Retrospective Review

Cervical Nerve Root Block Using a Curved Blunt Needle and Posterior Approach

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Background: Cervical transforaminal epidural steroid injections have become less popular due to the risk of catastrophic complications they pose. However, cervical nerve root blocks are useful for surgical planning in patients with cervical radicular pain syndromes.

Objectives: Our aim was to find a method of performing cervical selective nerve root blocks that removed the risk of catastrophic complications.

Study Design: Retrospective case review.

Setting: Academic multidisciplinary spine center.

Methods: Among patients, 50 consecutive cases were retrospectively reviewed for immediate pain scores and follow-up results. In the intervention, a posterior approach using a curved blunt needle was employed for cervical selective nerve root blocks to minimize the risk of arterial injection. To measure the outcomes, we used quantitative pain severity scores and qualitative responses.

Results: This technique detailed in this study has a high immediate analgesic effect that can be used for diagnostic purposes. It is not known if this technique has prognostic value with respect to surgery. The prolonged response rate is about 50%, which is in line with other techniques.

Limitations: This study had no control group.

Conclusion(s): Cervical selective nerve root blocks using a curved blunt needle and a posterior approach are effective in selectively identifying nerves that cause clinical symptoms. This technique minimizes the risk of arterial or spinal cord impingement and therefore may be safer than transforaminal selective nerve root blocks.

Key words: Cervical radiculitis, cervical radiculopathy, cervical radicular pain, cervical foraminal stenosis, cervical disk herniation, cervical stenosis, cervical selective nerve root block, cervical transforaminal steroid injection

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Cervical epidural injections, both diagnostic and therapeutic, are an important tool for treating pain (1). Therapeutic injections have the strongest evidence in their favor when used for symptomatic disc protrusion, but they also have a role in treating spinal stenosis, axial discogenic pain, and persistent spinal pain syndrome type 2 (2). The most common approaches used when administering

therapeutic injections are interlaminar and transforaminal. Because of safety concerns, the use of transforaminal injections has become less common (3), although a recent study reported that transforaminal techniques were equally efficient, if not as safe, as catheter-guided interlaminar procedures (4).

Cervical radicular pain is often evaluated with selective nerve root blocks. Selective nerve root blocks are helpful diagnostic procedures when the physical examination and imaging are not congruous with a patient's history (5). Also, many patients have multilevel central or foraminal stenosis, and nerve root blocks are useful for identifying the most symptomatic roots in these cases (6). Furthermore, responses to selective nerve root blocks correlate with pain relief after surgery. Interestingly, lumbar nerve root blocks are the only injection procedures reported to reduce surgery rates for a year or a period of years (7,8).

Potential permanent complications of cervical transforaminal and selective nerve root block procedures include anterior spinal artery infarctions, vertebral artery dissection, spinal cord trauma, epidural hematomas, epidural abscesses, and nerve root trauma (9). The neural foramen contains multiple arteries in unpredictable locations (10). These arteries can be punctured and injected into during a transforaminal injection, causing anterior spinal artery flow disruption and spinal cord infarction. Embolization (either atheromatous or particulate), vasospasm, and occlusion by intimal flaps may be factors. Also, a lateral approach to the foramen for a transforaminal injection can allow the needle to enter the foraminal arteries and spinal canal, causing injury to the nerve root or directly to the cord. No existing technology can reliably prevent the placement of a sharp needle into an artery.

Cervical selective nerve root blocks that use a blunt needle and a posterior approach may reduce the risk of these complications. The needle tip is placed lateral to the foramen and vertebral artery, avoiding the arteries in the foramen. Also, selective nerve root blocks may pose less risk of epidural hematomas and abscesses than do interlaminar injections.

After IRB approval, a retrospective study was conducted to assess the results of this technique.

Methods

Billing records for cervical nerve root blocks were used to identify 50 consecutive cases of cervical radicular syndromes and single-level or multilevel cervical spine pathology on imaging studies. For those conditions, the patients were injected with diagnostic and therapeutic procedures to confirm the suspected nerve root levels and reduce pain. Patients were treated from May 2020 to May 2023 in an academic multispecialty spine clinic practice. The patients were evaluated by an orthopedic spine surgeon and anesthesiology pain physician.

The procedure was performed using fluoroscopy, with the patient in the prone position. Better visualization sometimes required a swimmer's view and collimation along the axis of the needle. Intravenous sedation was limited to 12.5 micrograms of fentanyl or less. The local anesthetic was infiltrated just lateral to the facet joint at the target level as seen on an anterior–posterior fluoroscopic image. An 18 G blunt access cannula (Epimed International) was placed under local anesthesia toward the lateral facet joint at the target level (Fig. 1). A 20 G cannula was used with a 25 G curved blunt needle for smaller patients.

A lateral image was used to guide this introducer needle toward the posterior neural foramen. The foramen cannot often be visualized on a lateral view but is present anterior to the facet joint. Once the tip of the blunt access cannula reached the depth of the facet joint, the sharp metal needle was removed and the plastic cannula left in place. A 20 G Coudé® (curved) Blunt Nerve Block Needle (Epimed International) was placed through the introducer to the posterior foramina area. Fig. 2 shows a 20 G curved blunt needle.

Fig. 3 shows an anterior-posterior image of the curved blunt needle lateral to the C6-7 facet joint for a C7 selective nerve root block. This needle had a lumen that opened proximal to the tip. The tip was advanced

Fig. 1. *18 G cannula (Epimed International, blunt access cannula).*

Fig. 2. *1820 G curved blunt nerve block needle.*

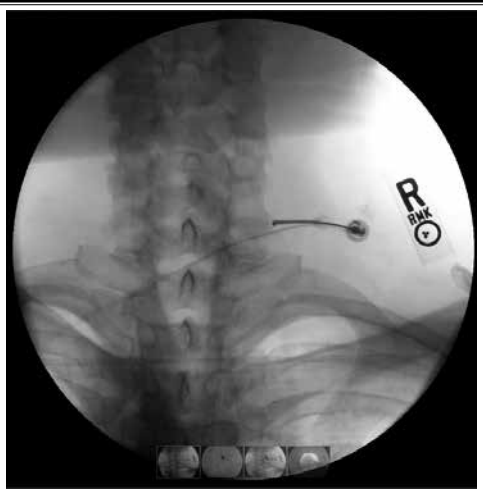

Fig. 3. *Anterior posterior fluoroscopic image of curved blunt needle lateral to the C6-7 facet joint.*

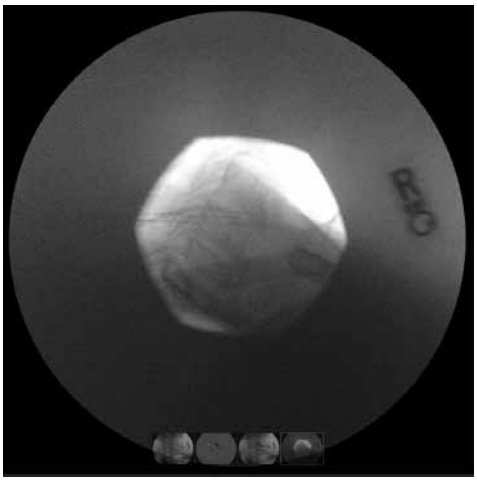

Fig. 4. *Showing the curved blunt needle tip anterior to the facet joint.*

until the lumen of the needle was anterior to the facet joint. The nerve root was anterior to the blunt needle tip. Fig. 4 shows a lateral fluoroscopic image of a curved blunt needle in a position lateral to the foramen. Meticulous efforts were made to eliminate visible air bubbles in all syringes and tubing. The curved blunt probe hub was filled with contrast, and a long, small-bore (1-1.5 mL capacity, small-bore tubing, 156 cm) extension tube from the BD Alaris™ System (ref. 11088483) (Becton, Dickinson and Company) filled with contrast was connected to the needle hub. This arrangement allowed the operator to stand away from the fluoroscopy beam. An aspiration test was performed.

Digital subtraction angiography and/or contrast injection using real-time continuous fluoroscopy was used to confirm placement and rule out intravascular injection. On the lateral fluoroscopic view, contrast was meant to be seen anterior to the facet joint, just external to the neural foramen. Fig. 5 shows the conclusion of a contrast injection using digital subtraction. The contrast was not meant to spread into the neural foramen. A test dose of 1 mL of one percent lidocaine was injected to rule out anterior spinal artery embolization. The test dose was also the total local anesthetic given. After observation, 5-10 mg of dexamethasone was injected. Attention to the volumes injected in the small-bore tubing was needed to avoid incorrect dosing. Fig. 6 shows a fluoroscopic image after injection. Pain scores (on a scale of 0-10) before and after the procedure were obtained from nursing notes. Qualitative pain outcomes were obtained from clinic follow-up notes.

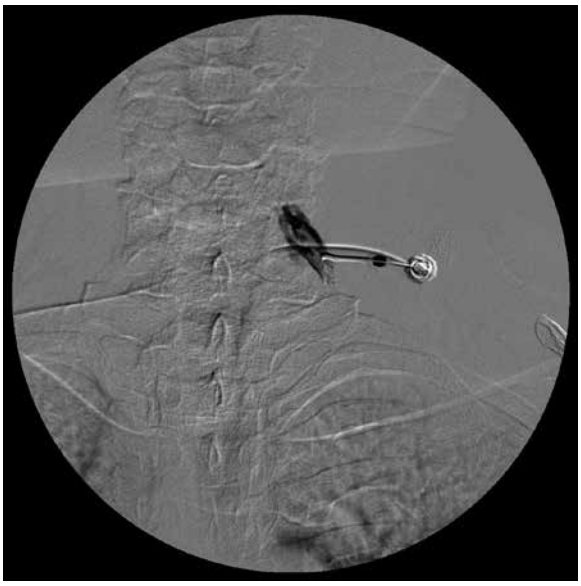

Fig. 5. *Final image of the contrast injection using digital subtraction.*

The mean levels of pre-injection and post-injection pain severity were compared using the dependent samples t-test. Statistical analyses were carried out using SAS® Version 9.4 (SAS Institute, Inc.). The level of significance was set at $\alpha = 0.05$ (2-tailed).

Results

After receiving institutional review board approval was obtained, 50 consecutive patient records were

reviewed retrospectively. One patient was not injected due to venous runoff. Another patient was not injected due to said patient's obesity making it impossible to obtain a good lateral fluoroscopic image. A third patient received a thoracic injection. These 3 patients are not included in the descriptive narrative analysis. Table 1 shows the number of blocks at each cervical level.

Twenty-one blocks were performed on the left side and 26 on the right. Twenty-nine patients had multilevel stenosis or other potential causes for their radicular pain. Eighteen patients had single-level radicular pain. Table 2 shows the number of patients who had each primary diagnosis.

Five patients had more than one block. Two of these had the same level blocked twice, and the other 3 had different levels blocked. One patient had 3 blocks, each at a different level. Five patients had little to no immediate relief. All of those patients had multilevel pathology. Two of these 5 received blocks at a different level and felt complete relief immediately after the procedure.

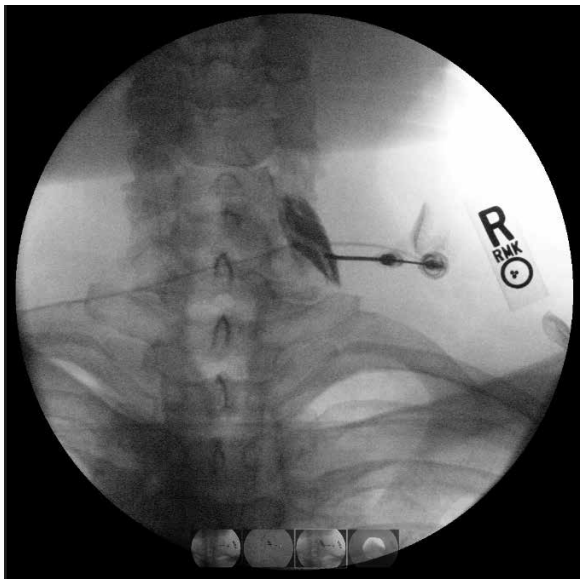

Fig. 6. *Final image after the test dose of the local anesthetic, followed later by dexamethasone.*

Table 1. *Number of blocks at each cervical level.*

Level	C4	C5	C6	C7	C8
Number of Patients	8	15	16	7	1

Forty-one patients felt no pain in the nursing recovery unit after the procedure. Of the 41 patients (87%) who had immediate relief after a first block, 22 (52%) had good to excellent pain relief for weeks after the procedure. Three patients were lost to follow-up. Four patients went to surgery at an average of 11 weeks after their nerve root block.

Statistical analysis revealed a significant improvement (decrease) in the mean level of pain severity after the injection (post- minus pre-), with a mean decrease of -4.59 ± 2.89 scale units (95% CI -5.48, -3.70, $P < 0.0001$). These results are shown in Table 3.

No patients had clinically worrisome immediate complications, signs of intra-arterial injection of a local anesthetic, such as anterior spinal artery syndrome or seizure, or new neurologic deficits. One patient's pain score increased from 6 to 7 after a block, but the patient had complete relief after a later block at a different level. No patient is known to have developed a spinal hematoma or abscess. No complications other than minor soreness were reported at follow-up visits.

Discussion

The results show that cervical selective nerve root blocks administered from a posterior approach with an extraforaminal injection can identify the involved nerve roots in appropriate patients. One milliliter of one percent lidocaine was used as a test dose to rule out embolization of the anterior spinal artery. This dose may reach more than one spinal nerve root using a transforaminal approach, but that result is less likely than if an extraforaminal technique is used. However, responses from blocks must be interpreted with patient history, physical examination, imaging, and electrodiagnostic studies in mind before reaching conclusions about symptomatic levels of spinal pathology. Only 4 patients in this series went to surgery. All 4 experienced significant relief associated with blocks and surgery. Although taking the posterior approach to selective

Table 2. *Number of patients with each primary diagnosis.*

Diagnosis	Disk Herniation	Central Stenosis	Foraminal Stenosis	Central and Foraminal Stenosis	Radiculitis	Procedure Not Performed
Number of Patients	5	6	18	17	1	3

Table 3. *Change in mean levels of pain severity from pre- to post-injection.*

Outcome	n	Pre-Injection	Post-Injection	ΔM	95% CI ΔM	*P* value
		M (SD)	M (SD)	M (SD)		
Pain Severity	43	5.2 (2.6)	0.6 (1.8)	-4.6 (2.9)	-5.5 to -3.7	< 0.0001

Note. M = sample mean; ΔM = mean change in pain severity. Change was operationally defined as post-injection minus pre-injection level.

nerve blocks appears to identify the symptomatic nerve, the number of patients in this study who went to surgery is too small to analyze whether posterior selective nerve blocks are useful for obtaining better surgical outcomes.

As with all diagnostic injections, the selective nerve root block technique raises the question of whether the response is placebo or nonspecific. One study reported a 78% response to a placebo injection for lumbar medial branch blocks (11). Therefore, overinterpreting immediate responses to diagnostic blocks is a risk that can be mitigated only with confirmatory injections (12).

One potentially confounding factor in this study was that patients received small doses of fentanyl during the procedure. The fentanyl dose, while small, could have contributed to false positive responses. Manchikanti et al (13) found that fentanyl sedation could contribute to false positive results but that the fentanyl was no likelier to cause a false positive result than was a placebo injection.

Systemic steroid effects are also a potential explanation for longer responses to injections. Nevertheless, 87% of patients in this study had immediate short-term relief after a first injection, which was consistent with a local anesthetic effect. Two more patients had immediate relief after a second injection at a different level, bringing the potential diagnostic success rate up to 91%.

This technique is endorsed for reducing the risk of injection into the vertebral and radiculomedullary arteries. The enhanced safety associated with the selective nerve root block comes from several factors.

The posterior approach avoids arteries at risk for impingement during a posterolateral, or transforaminal, approach (14,15). Furthermore, as shown in Fig. 7, a rare variant of the vertebral artery (represented by the blue arrow) has its course in a lateral position from a spiral malformation, close to a hypothetical needle path from an anterolateral approach for a cervical transforaminal injection (16).

Blunt needles have a decreased incidence of vascular puncture, particularly arterial puncture (9,17-19).

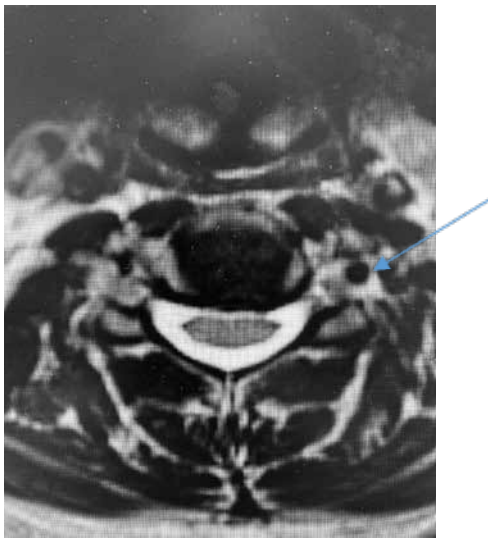

Fig. 7. *The vertebral artery (blue arrow) near the hypothetical path of a needle for a cervical transforaminal injection.*

While all vascular puncture is to be avoided, major adverse sequelae occur with arterial impingement. Generally, a curved blunt needle is preferred, since its ability to be steered makes it easier to position.

Because the presumed pathology causing the irritation of the nerve root would be in the spinal canal or foramen, one might hypothesize that a diagnostic injection would have to be intraforaminal to accurately assess whether a targeted nerve root was symptomatic. This study found that extraforaminal injections identified the involved nerve root successfully. Several studies corroborate our findings.

Although Wolter et al (20) found no correlation between extraforaminal contrast distribution and block failure or intraspinal contrast and block success, they found that the visual analog pain severity was reduced from 5.6 to 1.5. Yamauchi et al (21), using ultrasound-guided/nerve stimulator extraforaminal injections, reported pain scores of 65 before injection and 0 at 2 and 6 hours after injection. Cadaver studies

done under ultrasound guidance showed extraforaminal spreading only. In a study of extraforaminal cervical thoracic and lumbar selective spinal nerve root blocks, Mallinson et al (22) found no difference in pain relief based on contrast use or contrast spreading patterns. Furthermore, the sciatic nerve has been successfully injected in the gluteal region for sciatica originating in the spinal canal (23).

Several hypotheses about the reason for the effectiveness of extraforaminal injections have been presented. These are generally related to the therapeutic substances' modes of transport. A study by Mallinson et al (22) explained that the effectiveness was possibly related to local diffusion and the systemic effects of the injected medications. Yamauchi et al (21) hypothesized that the injected medications spread centrally due to hydrostatic pressure and osmotic effects. Manning et al (24) suggested that vascular connections between the nerve root and the epidural space allowed the transport of therapeutic medications, with vasodilatation, increased blood flow to the nerve root, and the washout of inflammatory substances being potential contributing factors.

Lymphatic transport has been suggested by animal studies, showing that dye can move from the nerve roots to the dorsal root ganglia and spinal canal via lymphatic connections (25). While lymphatic drainage usually flows out from the spinal canal, retrograde flow has been documented, and cellular, infectious, and chemical material can reach the CNS via lymphatic channels (26).

Axonal transport of steroids was shown by Froklis and Tanin, providing another possible explanation for the efficacy of extraforaminal injections (27).

Yet another explanation is simply the relief of peripheral symptoms. Many patients with cervical radicular pain have muscle spasms (28). A local anesthetic block of efferent pathways may relieve muscle spasms caused by cervical radiculopathy and provide analgesia for peripheral muscle spasms.

Yatziv and Devor have provided what may be the overarching, unifying explanation for the efficacy of extraforaminal selective nerve root blocks (29). They showed in a rat model that intraforaminal microdoses of low-dose lidocaine suppressed allodynia while sparing motor and sensory function. Yatziv and Devor hypothesized that the dorsal root ganglion was a significant generator of the ectopic barrage that drove neuropathic pain and that the microdosing of local anesthetics—but not opioids—suppressed that barrage. The mechanism of action of successful extraforaminal selective nerve root injections may be the suppression of ectopic activity of the dorsal root ganglion.

Evidence exists that suggests that some patients who have had successful selective nerve blocks are able to avoid surgery. In looking at patients who had been offered lumbar surgery and who were provided selective nerve root blocks, Riew found that 53% of the patients avoided surgery (30). Furthermore, of those patients who had not had surgery and were able to be followed up at 5 years, 81% still had not had surgery. Thus, selective nerve root injections may potentially play a role in the avoidance of operations. In our study, 10% of the patients went on to surgery. However, our study was not designed to evaluate surgical sparing, so no conclusions can be drawn from this study regarding whether patients who receive selective nerve root injections avoid surgery.

A rare complication of cervical selective nerve root injections that use sharp needles is respiratory depression from the local anesthetic (G. B. Racz, MD, verbal conversation, September 26, 2023) (17). The treatment for this complication consists of maintaining ventilation until spontaneous respiration returns. Because respiratory depression caused by cervical selective nerve root injections can take up to 30 minutes to occur, patients receiving this procedure should be monitored for 30 minutes after the injections. Note that while the monitoring can be done by ACLS-certified staff, the physician, for medical and legal reasons, should be present in the facility. A second rare complication is that injections given between 2 fused levels can result in epidural fluid loculation, pain, and spinal cord compression. The immediate treatment should be cervical flexion-rotation maneuvers that open the neural foramen and allow the injected fluid out and away from the cord. Syrinx formation can occur after epidural fluid loculation and spinal cord compression, so pain that follows injections should be evaluated promptly. If complications arise, consultation with available experts is recommended (31).

Conclusion

Extraforaminal cervical selective nerve root blocks that use curved blunt needles and a posterior approach appear to have utility in selectively identifying symptomatic nerves. This utility has applicability in making surgical determinations. The approach also minimizes the risk of entering the wall or lumen of an artery, thus potentially enhancing patient safety. Cervical posterior selective nerve root injections may help patients avoid

surgery, but further research is needed to assess this potential. Further research is also needed to assess whether these selective nerve root injections improve surgical outcomes.

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