

Osteopathic Musculoskeletal Examination and Subarachnoid Anesthetic Administration in a Patient With Severe Scoliosis

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Physicians primarily use palpation of anatomical landmarks to guide the placement of needles when administering neuraxial anesthetics. For patients with anatomical abnormalities such as scoliosis, it is also important for physicians to understand Fryette mechanics and spinal curvature anatomy, as well as preprocedural radiography and ultrasonography, to ensure accuracy in neuraxial anesthetic procedures. The authors report the case of a patient with severe scoliosis who required neuraxial anesthesia for total hip arthroplasty. Using palpation and imaging, his physicians were able to successfully administer a subarachnoid anesthetic injection on the first attempt. The authors discuss considerations for improving success rates of neuraxial anesthetic administration in these patients.

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Scoliosis is defined as a curvature in the coronal plane of the vertebral column. By convention, the lateral curvature must have a Cobb angle of 10° or more to be deemed scoliosis.¹ Scoliosis is divided into 3 categories: neuromuscular, congenital, and idiopathic. More than 80% of all scoliosis cases are adolescent idiopathic scoliosis.² The prevalence of adolescent idiopathic scoliosis is between 0.47% and 5.2%, with the adolescent form (ie, that developing at ages 11 to 18 years) accounting for approximately 90% of all idiopathic scoliosis cases in children.¹ Adult scoliosis has a prevalence of approximately 8% in US adults aged 25 years or older.¹ The female-to-male ratio ranges from 1.5:1 to 3:1, with the ratio increasing with age.¹

Distortions of normal anatomy, such as in patients with scoliosis, can pose challenges for physicians administering neuraxial anesthetics and increase the risk for failed procedures or complications. Landmark or palpatory methods are often the primary means used by physicians for determining needle placement during these procedures. For physicians using landmark or palpatory methods when administering neuraxial anesthetics, proper understanding of the spinal curvature anatomy is essential.³

We present the case of a man with severe scoliosis who required a subarachnoid anesthetic injection for left total hip arthroplasty. We also discuss methods for improving first-pass success rates for the administration of neuraxial anesthetics in patients with this condition.

Report of Case

A 62-year-old, 79-kg man presented for left total hip arthroplasty. His medical history included longstanding hypertension, dyslipidemia, obstructive sleep apnea, and idiopathic scoliosis. His surgical history included dental implants 1 year earlier, right total hip arthroplasty 4 years earlier, and appendectomy 8 years earlier. His medications at the time of the surgical procedure included acetaminophen-hydrocodone (325 mg-5 mg every 6 hours as needed), aspirin (81 mg daily), atenolol (50 mg daily), atorvastatin (20 mg daily), and hydrochlorothiazide (12.5 mg daily).

The patient was evaluated in the preoperative holding area, and a focused physical examination was completed. His right acromion process and left iliac crest were found to be in cephalic positions compared with the contralateral sides. A substantial spinal curvature was noted from spinal levels T12 to L4 during palpation of the spinous and transverse processes. Somatic dysfunction was diagnosed as T12 to L4 neural, sidebent right, and rotated left, with curvature apex at the L2 vertebra. Spinal rotation at the L2-L3 level was estimated at 35° using palpatory comparison of transverse processes. A previously obtained radiograph was reviewed (*Figure 1*), and levoscoliosis was confirmed, consistent with physical examination findings.

The patient was transferred to the operating room and an ultrasonography machine was brought in for standby. Midazolam (2 mg intravenously) was administered in divided doses to sedate the patient during the procedure. The patient was moved to a sitting position, and standard monitors were placed. After the back was prepared with a chlorhexidine-alcohol solution, anatomical landmarks were reconfirmed using palpation. An introducer needle was placed at the L2-L3 spinal level at an angle approximately 40° leftward from the apparent midline, as indicated by the L3 spinous process. A 25-gauge spinal needle (Sprotte, Teleflex Medical Inc) was passed through the introducer and entered the subarachnoid space on the first pass. Subarachnoid anesthesia was



Figure 1.

Spine radiograph showing severe S-shaped scoliosis involving primarily the lumbar and lower thoracic spine with severe, multilevel degenerative changes.

achieved with an injection of 0.75% hyperbaric bupivacaine (15 mg/2 mL) in 8.25% dextrose plus 200 µg of preservative-free morphine. Intravenous infusions of propofol (50 µg/kg/min) for sedation and ketamine (3 µg/kg/min) for additional analgesia were administered. The patient underwent the surgical procedure and recovery without complications, and he was discharged to home with a physical rehabilitation plan.

Discussion

Spines of patients with scoliosis typically follow the Fryette type I principle of physiologic spine motion.⁴ When zygapophyseal articulations are not engaged, type I mechanics dictate that sidebending of a group of vertebrae will rotate the individual vertebrae toward

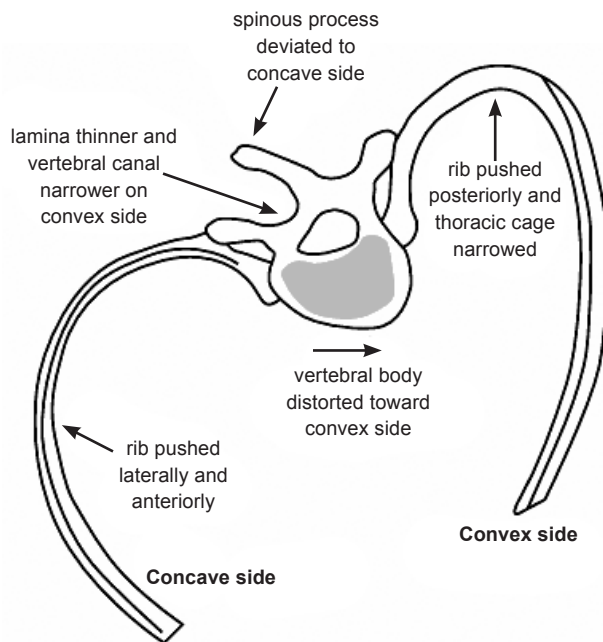


Figure 2.

Illustration of the spinal anatomical characteristics typically seen in individuals with scoliosis. Image from the University of Washington's *Musculoskeletal Atlas: A Musculoskeletal Atlas of the Human Body* by Carol Teitz, MD, and Dan Graney, PhD. Copyright 2003-2004 University of Washington. All rights reserved including all photographs and images. No reuse, redistribution, or commercial use without prior written permission of the authors and the University of Washington.

the side of convexity. Therefore, when administering neuraxial anesthetics to a patient with scoliosis, the physician should angle the needle laterally as the needle enters the space just superior to the spinous process within the convex curve. This technique will allow the needle to enter the subarachnoid space at the level of the rotated vertebrae. The amount of lateral angulation needed is dependent on the results of the osteopathic musculoskeletal examination and the severity of the scoliosis. Tactile examination of the transverse processes can help the physician determine the degree of vertebral rotation and therefore the expected angle from the spinous process to the subarachnoid space. However, the assessment of bony asymmetry in the lumbar region has been found to be unreliable.⁵ Therefore, physicians may consider the use of imaging modalities such as ultrasonography in cases in which procedural difficulty is anticipated.

Scoliosis causes vertebral structural changes that result in asymmetric transverse processes. Therefore, a perpendicular path from these transverse processes may not intersect with the subarachnoid space. This type of spinal structure is shown in *Figure 2*. In spines of patients with scoliosis, the concave side has a narrower vertebral canal with thinner pedicles than the convex side. Transverse processes of these spines are abnormal and skewed, with the spinous process being deviated to the concave side.

Spines with structural curves of 30° or less typically have minimal rotational changes, and physicians can use standard techniques during administration of neuraxial anesthetics.⁶ For spines with larger curves, physicians will need to rely on their tactile examination skills, Fryette mechanics, and understanding of spinal structural changes caused by scoliosis to determine the appropriate technique for neuraxial anesthesiology. In spines of patients with moderate to severe scoliosis, the ideal angle of the needle will be slightly lateral to a perpendicular path from the transverse processes. This angle will be slightly toward the side of convexity, with the needle aimed where interlaminar spaces are larger. An example of this needle path is shown in *Figure 3*. Tactile feedback of the needle during the procedure can assist the physician in guiding the needle in the direction of the interspinous ligament toward the subarachnoid space.

In addition to using osteopathic musculoskeletal examination findings and the Fryette principles, physicians should use imaging studies to successfully administer neuraxial anesthetics in patients with scoliosis. Radiography is required to confirm the diagnosis of scoliosis, with plain-film radiography commonly performed in the evaluation of these patients. Patients with a known history of scoliosis may likely have already had radiographic evaluation, the findings of which may be helpful for physicians to review before performing neuraxial procedures. However, the use of imaging to plan an approach at a specific level is not foolproof, as physicians may not correctly identify the planned interspace.⁷

Ultrasonography can also help improve success rates of neuraxial anesthetic administration in patients with scoliosis.⁸ The use of ultrasonography during preoperative physical examination has been associated with fewer attempts at needle insertion during neuraxial anesthetic administration.⁹ Preprocedural ultrasonography also outperforms physical examination alone in determining the location of specific vertebral interspaces,⁹ particularly in patients with anatomical landmarks that are difficult to palpate. However, ultrasonography devices are expensive, can be time consuming, and can have a steep learning curve.^{10,11} In addition, because not all physicians have access to these devices,^{10,11} it is important for physicians to be able to locate anatomical landmarks using palpatory skills.

Conclusion

The administration of neuraxial anesthetics in patients with scoliosis can be complicated because of spinal column curvature from apparent midline and distortion of individual vertebrae. Anatomical palpation remains the primary method used by physicians to guide needles during neuraxial anesthetic procedures. Osteopathic musculoskeletal examination findings and knowledge of Fryette mechanics and spinal curvature anatomy may aid the physician in determining the ideal needle entrance point. For severe scoliosis, physicians should position the needle from the spinous process toward the subarachnoid space, slightly lateral from a perpendicular angle to the transverse processes. Preoperative radiographs may also aid the physician in procedural planning. Despite some drawbacks, ultrasonography may be especially beneficial for preoperative assessment and for procedural use in patients with scoliosis.

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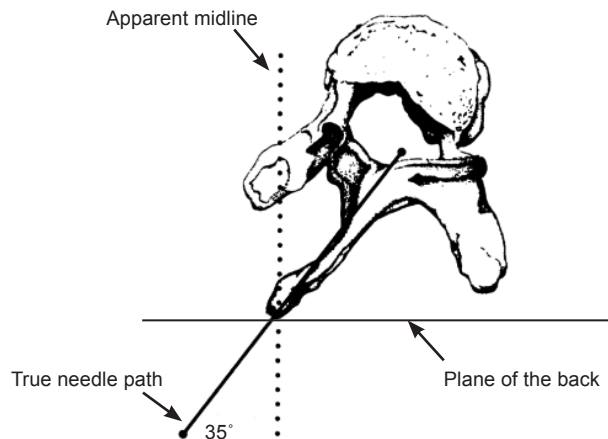


Figure 3.

Example of right-rotated moderate to severe scoliosis. The needle entry is at the apparent midline and the needle is angled toward the side of convexity. The needle angle is slightly lateral to the expected perpendicular path, determined using palpation of transverse process depth. Reprinted with the permission of Cambridge University Press: Disorders of the vertebral column. In: Gambling DR, Douglas MJ, McKay RSF, eds. *Obstetric Anesthesia and Uncommon Disorders*. 2nd ed. Cambridge, UK: Cambridge University Press; 2011:139.

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