain relief, but is also instrumental in confirming the facet joints as the source of pain. While it is acknowledged that the rate of false positives remains a concern, it stands as the most reliable diagnostic test available to date.

It is crucial to recognise facet joint injection as a dual-purpose intervention-serving both diagnostic and therapeutic roles. Following a confirmed diagnosis, more invasive procedures, such as medial branch radiofrequency ablation, may be considered for sustained pain management. In cases where routine diagnostic tests have ruled out alternative causes of lower back pain, and facet joint syndrome is suspected, the facet joint block remains the current gold standard diagnostic test.

Local infiltrations

Once the diagnosis is established, FJI can be used as a therapeutic modality. The most commonly injected substances into the facet joints are local aneasthetics, such as lidocaine or bupivacaine, and corticosteroids, such as triamcinolone or methylprednisolone. Local anaesthetics have been postulated to provide relief by various mechanisms, including suppression of nociceptive discharge, block of the sympathetic reflex arc, blockade of the axonal transport, and anti-inflammatory effects. Steroids have a dual mechanism of action. Firstly, they possess anti-inflammatory, anti-oedematous, and immunosuppressive properties, which help alleviate pain and inflammation. Secondly, steroids inhibit neuronal transmission within C-fibres, thereby reducing lumbar and radicular pain.

Imaging techniques such as fluoroscopy and CT are commonly used to guide the needle into the facet joint during facet joint injection. These techniques provide real-time visualisation of the needle position, ensuring accurate placement of the injection. During a fluoroscopy-guided facet joint injection, the physician inserts a needle into the facet joint and can watch the needle's placement in real time. Once the needle is in place, the physician injects a contrast dye to confirm that the medication will be delivered to the correct location. During a CT-guided injection, the scanner takes cross-sectional images that are used to precisely guide the needle to the injection site. Once the needle is in place, the medication is injected. CT-guided injections offer high precision and accuracy, but also involve more radiation exposure to the patient compared to fluoroscopy [6].

Ultrasound-guided facet joint injection is gaining popularity as a viable alternative due to its advantages, including low cost, lack of radiation exposure, and the ability to visualise the surrounding soft tissues and structures. This technique has been found to be comparable to fluoroscopy-guided injections in terms of accuracy and effectiveness in treating facet joint pain, with similar rates of successful pain relief and complications [8]. Ultrasound offers dynamic guidance, allowing the practitioner to visualise neighbouring structures like vessels and nerves, and can reduce the risk of trauma. Additionally, ultrasound allows for the visualisation of the injection of substances like corticosteroid crystals, which can help ensure accurate placement of the injection [7].

Others advantages of ultrasound guidance include an increased success rate, decreased complications caused by needle malpositioning, a faster effect of the blocks, and a reduced amount of local anaesthetics compared with fluoroscopy or CT-guided tecnhiqus [8].

Indications

Diagnostic facet joint injections are recommended when there is a high likelihood of pain being caused by facet joints, such as localised tenderness over the facet joint, pain in response to hyperextension, rotational movement, or lateral bending, leg pain that does not extend below the knee, chronic low back pain, neck pain that is not relieved by conservative management, low back pain with normal imaging, neck pain after a whiplash injury, and post-laminectomy syndrome in the absence of infection [9]. Prior to considering facet joint injections, it is advisable to attempt conservative treatments, including multimodal medication management, physical therapy, and behavioural modifications, for at least three months. Additionally, it is crucial to recognise moderate to severe pain burden with a pain score of 4/10 or higher on the numeric pain scale, accompanied by a decrease in functionality or quality of life [1].

Patients who have confirmed facet joint pain and who have responded positively to diagnostic facet joint injections may be considered for therapeutic facet joint injections as a supplement to conservative pain management. This therapy may be appropriate for patients who are unable to manage their pain with oral or systemic drug therapy, as well as those with pain resulting from adjacent segment deterioration after spinal fusion or spondylolytic defects [1].

Contraindications

There are no absolute contraindications for FJIs, except for cases where the patient refuses the procedure. However, some conditions may pose relative contraindications such as systemic or local infection over the injection site, coagulopathy or bleeding diathesis, allergy to medications used for the injection, neurologic disorders that may be masked by the procedure, and pregnancy [1]. For patients with a high body mass index, the use of longer needles (12 cm) may be considered to ensure the effectiveness of the injection. Patients with significant spinal deformity may be limited and the procedure should be carried out by a skilled and experienced practitioner.

Technique

Equipment

- US machine with linear probe (Hz: 8-14 Mhz)
- 18-gauge needle for drug aspiration
- 20-25-gauge hypodermic needle for local anesthesia
- 1% lidocaine applied topically
- a 20-22-gauge spinal needle for facet joint entry
- Ultrasound probe needle guides

Ultrasound probe needle guides, also known as needle guidance systems or needle tracking systems, are devices that can be used to improve the accuracy and safety of ultrasound-guided FJIs. These systems consist of a needle guide or tracking

device that attaches to the ultrasound probe and a compatible needle that is inserted through the guide. The guide helps to stabilise the needle and maintain its trajectory towards the target facet joint, reducing the risk of accidental puncture of adjacent structures and improving the accuracy of needle placement.
Several types of needle guides are available, including reusable and disposable options, and can be used with a variety of needle sizes and angles.

Medications

- Local anaesthetic (lidocaine, bupivacaine, and ropivacaine) Lidocaine is a fast-acting, short-duration local anaesthetic (1-2 hours);
- while bupivacaine and ropivacaine have a longer duration of action (4-8 hours);
- Steroids such as methylprednisolone acetate (duration of action 8 days), triamcinolone acetonide (14 days), triamcinolone hexacetonide (21 days), dexamethasone acetate (8 days) [6].

Depending on the kind of anaesthetic, local anaesthetics act by preventing nerve conduction and stimulation over time (lidocaine, bupivacaine, and ropivacaine are commonly used). Corticosteroids have anti-inflammatory, immunosuppressive, and C-fibre neuronal transmission-inhibitory effects [3]. Methylprednisolone, dexamethasone, triamcinolone, and betamethasone are the most frequently utilised medications [10].

Procedural steps

To perform ultrasound-guided FJI, a high-frequency linear transducer is placed over the target facet joint. The transducer is used to visualise the joint and surrounding structures, and the needle is advanced under direct visualisation toward the joint. Once the needle tip is confirmed to be in the correct position, contrast medium or local anaesthetic can be injected to confirm intra-articular placement.
The injection procedure includes the following steps:

- typically, the procedure is performed without sedation;
- the patient lies on a procedure table while the physician cleanses the skin over the area to be tested (Fig. 1);
- the physician administers an anaesthetic to the skin and subcutaneous tissue, which may cause a slight stinging sensation;
- the facet joint can be located with the help of ultrasound guidance (Figs. 2, 4-6);
- using sonography, the physician carefully inserts a small needle into the facet joint;
- after confirming the intraarticular access, the physician slowly injects a combination of local anaesthetic and steroids (Fig. 3);
- a mixture of an anaesthetic, such as lidocaine, and an anti-inflammatory medication, such as a steroid or cortisone, is slowly injected into the joint. The injection itself only takes a few seconds, while the entire procedure usually takes between 15 and 30 minutes.

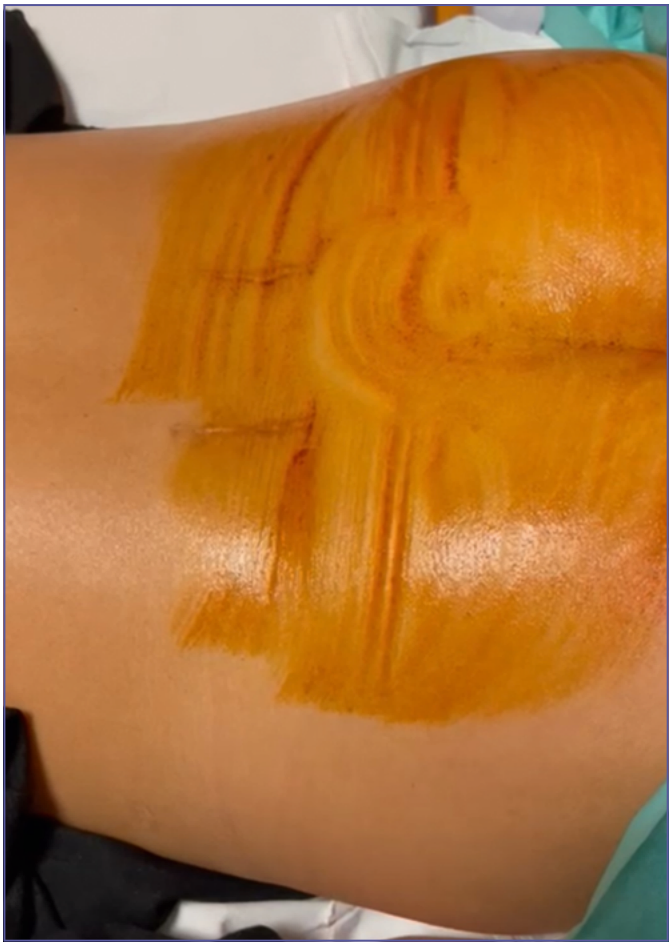

Figure 1. Sterile field preparation.

Immediately following the injection

Following the procedure, the patient is advised to rest in the recovery area for 20 to 30 minutes. Afterwards, they are asked to perform movements or activities that would typically provoke their pain.
Immediate pain relief after the injection may vary for patients, depending on whether the targeted facet joint(s) is the primary source of their pain. If the joint(s) being targeted are not causing the pain, the patient will not experience immediate pain relief from the injection.
In some cases, patients may experience numbness, weakness, or an unusual sensation in their neck or back for a few hours after the injection.

Discussion

Clinical facet joint syndrome is defined as unilateral or bilateral back pain radiating one or both buttocks, sides of the groin, the thighs and stopping above the knee.
There are no specific clinical or imaging features that defini-

Figure 2. The facet joint is located by US-guidance.

Figure 3. Intra-articular injection.

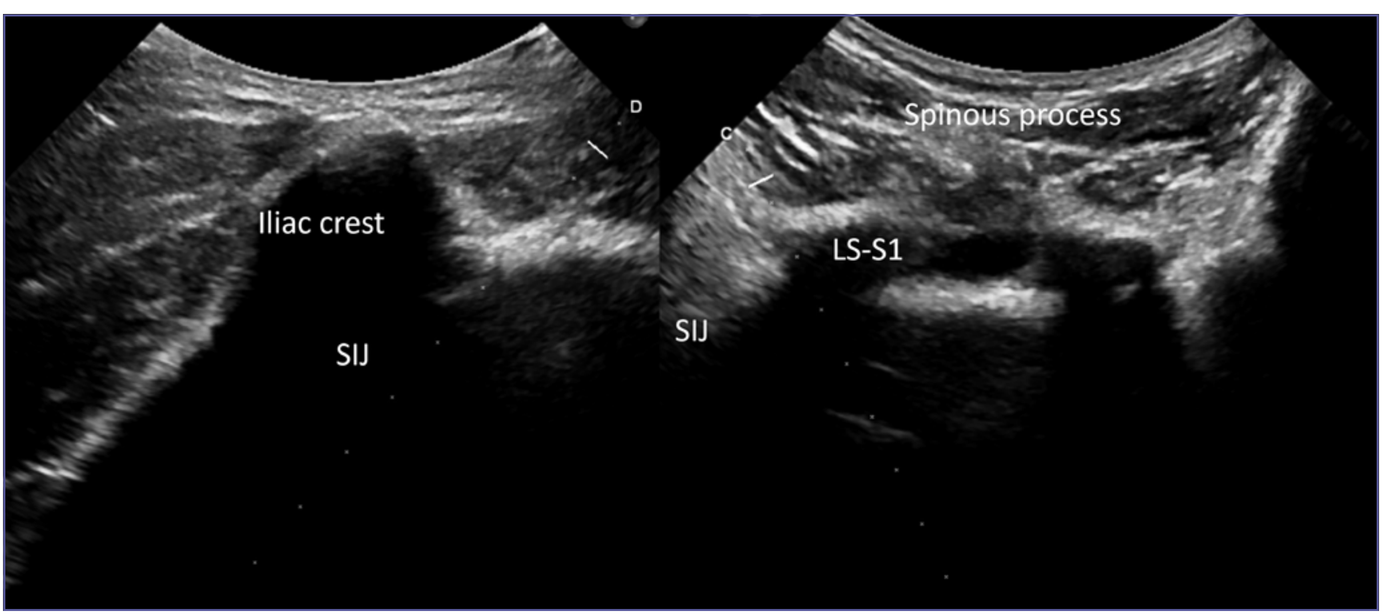

Figure 4. L5-S1 is easily located as the first horizontal laminas above the sacrum, aligned with the iliac crest and the sacroiliac joint. The guide directs the needle directly into the facet joint.

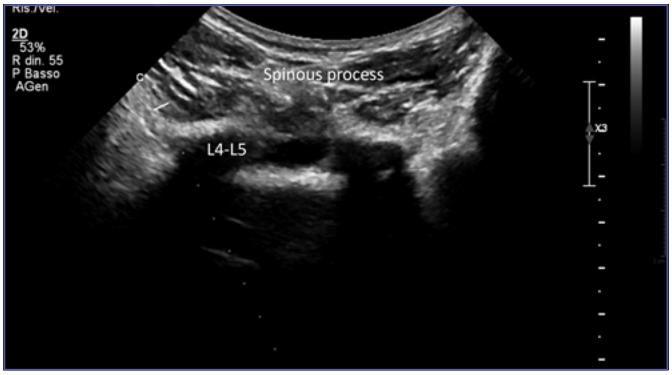

Figure 5. L4-L5 is located jut above, aligned with the upper tip of the iliac crest.

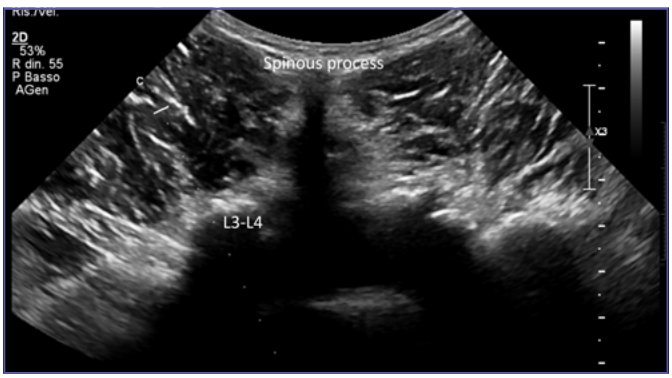

Figure 6. L3-L4 joint.

tively indicate the source of pain originating from facet joints and FJI are considered the most reliable diagnostic tool for facet joint pain. Controlled blocks are the only reliable tool in the diagnosis of FJ pain as a cause of low back pain [11]. Hence, diagnostic blocks are a keystone of diagnosis of facet joint syndrome. If diagnostic blocks of facet joints effectively relieve the patient's pain, a denervation procedure of the medial nerve branches that supply the specific facet joints can be offered as a potential treatment option [3]. Cohen et al. showed a success rate of lumbar facet joint radiofrequencydenervation patients of 39% after a single block and 64% after a double block [12]. Due to the dual nerve supply of FJs, with innervation from the same level and the level above, diagnostic blocks of single joint should ideally involve a minimum of two levels [13].

There is substantial evidence supporting the superiority of medial branch blocks over intra-articular blocks in providing both short- and long- term relief [14]. Although intra-articular injections (with or without steroids) have traditionally been used in the diagnosis of facet joint pain, a controlled trial by Lilius et al. reported no outcome differences between intra- and periarticular injections [15]. Medial branch block have demonstrated higher specificity over FJI in selecting patients who are suitable candidates for medial branch neurolysis [16]. The systematic review of Ashmore found that ultrasound-guided MBB (medial branch block) and FJI had similar rates of inaccurate needle placement (11% for MBB, 7 to 13% for FJI). The time required to complete ultrasound-guided MBB was shorter compared to the fluoroscopic guided technique. However, when it came to ultrasound-guided FJIs, the review noted that the time to complete the procedure varied widely. Few complications were reported for these procedures [17].

Conservative management is usually the first treatment for facet joint syndrome and only if it fails, these patients may benefit for FJI with corticosteroids [18].

Historically, FJI were conducted by guided CT or FS. In the last 20 years, US guidance for FJI has become a viable and safe alternative. Ashmore in a systematic review suggests that ultrasound's limitations, such as lower resolution for deeper structures and patient factors like increased BMI, contribute to lower accuracy. However, ultrasound-guided FJI has shown comparable immediate post-procedural outcomes to conventional imaging modalities [17].

Ultrasound may be suitable in certain scenarios, such as when avoiding radiation exposure is important or when diagnostic accuracy is secondary [17].

US guided injections may be more efficient than other imaging guided techniques due to their less precise target, potentially resulting in a dual effect of intra-articular and medial nerve block. Furthermore, due the shorter procedure time, safety and no radiation exposure they should be preferred over other imaging guided techniques.

The meta-analysis by Tao Wu et al. in 2015 compared the effectiveness of ultrasound-guided and computed tomography/fluoroscopy guided techniques in FJI. The study found no significant differences in pain and functional improvement between the two techniques. However, USG injection was found to be feasible and had the added benefit of minimising radiation exposure to patients and practitioners. US-guided injections were found to be as effective as FS-guided injections and less time- and cost-consuming [19]. A recent study by Touboul et al. (2022) compared ultrasound-guided and fluoroscopy-guided lumbar zygapophyseal joint injections for low back pain management. They found no significant difference in pain reduction and functional improvement, but ultrasound-guided injections had lower radiation exposure and shorter procedure times. The study concludes that ultrasound-guided injections are a safe and effective alternative to fluoroscopy-guided injections [7].

The study by Musa Çırak and Sibel Çağlar Okur (2020) investigated the effectiveness of ultrasound-guided FJI in reducing pain and improving mobility in 27 patients with failed back surgery syndrome. The injections significantly reduced pain and improved mobility. However, the study had limitations such as a small sample size and short follow-up period [20].

Nevertheless, if FJI can provide both diagnostic utility and therapeutic benefits, potential risks and adverse effects must also be considered. Factors such as patient selection, injection technique, injectate choice are crucial for minimising risks and maximising benefits [2].

According to Ye et al., fluoroscopy carries a complication rate of 5-10%, with some potentially life-threatening complications such as pleural perforations and pneumothorax. Similarly, CT-guided injections have a lower complication rate of 0.5%. In contrast, US-guided injections offer several advantages including direct visualisation of the target, adjacent structures, and the spread of local anaesthetic. With US guidance, the needle can be precisely and safely advanced to the target structures [8]. Notwithstanding the clearly demonstrated the short-lasting effect of FJI, the clinical evidence supporting their long-lasting efficacy is considered limited and more data must be. More data is needed to establish the extent and duration of the long-lasting effect of FJI [21].

Clinical trials have yielded conflicting or undetermined results. The trial by Carette et al. was a high-quality, randomised, double-blind, placebo or active-control study, and yielded negative results [22]. The second trial, by Fuchs et al., showed weakly positive or undetermined effects with a high number of injections [23]. Luiza Helena Ribeiro et al. conducted a randomised controlled trial to compare FJI with systemic steroids in patients with facet joint syndrome, with intra-articular injection of steroids showing slight superiority over intramuscular injection [24]. Several non-randomised studies provided clinical evidence reporting positive results after FJI [25].

Facet joint blocks may also be used to predict lumbar surgical outcomes and surgical therapies including arthrodesis for degenerative facet joint disorders are discouraging. In most cases, non-operative treatment should be attempted before surgical management. In case of spondylolisthesis, pain relief may be obtained with arthrodesis when interventional management fails, but there are currently no guidelines [18].

Conclusions

In summary, ultrasound-guided lumbar FJI has emerged as a viable and cost-effective method, presenting notable advantages such as minimal cost, absence of radiation exposure, and comparable accuracy and effectiveness to fluoroscopy. While intra-articular injections with fluoroscopy or CT provide higher resolution imaging of deeper structures, the radiation-free nature and overall safety of ultrasound-guided lumbar FJI, especially when performed with needle guidance systems, positions it as a valuable treatment alternative.

Conflict of interest statement

The authors declare no conflict of interest.

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Author contributions

VZ, EVC, PF, MC: conceptualization; VZ, EVC, PF: methodology; PF, EVC: validation; VZ, MVB, VC: formal analysis; MCE, EVC: investigation; VZ, YL, PF: data curation; VZ, YL, PF: writing - original draft preparation, writing - review and editing; RMC, PLT, GZ: supervision; RMC, PF: project administration.

Ethical consideration

Not applicable.

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