Case Report

DOI: 10.7860/JCDR/2025/77196.21482

Anaesthesia Section

Successful Spinal Anaesthesia in Severe Kyphoscoliosis Patient for Knee Surgery: A Case Report

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ABSTRACT

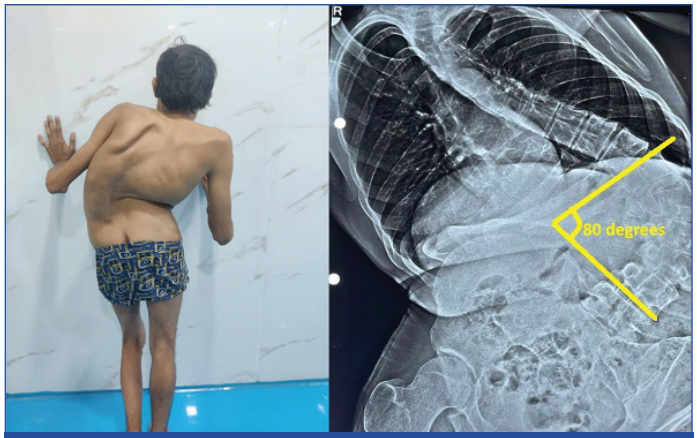
Kyphoscoliosis, a complex spinal deformity, presents unique challenges in the perioperative management of patients requiring general anaesthesia as well as neuraxial anaesthesia. General anaesthesia in patients with kyphoscoliosis is challenging due to difficult airway management, reduced lung capacity, and altered pulmonary and cardiovascular mechanics, all of which increase the risk of respiratory and haemodynamic complications. Moreover, the spinal deformity complicates positioning and affects the administration of neuraxial anaesthesia, requiring careful preoperative planning and close intraoperative monitoring. We discuss a case involving a 32-year-old male with a history of childhood kyphoscoliosis, diagnosed with a left Anterior Cruciate Ligament (ACL) tear. He had no neurological abnormalities and no other complaints apart from localised pruritus in the lower abdomen. Upon evaluation, the Cobb angle measured 80° on the X-ray of the spine, and he had moderate pulmonary hypertension observed in a Two-Dimensional (2D) echocardiogram, along with restrictive lung disease without obstruction noted on spirometry. After this assessment, ACL repair under spinal anaesthesia was planned. The common problems faced during the procedure included the identification of intervertebral spaces and unpredictable spread of the spinal anaesthetic. We report the successful anaesthetic management of an adult male with severe kyphoscoliosis scheduled for left arthroscopic knee surgery under spinal anaesthesia.

Keywords: Arthroscopy, Kobbs angle, Spinal deformity

CASE REPORT

A 32-year-old male weighing 45 kg and measuring 145 cm {Body Mass Index (BMI) of 21.4 kg/m^2}, a known case of kyphoscoliosis, presented with complaints of difficulty in walking and left knee pain following a road traffic accident. Magnetic Resonance Imaging (MRI) of the knee showed an ACL avulsion fracture requiring surgical correction. The patient had a long-standing history of idiopathic kyphoscoliosis since childhood [Table/Fig-1]. There was no sensory or motor deficit or disturbances in bowel and bladder function. He was able to lie down supine and walk independently. There were no other comorbidities or previous spine surgeries. He was haemodynamically stable, and an examination of the spine showed an S-shaped curvature. His airway was assessed as Mallampati class III. Bedside pulmonary function tests showed a negative cough test and wheeze test; the forced expiratory time was 4 seconds, Sabrasez breath-holding time was 33 seconds, and Snider's match test indicated the ability to blow out a candle at a distance of 19 cm. All routine blood investigations were within normal limits. A chest X-ray showed normal lung parenchyma with single major lumbar scoliosis convexity towards the left side. The Cobb angle was calculated to be 80 degrees [Table/Fig-1], which falls in the severe kyphoscoliosis category. The 12-lead electrocardiogram was normal, and the 2D echocardiogram indicated moderate pulmonary arterial hypertension. Spirometry revealed a restrictive pattern, with Forced Expiratory Volume in 1 second (FEV1) at 30% and Forced Vital Capacity (FVC) at 39%, without obstruction. Spinal anaesthesia using the landmark technique was planned for the procedure, keeping an ultrasonogram device on standby. General anaesthesia was avoided due to the potential for postoperative pulmonary complications and the need for mechanical ventilation after extubation. The patient was informed about the anaesthesia plan and the complications associated with general anaesthesia, including the possibility of postoperative ventilator support. Written informed consent was obtained from the patient.

On the day of surgery, an 18G intravenous (i.v.) cannula was secured in the preoperative room, and the patient was preloaded with



[Table/Fig-1]: A 32-year-old male patient with kyphoscoliosis (left). X-ray (PA view) of the spine measuring the Kobb's angle of 80° (right).

Ringer's lactate at a rate of 10 mL/kg. Operation room preparations included a difficult airway trolley, ventilation, and circulation support in case of high or total spinal anaesthesia. Inside the Operation Theater (OT), monitors were attached according to the American Society of Anaesthesiologists (ASA) standards {Electrocardiogram (ECG), SpO_2, non-invasive blood pressure, and non-invasive temperature monitoring}, and values were recorded. The baseline heart rate was measured at 98 bpm, Non-Invasive Blood Pressure (NIBP) was 112/70 mmHg, SpO_2 was 98% on room air, and the axillary temperature was 36.3°C. The patient was placed in the left lateral position. Palpation of the Intervertebral Spine (IVS) was performed by tracing the spine from the cervical region. The L2-L3 IVS was identified as suitable for spinal anaesthesia after palpation [Table/Fig-2].

Spinal anaesthesia was administered using a modified paramedian approach with a 25G spinal needle. After three needle passes on the convex side of the spine, the subarachnoid space was successfully accessed, confirmed by the free flow of Cerebrospinal Fluid (CSF) [Table/Fig-2]. Subsequently, 3 mL of 0.5% hyperbaric bupivacaine

[Table/Fig-2]: Local anaesthetic given to skin of L2-L3 intervertebral space prior spinal needle insertion (left). Flow of CSF confirming the needle at subarachnoid space in the convex side (right).

(15 mg) was injected, and the patient was positioned supine. To prevent aggravation of the pruritus that the patient experienced before the procedure and to avoid nausea, additives such as fentanyl were not added to the spinal drug. Surgery commenced after achieving adequate motor and sensory blockade up to the T8 dermatome, confirmed by the pinprick test. The spinal block was dense and effective, with no sparse effects. No intraoperative complications occurred. After two hours of surgery, the patient was shifted to the Postoperative Care Unit (PACU) and monitored until the sensory block regressed to the T12 dermatome. The patient had no evidence of post-dural puncture headache and experienced an uneventful recovery phase. Postoperative analgesia was achieved with Inj. Paracetamol 1 g every 12 hours, and the patient was discharged four days after the surgery.

DISCUSSION

Scoliosis is characterised by a sideways deviation from the spine's normal vertical alignment. This lateral curvature is accompanied by vertebral rotation, resulting in a three-dimensional spinal deformity that affects the sagittal, frontal, and coronal planes. Scoliosis is often associated with kyphosis. The severity of scoliosis can be assessed by measuring Cobb's angle using the Lipmann Cobb method. An angle of 10-20 degrees is considered mild, 21-40 degrees is moderate, and more than 40 degrees is classified as severe scoliosis [1].

The curved spinal anatomy, altered epidural and subarachnoid spaces, irregular CSF flow, difficulties with patient positioning, and technical challenges made performing spinal or epidural anaesthesia tricky and often unsuccessful. Neuraxial anaesthesia for surgeries below the umbilicus has been performed in patients with kyphoscoliosis in the past, and it has been reported to be safer than general anaesthesia [2]. Given these complexities, various approaches are employed, ranging from alternative needle insertion techniques such as paramedian, modified paramedian, and oblique paramedian, to the use of advanced imaging modalities like ultrasound and fluoroscopy [3] for successful spinal anaesthesia.

Once spinal anaesthesia is planned, a preoperative radiological evaluation of the entire spine (X-ray or MRI) by the anaesthesiologist is essential for identifying canal stenosis, locating the IVS, and detecting sclerotic changes that could affect the procedure [4]. The paramedian approach has been widely utilised as an alternative to the traditional midline approach, allowing for easier needle insertion by bypassing the rotated or difficult-to-locate spinous processes. Boon JM et al., concluded in their anatomical study on 36 cadavers that the modified paramedian approach for spinal anaesthesia involves inserting the needle perpendicularly to the back, lateral to the spinous process on the convex side of the spine. This method is considered superior to the traditional paramedian technique [5]. The needle is advanced toward the lamina and then "walked" cephalad (toward the head) until it reaches the interlaminar space. This approach helps avoid complications caused by rotated or displaced spinous processes in patients with kyphoscoliosis, making it a valuable alternative when the midline or standard paramedian techniques are not feasible.

Taylor's approach targets the L5-S1 interspace, which is often the least affected by the spinal deformities seen in kyphoscoliosis. By using this larger interspace, Taylor's approach increases the likelihood of successfully accessing the subarachnoid space for spinal anaesthesia [6], even in patients with severe spinal curvature. Ultrasound guidance has gained popularity as a non-invasive method to visualise spinal anatomy in real-time, aiding in precise needle placement and reducing the number of attempts required [5]. Similarly, fluoroscopy offers continuous X-ray imaging, allowing for accurate needle trajectory and placement, particularly in severely deformed spines [7].

The guidelines and algorithm proposed by Bowens C et al., provide a structured approach to neuraxial anaesthesia in scoliosis, which helps improve both the safety and success of the procedure [8]. This algorithm was used to draft the anaesthetic approach in our case. Specifically, we followed the recommendations for a paramedian approach on the convex side of the scoliotic curve, as the patient's severe kyphoscoliosis (80°) made this the optimal route for neuraxial access. However, ultrasound guidance—which the article suggests for severe scoliosis—was not utilised due to time constraints and familiarity with landmark-based techniques [8].

In patients with kyphoscoliosis, the spread of spinal anaesthetic drugs can be highly unpredictable due to altered CSF flow, which can lead to patchy blocks. The distorted vertebral anatomy increases the risk of inadvertent high spinal blocks or uneven distribution. The curvature of the spine may create asymmetrical gravitational effects, making it difficult to predict how the anaesthetic will distribute along the spinal axis. Additionally, the volume and compliance of the subarachnoid space may be abnormal, affecting the drug's spread. The extent of the sensory block is influenced by the upward spread of the local anaesthetic in the CSF and its absorption by neural tissues in sufficient quantities to induce the desired anaesthetic effect.

Lui AC et al., conducted a study using a spinal canal model and showed that baricity was a major factor in determining the distribution of lidocaine in the CSF [9]. Sakura S proposed that hyperbaric solutions can reliably create sensory blocks with a sufficient level of consistency, making them appropriate for surgeries conducted under spinal anaesthesia [10]. Due to the abnormal curvature and altered anatomy in kyphoscoliosis, the distribution of hypobaric solutions can be less predictable, potentially leading to inconsistent or patchy sensory blocks. Conversely, hypobaric drugs may float upwards in an unpredictable manner relative to the spinal deformity, making it harder to control the anaesthetic effect. This reduces the success rate, especially when trying to achieve uniform anaesthesia. Therefore, we opted to administer hyperbaric spinal anaesthetic in our case, as it is more reliable and consistent.

CONCLUSION(S)

With careful preoperative assessment, radiological evaluation, and precise technique, neuraxial anaesthesia remains a viable option for achieving effective anaesthesia and analgesia, leading to favourable outcomes. This case report contributes valuable evidence to the existing literature by demonstrating a unique and effective technique for administering spinal anaesthesia using the modified paramedian approach in a patient with kyphoscoliosis.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Dec 09, 2024
- Manual Googling: Mar 22, 2025
- iThenticate Software: Mar 25, 2025 (4%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Dec 07, 2024**
Date of Peer Review: **Jan 14, 2025**
Date of Acceptance: **Mar 27, 2025**
Date of Publishing: **Sep 01, 2025**