

An approach to neuraxial anaesthesia for the severely scoliotic spine

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Editor's key points

- Computed tomography, corroborated with fluoroscopic images and ultrasound, was used to guide an epidural catheter in a patient with scoliosis.
- Importantly, the authors developed an algorithm to neuraxial anaesthesia in scoliosis.
- A systematic approach may improve the success rate of neuraxial anaesthesia in scoliosis.

We report on a case in which computed tomography was used to guide placement of an epidural catheter in a patient with severe scoliosis and congenital dwarfism. In addition, the computed tomograms were corroborated with ultrasound and fluoroscopic images in the patient. Three years later, the patient had a spinal anaesthetic performed with only the use of ultrasound-guidance. Ease of placement of the epidural and spinal was greatly enhanced by imaging. We present an algorithmic approach to neuraxial anaesthesia in the patient with scoliosis to help guide placement. The algorithm first directs the provider to determine the type and severity of the scoliosis from the patient's history, physical examination, and any prior radiologic studies. If the anaesthesia provider understands and is comfortable with the patient's anatomy, then the provider may cautiously proceed with placement. Depending upon the degree of lateral curvature (Cobb angle), idiopathic scoliosis is classified as mild (11–25°), moderate (25–50°), or severe (>50°). Mild idiopathic scoliosis is managed with good positioning. Moderate idiopathic scoliosis is managed with a paramedian approach on the convex-side of the curve or a midline approach with angulation towards the convex-side or with the aid of imaging such as ultrasound. Severe idiopathic scoliosis is managed with the assistance of imaging or an alternative form of pain management should be considered. A systematic approach may facilitate safe, efficient, and successful neuraxial anaesthesia procedures in the scoliotic patient.

Keywords: epidural; regional anaesthesia; safety; techniques; scoliosis; spinal

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Neuraxial anaesthesia is routinely performed without the aid of imaging modalities. In certain patient populations such as obesity or severe scoliosis, placement of epidural catheters without imaging may be difficult and potentially unsafe.¹ In these cases, the use of fluoroscopy, computed tomography (CT), or ultrasound may be beneficial. Of these imaging modalities, only ultrasound is portable, relatively inexpensive and free of ionizing radiation. Similar to fluoroscopy, ultrasound has the potential to be used in real-time. We report on a case in which all three of these imaging modalities were utilized to view the epidural space in a patient with severe scoliosis and congenital dwarfism. This case highlights the value of a systematic approach when performing neuraxial anaesthesia in the patient with severe scoliosis. The authors obtained Institutional Review Board approval and written permission from the patient to report the case.

Case report

A 56-yr-old female, ASA III, presented for a pelvic exenteration and hysterectomy for an invasive rectal adenocarcinoma. The

patient had previously received radiation treatment and chemotherapy. She was 142 cm tall and weighed 37 kg. Her past medical history was notable for scoliosis, congenital dwarfism, lumbar degenerative disc disease, and hypertension. The patient had severe dextrorotatory thoracic scoliosis with a Cobb angle of 60° (Fig. 1) and a compensatory laevorotatory lumbar curve of 40° (Fig. 2). However, she had preserved pulmonary function without evidence of restriction or obstruction, and her coagulation studies were normal. A preoperative epidural was planned to facilitate extubation and manage postoperative pain.

Computed tomograms of the lumbar spine, which were performed for the patient's surgical workup, were reviewed. It was noted that the L1–2 interspace could be easily penetrated by starting 1.5 cm left of the spinous process (convex-side of curve) and proceeding to a depth of ~4 cm from the skin using a paramedian approach (Fig. 3). The patient was placed in a sitting position, and the spinous process was identified by palpation, counting from the intercrystal line. An 18 gauge Tuohy needle was placed with one needle pass in the suspected L1–2 epidural space along the trajectory identified by CT, no

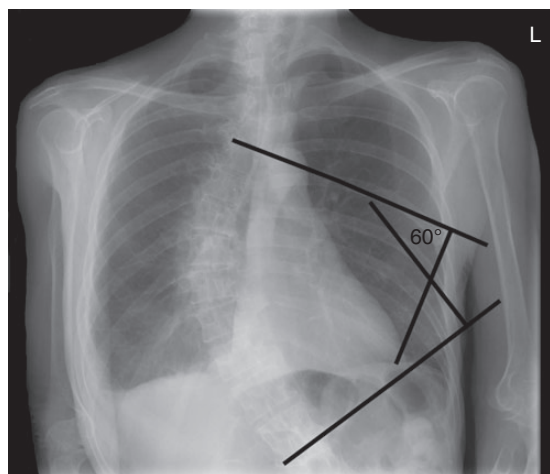


Fig 1 Chest radiograph demonstrating dextrorotatory thoracic scoliosis with a Cobb angle of 60°.

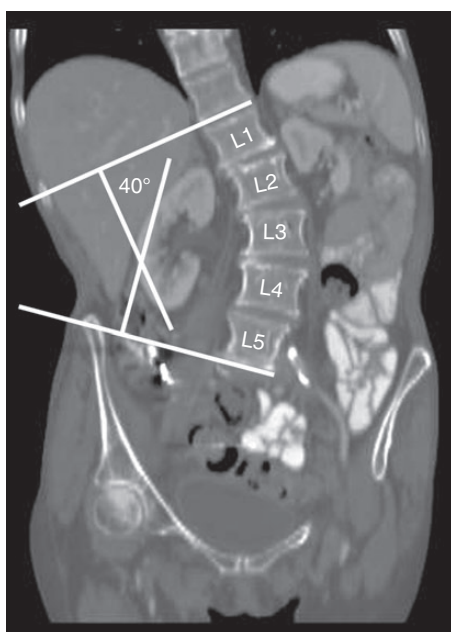


Fig 2 Coronal computed tomogram demonstrating a compensatory lumbar curve with a Cobb angle of 40°.

paresthesias were elicited. Loss of resistance occurred at 4.5 cm. The epidural catheter was advanced 5 cm past the tip of the needle and secured 9.5 cm at the skin. Administration of a test dose (3 ml of 1.5% lidocaine with 1:200K epinephrine) was negative for intravascular and intrathecal injection.

The patient was taken to the operating room where her surgical procedure was performed without complication. At the conclusion of the case, fluoroscopy was done with Omnipaque contrast dye, which revealed correct placement of the catheter

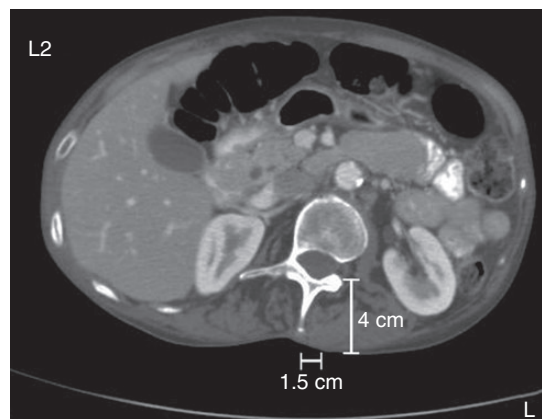


Fig 3 Transverse computed tomogram demonstrating L2 vertebral body rotation and pathway for paramedian approach to the epidural space.

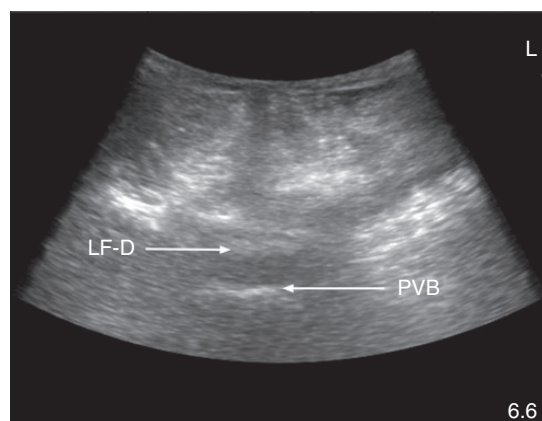


Fig 4 Transverse ultrasound image depicting anatomy consistent with the transverse computed tomogram. LF-D, ligamentum flavum-dura mater complex; PVB, posterior vertebral body.

at the L1–2 epidural space. More of the dye distributed to the left than the right, and clinically the patient's block was greater on the left than the right. However, the patient had excellent pain control while the epidural catheter was in place. The catheter was discontinued on postoperative day three without sequelae.

After the catheter was removed, an ultrasound examination was performed. A portable ultrasound machine (MicroMaxx, SonoSite, Bothell, WA, USA) and a 2–5 MHz curved array probe (C60, SonoSite, Bothell, WA, USA) was used for the evaluation. Longitudinal paramedian and transverse views of the L1–2 interspace were obtained. The ultrasound images displayed anatomy that was consistent with the computed tomograms, including the rotation of the vertebral body and the depth of the epidural space (Fig. 4).

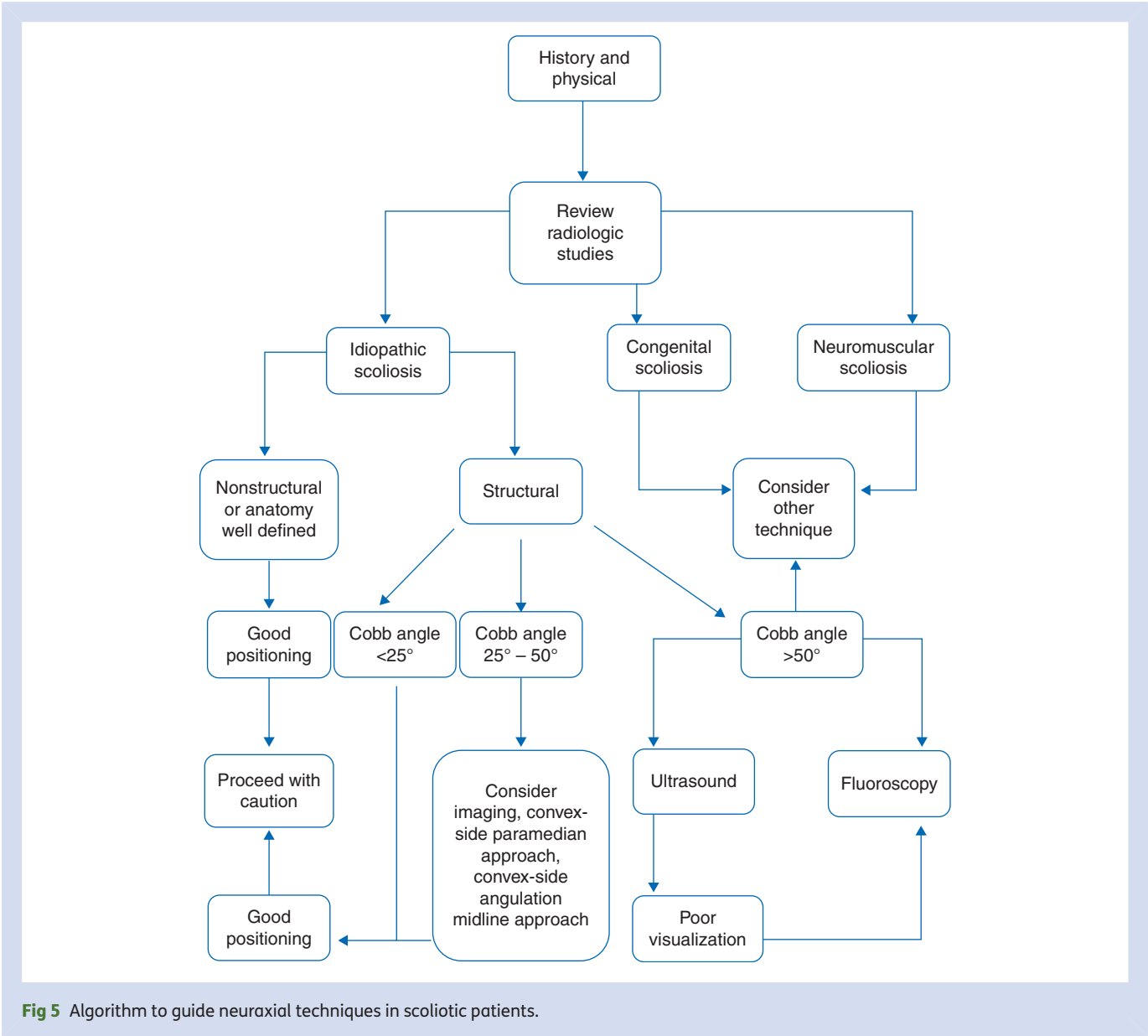


Fig 5 Algorithm to guide neuraxial techniques in scoliotic patients.

Three years later, the patient presented for a left total hip arthroplasty after being diagnosed with left hip avascular necrosis, and femoral neck and acetabular fractures secondary to radiation necrosis. The patient's scoliosis had progressed, with the thoracic curve Cobb angle measuring 72°. She was taken to the operating room where only an ultrasound machine was utilized to facilitate placement of a spinal at the L3–4 level. Using a 22G Quincke needle, two passes of the needle were needed to enter the spinal space using a convex-side paramedian approach, no paresthesias were elicited. Free flow of cerebrospinal fluid was observed at the needle hub and 3 ml of isobaric 0.5% bupivacaine was injected. The spinal anaesthetic was adequate for the surgery, with sedation provided by a propofol infusion. There were no post-operative complications.

Discussion

The scoliotic spine poses a unique challenge for the anaesthesia provider, and may complicate general or regional anaesthesia. Scoliosis is broadly classified into three categories: congenital, neuromuscular, or idiopathic. Scoliosis is defined as lateral curvature of the spine of >10°. The degree of lateral curvature is determined by the Cobb angle.² The Cobb angle is measured between the most tilted vertebral bodies in the coronal plane. A line is drawn parallel to the superior end plate of the cephalad vertebrae with the greatest angulation. A second line is drawn parallel to the inferior end plate of the caudal vertebrae with the greatest angulation. A perpendicular line is drawn from each of these lines, which creates the Cobb angle (Fig. 1). In addition to the lateral curvature in idiopathic scoliosis, there is also rotation of the vertebral

bodies. Anatomically, the spinous processes point towards the midline (concave-side) and the vertebral bodies rotate towards the convex-side of the curve.³ A strong linear relationship exists between the Cobb angle and vertebral rotation in both thoracic and lumbar curves in untreated patients, and maximum rotation occurs at the apex of the scoliotic curve.⁴

Difficulty in performing neuraxial anaesthesia may result in neural injury, spinal haematoma, post-dural puncture headache, or infection.^{5–8} In addition, it may decrease procedure efficiency and increase patient discomfort and dissatisfaction. It also has been shown that anatomic deformity is an independent predictor of difficulty in performing neuraxial anaesthesia.^{9–12} Utilizing ultrasound in patient populations at high risk for difficult placement may improve the success rate.¹³ The bony anatomy of the vertebral spine makes it more difficult to visualize structures in this region; however, even ultrasound can provide enough anatomic detail to ascertain the location, depth, and angle needed to successfully place a spinal or epidural catheter.^{11,14}

The following is an algorithmic approach to providing safe neuraxial anaesthesia procedures in the scoliotic patient (Fig. 5). First, the provider should determine the type and severity of the scoliosis from the patient's history, physical examination and any prior radiologic studies. Patients that have neuromuscular or congenital scoliosis have to be evaluated carefully. In the case of neuromuscular scoliosis, the curves may be so complicated that placement is unsafe. Congenital scoliosis occurs when one or more vertebral components (vertebral bodies, pedicles, or laminae) are missing or maldeveloped.¹⁵ This could increase the risk of injury to neural structures. If the anatomy is straightforward and well understood in congenital or neuromuscular scoliosis, then the provider could cautiously proceed, but often these are complex scoliotic curves and consideration should be given to using a different technique for placement or pain management. Almenrader placed epidural catheters under direct visualization at the end of reconstructive, non-idiopathic scoliosis surgery.¹⁶

Idiopathic scoliosis is classified as nonstructural or structural. If the scoliosis can be corrected by positioning (non-structural scoliosis) or if the anatomy is well-defined, then the provider should proceed with the neuraxial procedure, utilizing good positioning, and caution. Structural scoliosis is a rigid curve, which cannot be modified significantly by postural manoeuvres. Surgical therapy for structural scoliosis is based on the severity of the curve and probability that the curve will progress.² Mild scoliosis (11–25°) is observed, moderate scoliosis (25–50°) with likely progression in the skeletally immature is braced, and severe scoliosis (>50°) is treated with surgery. Based on these same parameters which indicate increasing complexity of scoliosis, we make the following recommendations. For mild scoliosis, the provider should proceed with the neuraxial procedure using good patient positioning and caution. In moderate scoliosis, the provider should consider imaging modalities such as ultrasound or fluoroscopy. As the vertebral body rotates towards the convex-side of the scoliotic curve, a direct path to the neuraxial spaces occurs on the

convex-side when using a paramedian approach. Therefore, if the spinous process is palpable or can be identified with a needle, then a paramedian approach could be attempted on the convex-side of the curve.^{17,18} If a midline approach is used, the spinal needle should be angled in the transverse (axial) plane towards the convex-side of the curve.¹⁹ In patients that have scoliotic curves with a Cobb angle >50° and unclear anatomy, imaging modalities should be used for neuraxial access or a different mode of pain management should be considered. As ultrasound does not use ionizing radiation and is more portable, it would be the first choice for an imaging modality. If visualization is not adequate with ultrasound, then fluoroscopy could be used. The first author has successfully used the algorithm in five additional scoliotic patients. Further research and experience is needed to validate this algorithm; however, it provides a systematic approach to performing neuraxial anaesthesia in the scoliotic patient, which may improve efficiency, success, and reduce injury.

Authors' contributions

C.B.: data collection, algorithm design, manuscript preparation, and approved final manuscript. K.H.D.: data collection, manuscript preparation, and approved final manuscript. C.J.D.: manuscript preparation, and approved final manuscript. J.M.C.: algorithm design, manuscript preparation, and approved final manuscript.

Declaration of interest

None declared.

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