

Neuraxial Analgesia in a Parturient with Thoracolumbar Spinal Fusion and Other Comorbidities: An Interdisciplinary Peripartum Management Approach

Bushra Yasin*, Nitish Sharma, Jean Eloy, Ming Xiong

Department of Anesthesiology, Rutgers New Jersey Medical School, Newark, NJ, USA

Email: *bushrayasin@gmail.com

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Abstract

We present the case of a 31-year-old term parturient with a history of extensive thoracolumbar spinal fusion and a repaired anomalous origin of the left coronary artery from the pulmonary artery (ALCAPA), who requested epidural analgesia for vaginal delivery. Given her cardiac history, preprocedural intravenous fluid administration was intentionally avoided to minimize the risk of volume overload and hemodynamic compromise. Despite a midline surgical scar extending to L4, posterior spinal instrumentation from T2 to L2, and mild residual spinal curvature, all of which distorted surface landmarks and posed technical challenges to neuraxial access, the patient's anatomy was carefully evaluated. A lumbar epidural catheter was successfully placed at the L4 - L5 interspace using a median approach. A test dose confirmed correct placement without intravascular or intrathecal migration, and the initial bolus of local anesthetic was deferred to minimize the risk of abrupt sympathetic blockade. This case demonstrates the feasibility and safety of neuraxial labor analgesia in patients with coexisting spinal deformity and congenital cardiac disease, and underscores the importance of individualized anesthetic planning, meticulous technique, and multidisciplinary collaboration.

Keywords

Neuraxial Anesthesia, Epidural Block, Spinal Fusion, Scoliosis, Anomalous Coronary Artery, Congenital Heart Disease

1. Introduction

Neuraxial labor analgesia is widely regarded as the gold standard in obstetric an-

esthesia due to its efficacy and safety profile for both mother and fetus. However, its application becomes technically and physiologically challenging in patients with prior spinal surgery or congenital cardiac anomalies. Spinal fusion alters vertebral anatomy, distorts surface landmarks, reduces interlaminar space accessibility, and is associated with epidural fibrosis, all of which can impede successful epidural catheter placement. Additionally, the presence of congenital cardiac anomalies necessitates careful hemodynamic management during neuraxial blockade due to the risk of sympathetic denervation and consequent hypotension.

The presence of posterior spinal fusion can significantly reduce the success rate of neuraxial techniques. Anatomical distortion, multilevel instrumentation, and fibrotic changes within the epidural space can increase procedural difficulty, necessitate multiple needle passes, and result in failed or patchy blocks [1]. Furthermore, a retrospective study of patients with pre-existing spinal pathology reported a 1.1% incidence of new or worsening neurologic deficits following neuraxial blockade. This rate is substantially higher than that observed in the general obstetric population, where the incidence of permanent neurologic injury is estimated at less than 0.02%. While the absolute risk remains low, this finding underscores the importance of meticulous technique, appropriate risk stratification, and thorough informed consent in this patient population [2].

In addition, parturients with congenital heart disease require meticulous anesthetic planning due to their limited cardiovascular reserve. Neuraxial blockade can reduce the cardiovascular stress of labor but may also cause hypotension and decreased cardiac output, posing a significant risk in patients with impaired myocardial function. Given this patient's history of congenital heart surgery, mild pulmonary hypertension, and asthma, intravenous fluid preloading was intentionally avoided to minimize the risk of volume overload and hemodynamic instability [3].

This case underscores the importance of an individualized anesthetic approach in such patients, including cautious titration of neuraxial agents, avoidance of rapid bolus dosing, and vigilant hemodynamic monitoring to maintain cardiovascular stability throughout labor and delivery.

2. Case Presentation

A 31-year-old G4P3 woman, ASA III, presented at 38 week' gestation in early labor following spontaneous rupture of membranes. She was 162 cm tall and weighed 70 kg. The pregnancy was complicated by preeclampsia without severe features. Her obstetric history included one prior cesarean delivery performed under general anesthesia and a subsequent successful trial of labor after cesarean (TOLAC), during which neuraxial analgesia was withheld based on provider recommendation. For the current delivery, she was considered an appropriate candidate for vaginal birth and expressed a strong preference for epidural analgesia.

Her medical history was significant for congenital heart disease and scoliosis. She underwent surgical repair of an anomalous origin of the left coronary artery from

the pulmonary artery (ALCAPA) at six months of age. In adolescence, she was subsequently found to have developed cardiomegaly, mild pulmonary hypertension, asthma, and bibasilar atelectasis. Despite these findings, she remained functionally asymptomatic with preserved exercise tolerance. A recent echocardiogram demonstrated a left ventricular ejection fraction (LVEF) of 65%.

At 11 years old, the patient underwent posterior spinal fusion with pedicle screw instrumentation from T2 to L2 for scoliosis (**Figure 1**). Physical examination revealed a well-healed midline thoracolumbar scar extending to the L4 level (**Figure 2**). Despite the corrective surgery, the patient had residual curvature involving the upper left thoracic and lower right thoracic spine. These findings raised concerns regarding neuraxial access, particularly in the setting of prior spinal instrumentation.



Figure 1. AP X-ray image displaying posterior spinal instrumentation and fusion from T6 to L3. Posterior rods are seen bilaterally extending from T2 to L2, held in place by polyaxial pedicle screws throughout the thoracic and lumbar spine.



Figure 2. A photograph demonstrating a well-healed midline surgical scar extending caudally to the L3 - L4 level, beyond the documented level of spinal fusion, which ended at L2.

After multidisciplinary consultation with obstetrics and cardiology, an epidural technique was tailored to the patient's anatomy and cardiac risk. Modifications included selecting an interspace below the spinal fusion and scar, using a median approach, and preparing to angle the needle toward the convexity of the spinal curve. The patient was positioned in the sitting posture, and spinal levels were estimated by palpation of the intercrystal line. A 17-gauge, 10 cm Tuohy needle was inserted at the L4 - L5 interspace, distal to the scar and fused segments, via a median approach, and directed toward the convexity of the right lower thoracic scoliosis. Loss of resistance to saline was achieved at a depth of 9 cm. A 19-gauge epidural catheter was advanced 5 cm beyond the needle tip and secured at 12 cm from the skin. The catheter was successfully placed on the first attempt. A test dose of 3 mL of 1.5% lidocaine with 1:200,000 epinephrine was negative for inadvertent intrathecal or intravascular placement. Following the negative test dose, fentanyl 100 mcg and 0.125% bupivacaine were administered incrementally in small volumes. Given the patient's cardiopulmonary history, intravenous fluid preloading was omitted, and a bolus of local anesthetic was intentionally withheld to minimize the risk of hemodynamic compromise. A patient-controlled epidural analgesia (PCEA) pump was initiated to allow self-administered boluses, providing effective labor analgesia while maintaining hemodynamic stability.

The patient reported satisfactory pain relief and remained hemodynamically stable throughout labor, confirming the successful placement and function of the epidural catheter. She delivered vaginally without complications. Both maternal and neonatal outcomes were favorable.

3. Discussion

Neuraxial analgesia in patients with complex spinal and cardiac histories poses both technical and physiological challenges. In this case, the patient had three key comorbidities: extensive thoracolumbar spinal fusion, a repaired congenital cardiac anomaly (ALCAPA), and preeclampsia without severe features, each necessitating tailored anesthetic considerations.

Anatomically, extensive spinal instrumentation complicates epidural access. Pedicle screws and rods used in posterior spinal fusion can obstruct the needle trajectory and eliminate intersegmental mobility. Fusion may also lead to epidural fibrosis, which distorts the epidural space and alters anesthetic spread. Several studies have documented variable degrees of epidural fibrosis in patients following spinal surgery, underscoring the challenges in catheter placement and the unpredictability of block effectiveness [4].

Surface landmark identification can also be misleading due to residual scoliosis and surgical scarring. In our case, the epidural was successfully placed at the L4 - L5 interspace, distal to the fused segments and surgical scar. The Tuohy needle was intentionally angled in the transverse plane toward the convexity of the spinal curve to improve alignment with the epidural space. This technique increases the likelihood of successful catheter placement in patients with scoliosis and may im-

prove block efficacy [5] [6].

From a physiological standpoint, patients with a history of congenital heart disease, such as ALCAPA, even when repaired, may have residual myocardial remodeling and reduced coronary reserve. The decision to avoid fluid preloading and bolus dosing reflected the need to preserve hemodynamic stability and avoid cardiac decompensation. Sympathetic blockade can lead to reduced systemic vascular resistance and venous return, potentially compromising coronary perfusion and precipitating hemodynamic instability [7]. In addition, the patient's diagnosis of preeclampsia without severe features introduced additional anesthetic considerations. While not associated with end-organ dysfunction, preeclampsia entails endothelial dysfunction, capillary leak, and reduced oncotic pressure, all of which increase the risk for pulmonary edema, especially in the setting of underlying cardiac disease or reduced reserve. This compounded risk of hemodynamic instability reinforced our cautious fluid strategy and the incremental titration of anesthetic agents.

Effective analgesia was particularly critical in this patient, not only for comfort, but also to blunt the sympathetic surge associated with labor pain. Uncontrolled pain can trigger excessive catecholamine release, leading to hypertension and increased myocardial oxygen demand, potentially precipitating cardiac ischemia or decompensation in individuals with impaired coronary reserve. Through the use of carefully titrated epidural analgesia, we were able to attenuate the hemodynamic response to pain and reduce overall cardiac stress throughout labor.

While neuraxial analgesia remains the gold standard for labor pain management, alternative modalities, such as remifentanyl patient-controlled analgesia (PCA), inhaled nitrous oxide, and single-shot intrathecal opioids, are sometimes considered in anatomically challenging cases. However, each carries notable limitations. Remifentanyl PCA, though rapidly titratable, is associated with maternal hypoxia and oversedation and requires continuous one-to-one monitoring [8]. Nitrous oxide offers only modest analgesia and may cause nausea, dizziness, and sedation [9]. Single-shot intrathecal opioids provide brief relief but lack titrability and carry risks such as pruritus and respiratory depression [10]. These alternatives may result in inadequate analgesia, increased maternal distress, and a higher incidence of unplanned cesarean deliveries, a particularly concerning outcome in patients with underlying cardiac disease. By contrast, carefully planned and titrated epidural analgesia offers superior, adjustable pain control with more favorable hemodynamic stability. In this patient, it provided effective analgesia, supported a stable labor course, and enabled her to pursue a second trial of labor after cesarean (TOLAC). This case reinforces neuraxial analgesia as the preferred modality for labor pain management in high-risk parturients, when feasible.

This case highlights the critical role of multidisciplinary collaboration in the anesthetic management of a medically complex obstetric patient. Cardiology consultation guided the development of a fluid management strategy that avoided volume loading and minimized the risk of hemodynamic instability associated with

abrupt sympathetic blockade. Obstetric evaluation confirmed the appropriateness of vaginal delivery and endorsed early neuraxial placement to attenuate the physiologic stress of labor. These recommendations were seamlessly incorporated into the anesthetic plan, enabling a tailored approach that balanced analgesic efficacy with cardiovascular safety.

4. Conclusions

This case illustrates the feasibility of neuraxial labor analgesia in a medically and anatomically complex obstetric patient who had thoracolumbar spinal fusion including posterior instrumentation, residual spinal curvature, congenital heart disease, and preeclampsia without severe features. Each condition posed unique physiologic and technical considerations, requiring individualized anesthetic planning, close interdisciplinary collaboration, and real-time adaptability. In patients with spinal deformity, a midline approach can remain effective when the needle is directed toward the convexity of the curve, facilitating alignment with the epidural space.

Despite the anatomical challenges, studies have reported successful epidural analgesia in up to 88% of patients with prior spinal fusion, although this remains lower than the 100% success rate observed in control patients without spinal instrumentation [11]. When feasible, neuraxial analgesia should be performed at a level below the spinal instrumentation or surgical scar. In particularly challenging cases, or when multiple attempts are anticipated, adjunctive imaging modalities such as ultrasound are recommended to aid in vertebral level identification and to minimize the risk of neurological injury [12]. Ultrasound facilitates midline identification, estimates the depth to the epidural space, and aids in locating unfused interspaces, particularly when surface landmarks are distorted by scoliosis or prior instrumentation. Although the ligamentum flavum is not directly visualized, its depth can be inferred based on adjacent bony structures. In this case, due to the urgency of labor and the presence of experienced providers, the epidural was placed successfully without ultrasound guidance. Nonetheless, its use may have enhanced spatial orientation and should be considered in similar cases when time and resources permit.

This case underscores that, with an individualized anesthetic strategy and close interdisciplinary coordination, neuraxial techniques remain a viable and effective option for labor analgesia in parturients with complex spinal anatomy.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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