Neuraxial anesthesia for scoliosis and previous spinal surgery in pregnancy

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QUESTIONS

Before continuing, try to answer the following questions. The answers can be found at the end of the article, together with an explanation. **Please answer True or False:**

1. Regarding scoliosis:
a. Adolescent idiopathic scoliosis (AIS) is the most common subtype affecting 1-3% of children aged 10-16 years
b. The Cobb angle is a measure of the lateral curvature of the spine
c. The Cobb angle is measured based on physical exam
d. Males are more commonly affected than females
e. Early pre-operative evaluation and testing is important

2. Physiologic and anatomic changes that may be seen in scoliosis include:
a. Obstructive lung disease
b. Altered airway anatomy
c. Left ventricular hypertrophy
d. Pulmonary hypertension
e. Cor pulmonale

3. Regarding neuraxial anesthesia for a patient with a history of scoliosis:
a. Neuraxial anesthesia is contraindicated due to the high risk of neurologic damage
b Surgical correction of scoliosis presents additional challenges
c. Epidurals have been shown to be more effective in providing an adequate block than a single shot spinal
d. Epidurals should be the last resort for labor analgesia in this group of patients
e. Ultrasound-guidance can be helpful

Key Points

- Scoliosis has a reported overall incidence of approximately 2%; adolescent idiopathic scoliosis (AIS) is the most common type
- A patient with a history of scoliosis requires a thorough pre-anesthesia evaluation
- Whether corrected or uncorrected, altered anatomy in scoliosis may make neuraxial procedures difficult and may result in inadequate analgesia or anesthesia
- Neuraxial anesthesia may have particular advantage in parturients with scoliosis; they are more likely to have an operative delivery and are at increased risk from general anesthesia

INTRODUCTION

Scoliosis has an incidence of approximately 2% in the general population with a higher frequency in females. It is therefore important for an obstetric anesthesiologist to be familiar with the implications of scoliosis and to know how to optimize safe anesthetic management[1, 2]. This tutorial provides an overview of scoliosis including the unique anatomic and physiologic considerations that may be present. The feasibility of neuraxial anesthesia in a parturient with scoliosis or previous spinal surgery is discussed with emphasis on challenges and complications. Alternative approaches to neuraxial anesthesia are also presented, including the benefit of using an ultrasound guided technique to assist with neuraxial placement.

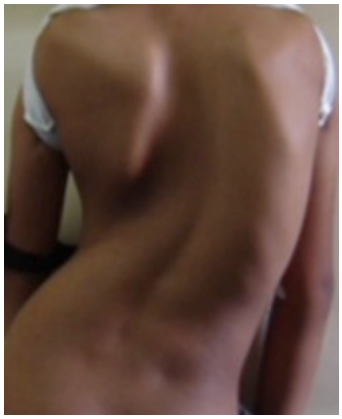
WHAT IS SCOLIOSIS?

Scoliosis is defined as 'a lateral curvature of the spine' (Figure 1). The word "scoliosis" originates from a Greek word meaning curved or bent. Scoliosis can be classified as either primary (idiopathic) or

secondary (resulting from a disease process). The most common type of scoliosis is adolescent idiopathic scoliosis (AIS), which accounts for approximately 70% of cases[1]. The incidence of AIS is 1-3% in children aged 10 to 16 years[1]. In AIS, the curvature of the spine classically presents around the time of puberty in an adolescent who has no history of prior spinal abnormalities[1]. There are a multitude of causes of secondary scoliosis (Table 1). The incidence of scoliosis is higher in females than males, with a ratio of 3.6:1[1].

- **Neuromuscular (cerebral palsy, spina bifida, poliomyelitis)**
- **Metabolic (Hunter's syndrome)**
- **Congenital malformations (hypotonia)**
- **Osteoporosis**
- **Tuberculosis**
- **Trauma**
- **Malignancy**
- **Dysmorphic syndromes (Marfan's syndrome, osteogenesis imperfecta, neurofibromatosis)**

Table 1. Causes of secondary scoliosis[4]



A diagnosis of scoliosis is often made clinically, but the grading of scoliosis requires imaging. A simple anteroposterior radiograph allows the Cobb angle to be measured, which represents the degree of lateral curvature. To determine the Cobb angle, the most tilted vertebra above and below the curve are identified. A parallel line is drawn from the superior aspect of the uppermost affected vertebra and from the inferior aspect of the lowermost affected vertebra. The angle made by the intersection of these two lines is the Cobb angle (Figure 2). A conservative versus surgical approach is based on the degree of curvature and on the rate of progression[2]. Surgery is typically indicated for a Cobb angle greater than 40° in the lumbar spine or greater than 50° in the thoracic spine[6]. Spinal fusion is the most common form of corrective surgery, which is performed in an attempt to prevent cardiopulmonary complications such as pulmonary hypertension and right ventricular hypertrophy.

Figure 1. Photograph of a patient with scoliosis[3]

Regardless of whether surgical correction has been performed, patients with severe scoliosis may have significant musculoskeletal or cardiopulmonary disease (Table 2). These may be the cause of scoliosis (e.g. secondary scoliosis from muscular dystrophy or spina bifida) or as a mechanical result of scoliosis (e.g. reduced neck flexion or restrictive lung defect). Existing airway, cardiac and pulmonary symptoms due to scoliosis may be further exacerbated by the anatomic and physiological changes of pregnancy[6].

System	Conditions
Airway	Altered airway anatomy, difficult laryngoscopy and intubation
Respiratory	Restrictive lung disease, pulmonary hypertension, hypoxic pulmonary vasoconstriction
Cardiac	Cor pulmonale, right ventricular hypertrophy, cardiomyopathy

Table 2. Cardiorespiratory conditions as a result of scoliosis[1]

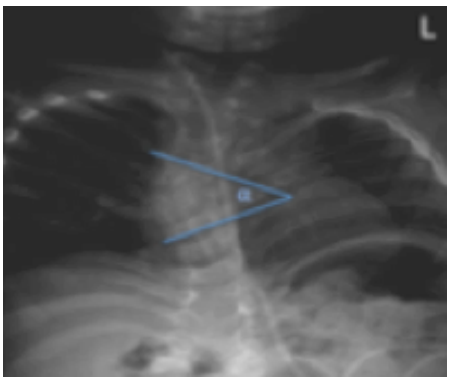


Figure 2. X-ray image displaying the Cobb angle[5]

GENERAL ANESTHESIA IN PATIENTS WITH SCOLIOSIS

In patients with scoliosis, early preoperative evaluation is important to identify musculoskeletal and cardiopulmonary disease by taking a thorough history, performing a physical exam and obtaining a diagnostic work up including an echocardiogram and pulmonary function tests. Additionally, spinal imaging should be reviewed in advance and anesthetic considerations should be discussed with the parturient.

Given the physiologic and anatomic changes present in patients with severe scoliosis, maternal morbidity and mortality are higher with cesarean section under general anesthesia compared with neuraxial anesthesia[2]. There are some instances where general anesthesia may be more appropriate, such as: maternal preference; severe maternal cardiopulmonary disease; and unsuccessful neuraxial anesthetic technique[6].

NEURAXIAL ANESTHESIA IN PATIENTS WITH SCOLIOSIS

Patients with scoliosis are likely to benefit from neuraxial analgesia during labor as it provides an anesthetic option if an operative delivery is required. Parturients with scoliosis are at an increased risk of an operative delivery due to cephalo-pelvic disproportion with a rate of cesarean section or instrumental delivery 2.5 times the rate in parturients without scoliosis[7]. However, neuraxial procedures are potentially technically difficult and may not function effectively.

A recent literature review reported 117 neuraxial procedures attempted in 103 parturients (24 with uncorrected scoliosis and 93 with surgically corrected scoliosis)[2]. Rates of success of epidural and intrathecal techniques were 79% in the uncorrected group and 69% in the corrected group. The majority of failed techniques in the uncorrected group were due to patchy/asymmetric blocks, while in the corrected group the majority of failures were due to difficult placement. Overall, this study showed there is a relatively high success rate with neuraxial placement although it may take more attempts or require more trouble-shooting than in a patient without scoliosis[2].

Scoliosis distorts the anatomical landmarks used to identify the midline of the back (spinous processes) and level of insertion for neuraxial procedures (iliac crests)[2]. This makes neuraxial procedures more difficult, increases insertion time and the number of attempts required, as well as the failure and complication rates.

Prior to performing any neuraxial procedure, a thorough history and physical examination should be undertaken to elicit the type and severity of scoliosis. Previous imaging studies should be reviewed and formal studies should be obtained if this is lacking. The analgesic and/or anesthetic options and the associated risks and benefits should be discussed with the patient. It is important to discuss the increased possibility for failure of the technique resulting in inadequate analgesia, and also a potential increase in the complication rate including dural puncture, high block and nerve injury[8].

In uncorrected scoliosis, the midline of the epidural space is directed towards the convex side relative to the spinous processes, therefore the needle should be directed towards the convexity of the curve where the spaces between the vertebrae are larger allowing easier needle entry[2].

An algorithm based on the severity of the scoliosis has been suggested to help guide neuraxial anesthesia in parturients (Table 3).

Degree of Scoliosis	Neuraxial Technique Suggestions
Mild (Cobb angle 11-25°)	If the provider is confident with the anatomy, proceed cautiously with good positioning
Moderate (Cobb angle 25-50°)	Proceed with either: 1) A paramedian approach on the convex side 2) A midline approach with angulation towards the convex side 3) An imaging technique such as ultrasound
Severe (Cobb angle >50°)	Imaging such as ultrasound or fluoroscopy should be used to assist in safe placement with a low threshold for alternative pain management options

Table 3. Guide for neuraxial techniques in patients with scoliosis[9]

NEURAXIAL ANESTHESIA FOR PATIENTS WITH PREVIOUS SPINAL SURGERY

Prior spinal surgery, including surgical correction of scoliosis is not a contraindication to neuraxial anesthesia. There are, however, additional challenges to neuraxial anesthesia techniques after prior spinal surgery due to the anatomic changes. Bone graft and screws can cause scar tissue and adhesions, which may obliterate or hinder access to the epidural space. Previous surgery may also distort the epidural space interfering with spread of local anesthesia resulting in a patchy or unilateral block[2]. Spinal fusion with stiff rods (Figure 3) hinders pre-procedural patient positioning, reducing the patient's ability to flex their spine and open the interspinous spaces[8]. Choosing a level for insertion above or below the surgery may minimize these challenges and complications but does not exclude them completely[2]. Each patient must be evaluated on an individual basis to determine if it is appropriate to attempt a neuraxial technique.

Figure 3. X ray image displaying spinal instrumentation[10]

PRE-EXISTING NEUROLOGICAL DEFICITS

A pre-existing neurological deficit in a patient with a corrected or uncorrected spinal condition is a relative contraindication to neuraxial procedures. Performing a neuraxial technique on a patient with pre-existing neurological deficit may result in further nerve damage from needle and/or catheter placement or vasopressor-induced neural ischemia[8, 11, 12]. If a provider decides to proceed with neuraxial anesthesia, it is important that these risks are discussed

with the patient and that pre-existing neurologic deficits are accurately assessed and documented prior to the technique being performed. Following a neuraxial technique, neurological recovery should be actively assessed and documented and any new neurological changes promptly investigated[11].

LABOR ANALGESIA

What is the best approach?

While it is common practice to proceed with neuraxial anesthesia in a parturient with scoliosis or prior spinal surgery, it is controversial whether the best approach is an epidural, CSE or single shot spinal. There are no prospective randomized trials comparing these techniques in this context. CSE or single shot spinal anesthesia may offer an advantage to epidural anesthesia[2]. CSF flow is a more definite confirmation of placement than loss of resistance. Following back surgery there are potential planes that could be interpreted as a false loss of resistance. Additionally, injection of the local anesthetic into the CSF provides more reliable spread. Bypassing the 'distorted' epidural space completely eliminates factors that may contribute to the possible failure of the epidural catheter technique[2, 8]. In a patient with scoliosis who has had a failed epidural catheter or where the quality of block is inadequate, a single shot spinal or even a spinal catheter is a worthwhile alternative to consider if time allows.

Ultrasound-guidance for neuraxial placement

Reports on the use of pre-puncture ultrasound for assisting in identification of the epidural space in patients with scoliosis or previous spinal surgery are promising. The advantages include: identification of midline of the spine; estimation of the depth of the epidural; and anticipation of the needle trajectory[13]. Success is dependent on the technician's skill and experience so it is important for the user to practice ultrasound on parturients with normal spinal anatomy prior to attempting it on patients with abnormal anatomy. There is evidence that ultrasound improves epidural insertion success rates while decreasing the number of attempts required and increasing patient safety.

Trouble-shooting the epidural

One common problem encountered with epidural placement in a patient with scoliosis or prior spinal surgery is that the block may be patchy or unilateral. If this occurs, repositioning the patient prior to further boluses of local anesthetic may help[2]. An alternative is to perform a combined spinal-epidural (CSE), this is particularly useful if adhesions from previous surgery are considered to be causing the patchy block.

The epidural should be placed *early* so that there is time to make adjustments before an emergent situation arise that may require a cesarean section.

Alternatives to neuraxial analgesia

There are a variety of pharmacological and non-pharmacological alternatives for labor analgesia, however they are less effective than neuraxial procedures. Pharmacological options including inhaled nitrous oxide/oxygen (50:50) or patient-controlled-analgesia (PCA) containing a fast-acting narcotic such as fentanyl or remifentanil[14]. Ketamine infusions have also been described. Non-pharmacological alternatives for labor pain include transcutaneous electrical nerve stimulation (TENS), acupuncture, acupressure, birth ball, water immersion and hypnosis. These do not completely alleviate the discomfort but may help women cope better with labor pain.

SUMMARY

Patients with scoliosis and/or prior spinal surgery present significant challenges for the anesthesiologist. A pre-operative assessment and workup is necessary to guide clinical judgment and identify associated cardiac and/or pulmonary conditions. Despite the challenges, it is possible to successfully achieve neuraxial analgesia/anesthesia in the majority of parturients with scoliosis with or without corrective surgery. However, despite best efforts it may not be possible to establish an adequate block and general anesthesia may be required for an operative delivery.

ANSWERS TO QUESTIONS

1. Regarding scoliosis:

a. True: Adolescent idiopathic scoliosis (AIS) is the most common type representing approximately 70% of cases
b. True: The Cobb angle is a measure of the lateral curvature of the spine
c. False: The Cobb angle is measured based on imaging, typically an anteroposterior radiograph
d. False: Scoliosis is more common in females than males
e. True: Early pre-operative evaluation and testing is important for planning due to co-morbidities

2. Physiologic and anatomic changes that may be seen in scoliosis include:

a. False: Severe scoliosis can result in restrictive lung disease
b. True: Severe scoliosis (and some causes of secondary scoliosis) can result in altered airway anatomy making intubation difficult
c. False: Severe scoliosis can result in right ventricular hypertrophy
d. True: Severe scoliosis can result in pulmonary hypertension
e. True: Severe scoliosis can result in cor pulmonale

3. Regarding neuraxial anesthesia for a patient with a history of scoliosis:

a. False: Neuraxial anesthesia is the preferred technique due to higher mortality with general anesthesia
b. True: Surgical correction of scoliosis presents additional challenges due to scar tissue
c. False: Data is unclear but a single shot spinal is likely to provide better spread of local anesthetic and a more dense block
d. False: Epidurals should be placed early to allow time for trouble-shooting
e. True: Ultrasound-guidance can be helpful

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