Interventional Pain Medicine 1 (2022) 100119

Contents lists available at ScienceDirect

Interventional Pain Medicine

journal homepage: www.journals.elsevier.com/interventional-pain-medicine

A direct posterior approach for lumbar transforaminal epidural steroid injection

Dear Editor,

Many approaches have been used in performing lumbar transforaminal epidural steroid injections including the supraneural (or subpedicular), retroneural (or posterolateral), and infraneural (or retrodiscal) approaches. All these techniques have associated risks and limitations that include dural puncture and vascular penetration, among others. We describe a direct posterior approach that has the potential to provide an easier, safer, and equally effective alternative.

On a prone patient, we use an anteroposterior fluoroscopic view directly dorsal to the foramen and insert a spinal needle until it is docked on the lateral edge of the pars interarticularis. We then walk the needle slowly laterally until it comes off bone, where it is now at the posterior neural foramen. A lateral fluoroscopic view is then obtained, and contrast medium is injected. Steroid is then injected at this position.

Compared to the other known approaches, ours has multiple potential benefits. Our approach is easier to perform as it only requires an anteroposterior fluoroscopic view and minimal lateral views, which could also reduce radiation exposure. The risk of neurovascular injury could be lower with our approach as the needle is placed in a posterior and lateral final position in the neural foramen. With the posterior positioning of our needle, risk of dural puncture and cerebrospinal fluid leak could also be reduced.

Our approach is a technically less challenging, more efficient way of providing a lumbar transforaminal epidural steroid injection with equal diagnostic and therapeutic benefit compared with other techniques, with potential enhancement of patient safety as well.

A variety of anatomical approaches have been used in performing lumbar transforaminal epidural steroid injections (TFESI). The most widely used technique is the supraneural or subpedicular approach that targets the “safe triangle”, an area formed by the base of the pedicle, outer boundary of the vertebral body, and the exiting nerve root, which acts as the hypotenuse of the triangle [1,2]. This is performed in oblique fluoroscopic view with the needle guided immediately superior, anterior, and lateral to the exiting nerve.

Another commonly utilized technique is the posterolateral or retroneural approach which is a slight modification of the supraneural approach. As its name implies, the needle tip is advanced to the inferior posterior aspect of the neural foramen. The exiting nerve root serves as the superior margin [3–7].

Lastly, TFESI can be performed via an infraneural or retrodiscal approach where the needle is directed at the “Kambin triangle”, with its borders defined by the superior endplate of the inferior vertebral body, the superior articular process, and the exiting superior nerve root [8]. This technique is also called the pre-ganglionic approach as the needle is aimed toward the preganglionic portion of the nerve root at the level of the supra-adjacent intervertebral disc [9–12]. Figs. 1 and 2 demonstrate the 3 approaches to TFESI discussed above.

While these techniques are effective, they also have inherent risks, including dural puncture, nerve injury, vascular injury, and inadvertent intradiscal or intrathecal injections [13,14]. There does not appear to be a consensus of superiority of one approach over the other [15]. We describe a new approach for TFESI that is safe, efficient and can minimize the aforementioned risks to a great extent.

1. Technique

1.1. Step 1

The patient is positioned prone on the operating table, and the injection area is prepared and draped in a sterile fashion. Anteroposterior (AP) fluoroscopic view is obtained directly dorsal to the foramen.

1.2. Step 2

Spinal needle insertion site is dorsal to the pars at the lateral edge of the pars interarticularis.

1.3. Step 3

The needle is advanced to the level of the pars with a mild 5^0 lateral to medial angle to dock on the lateral edge of the pars interarticularis of the target vertebrae under AP fluoroscopic view. Fig. 3 shows how this bony landmark is used as a target for the needle.

1.4. Step 4

The needle is slowly walked off the lateral edge of the pars interarticularis through small movements laterally. This is performed by withdrawing the needle a few millimeters while medializing the needle hub, thus allowing for lateralizing of the needle tip. This step is performed incrementally until the tip advances beyond the lateral edge of the pars. Once the needle comes off the edge of the bone, care is taken to not advance the needle any further as it is now at the posterior neural foramen. A lateral fluoroscopic view is then obtained to confirm needle tip position in the posterior foramen.

1.5. Step 5

Prior to steroid injection, contrast medium is injected to confirm appropriate epidural distribution pattern within the foramen and along the course of the nerve.

We demonstrate a representative TFESI from a patient with a history of fibrous dysplasia who presents with radicular pain. The spinal needle

https://doi.org/10.1016/j.inpm.2022.100119
Received 1 April 2022; Received in revised form 3 June 2022; Accepted 12 June 2022

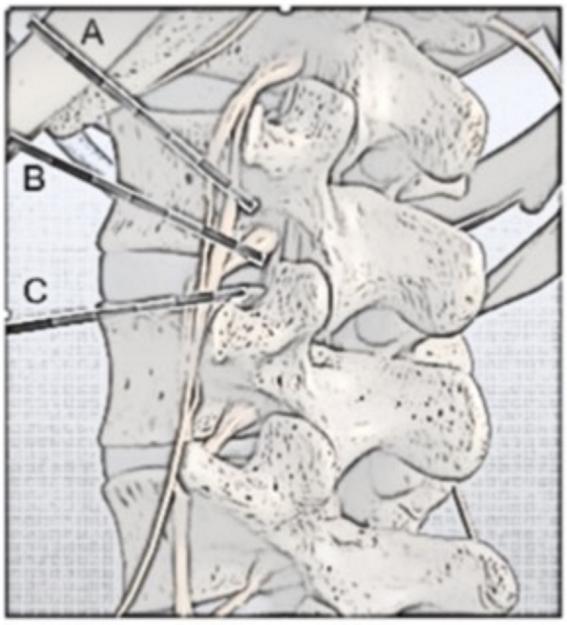

Fig. 1. Traditional approaches to transforaminal epidural steroid injections include the supraneural (A), retroneural (B) and infraneural (C).

is docked on the pars interarticularis (Fig. 4a–b), then walked laterally until the needle tip falls off the edge of the pars (Fig. 5a–b). Post-contrast injection demonstrates distribution of the contrast within the foramen and along the course of the nerve (Fig. 6a–b).

We describe an easy and safe approach for TFESI. The fact that our approach uses an established bony landmark as initial target unlike other techniques for TFESI has multiple benefits. We utilize a direct posterior to anterior approach with a slight lateral to medial trajectory. With the pars interarticularis as the target, the needle can be advanced under AP view safely with less reliance on lateral views. A lateral view is only obtained once the needle has been walked off the pars interarticularis to confirm that the needle was not accidently advanced too deep after coming off the bone. This is in contrast to previously described techniques in which the needle is advanced into the neural foramen from an oblique trajectory where serial lateral views are often required to verify depth. Because of this, our approach has the benefit of decreasing the amount of radiation exposure to the patient.

Additionally, the bony landmark gives the proceduralist better tactile response in gauging the depth of the needle and a safety shield. This differs from other techniques where the needle is placed in oblique view and then in lateral view without any landing targets on the bone. This helps to make the procedure technically less challenging and also to decrease the risk of nerve root injury and dural puncture, which is discussed in more detail below.

Our approach also has the potential to increase the safety of TFESI by decreasing the risk of neurovascular injury. Although the radicular artery and Artery of Adamkiewicz can be found anywhere within the neural foramen, they are most often positioned at the superior-anterior aspect. There is thus a higher risk of spinal cord infarction and paraplegia with the traditional supraneural approach. It has been found that only 3% of radicular arteries lie in the inferior one-third of the foramen. One study that examined 18 cases of paralysis from transforaminal epidural injection found that the needle was in the superior portion of the foramen in 77.7% of the cases and the anterior aspect of the foramen in 71.4% of the cases. None of the cases of paralysis in that study had inferior needle placement [16]. Our approach places the needle in a posterior and lateral final position, therefore reducing the risk of injury to the exiting nerve root and radicular arteries.

Other approaches have the risk of unintentional dural puncture and neural injury. The lumbar nerve roots are usually located in the superior portion of the neural foramen as they exit below the pedicles and course

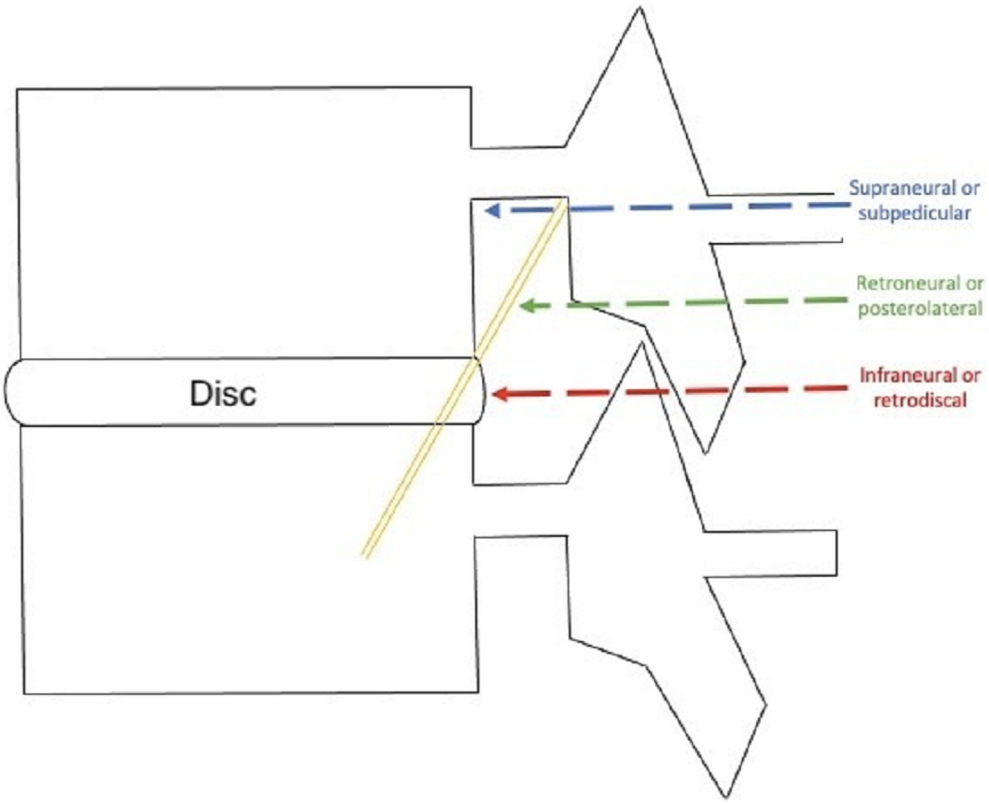

Fig. 2. Schematic representation of the supraneural, retroneural, and infraneural approaches.

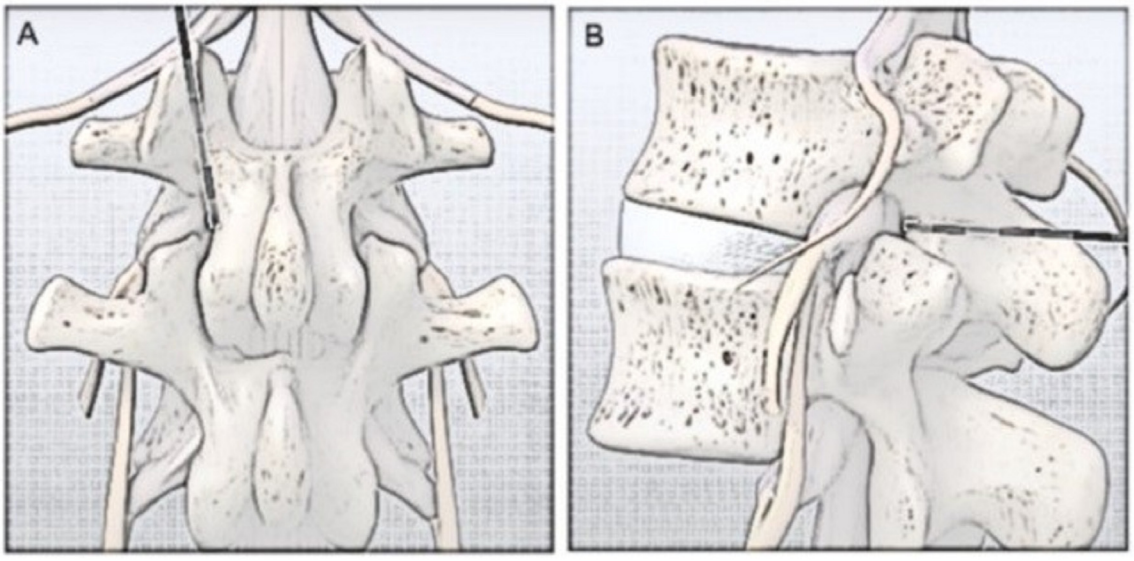

Fig. 3. Diagram demonstrating the target of the spinal needle tip at the lateral (A) and ventral (B) aspect of the pars interarticularis.

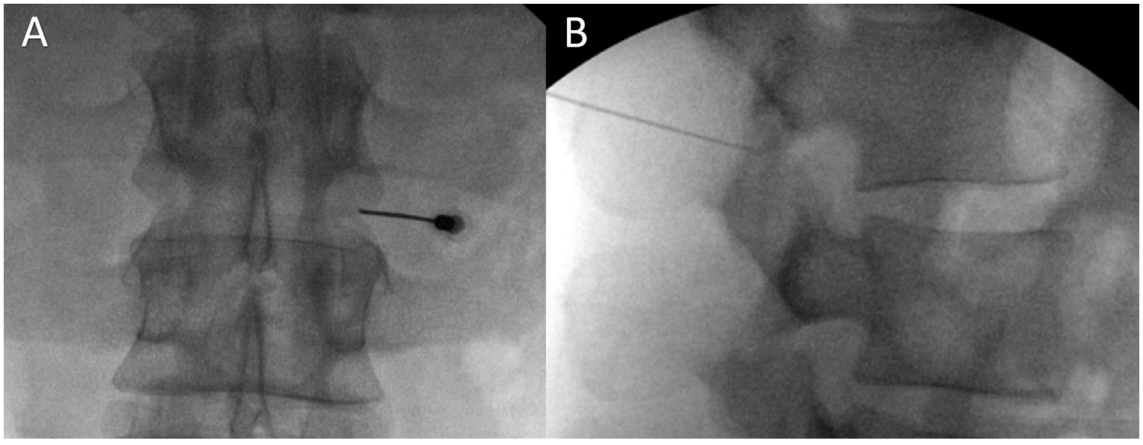

Fig. 4. Fluoroscopic AP (A) and lateral view (B) of the spinal needle on the pars interarticularis.

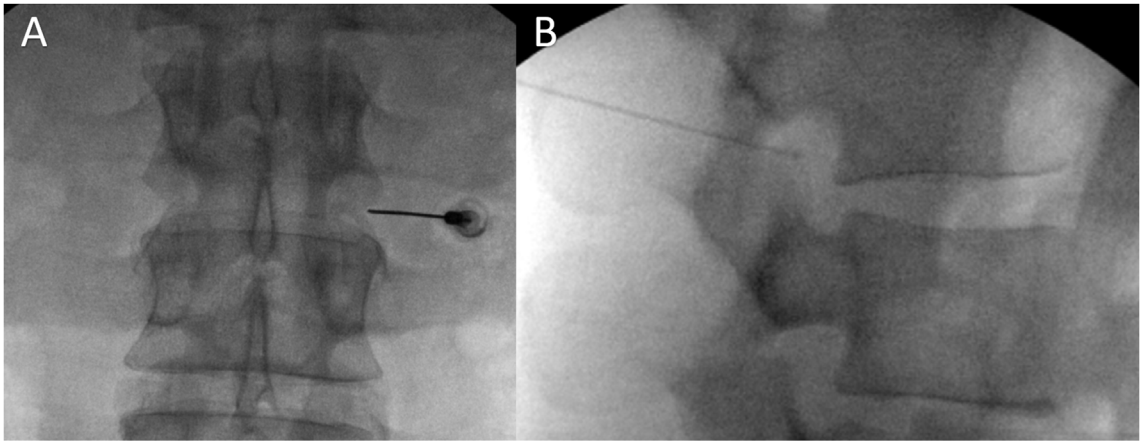

Fig. 5. Fluoroscopic AP view (A) of the spinal needle on the lateral edge of the pars interarticularis. Lateral view (B) showing the needle at the ventral margins of the pars interarticularis, in the posterior foramen.

anteriorly to form the lumbar plexus [17–19]. Further heightening the risk of dural puncture, specifically with the supraneural approach, is the fact that the spinal nerves are enveloped by dural sleeves, and there have been reported cases of dural puncture with piercing of these sleeves [20].

The posterior positioning of our needle helps to decrease the risk of dural puncture and cerebrospinal fluid leak by landing on the pars

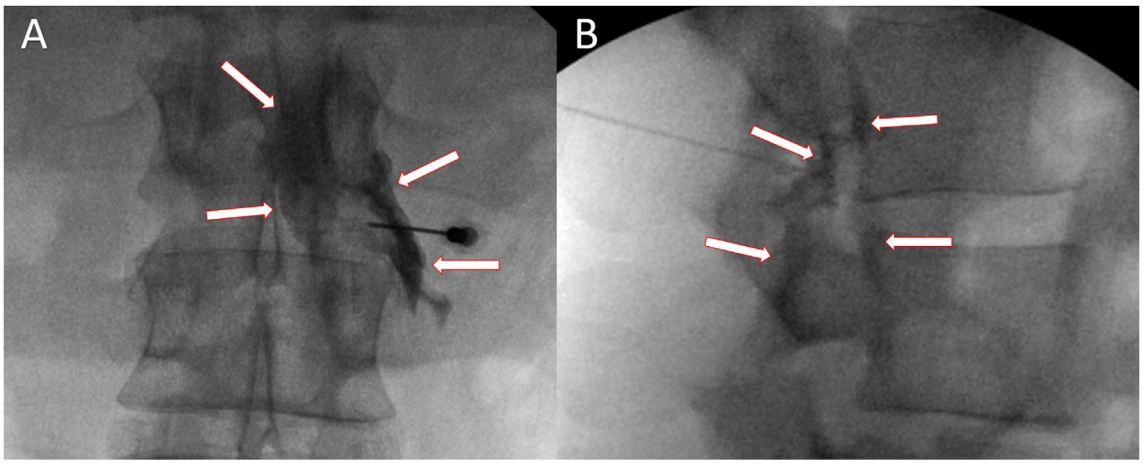

Fig. 6. Following contrast injection, contrast could be seen filling along the course of the nerve root (A) and within the foramen (B).

interarticularis first. Once our needle is walked off this bony landmark, it is not advanced beyond the ventral edge of the pars and is kept posteriorly. This varies from the posterolateral approach described by Lee et al. (2007) in that our target point is the posterolateral portion of the foramen and not the median inferior margin of the pedicle. This subtle difference helps improve safety and reproducibility. While this has the potential to reduce radiation exposure by reducing frequency of lateral fluoroscopic images, final lateral fluoroscopic projection views of the needle tip and contrast administration prior to steroid injection are an integral component of the transforaminal injection protocol and comply with best safety practices outlined by the Spine Intervention Society.

A possible limitation with our approach would be in patients with facet arthropathy and boney overgrowth. Severe facet overgrowth would narrow the neural foramen and make it more difficult to access the exiting nerve root using our technique. Another limitation would be a patient with history of lumbar decompression where the pars interarticularis has been removed. In such a case there would be no bony landmark to dock the needle on, making safe and accurate injection with our approach very difficult.

Utilizing the direct posterior approach, over 120 transforaminal epidural steroid injections have been performed at Moffitt Cancer Center from 2010 to 2022 without any complications of cerebrospinal fluid leakage, bleeding or nerve injury (data not shown).

In conclusion, our approach is a technically less challenging, more efficient way of performing lumbar TFESI that achieves the same diagnostic and therapeutic benefits as other techniques, with potential enhancement of patient safety as well. Randomized controlled trials are needed to compare the techniques for efficacy and safety to establish clear guidelines.

Thank You.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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