Real-time ultrasound-guided neuraxial anesthesia for cesarean section in parturients with previous internal fixation surgery for lumbar fracture: a case series

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Introduction

Neuraxial anesthesia (i.e., spinal or epidural block) is the preferred type of anesthesia for cesarean section (CS) worldwide (1-3). Compared with general anesthesia (GA), neuraxial anesthesia may reduce the incidence of maternal airway complications and without potential adverse effects of general anesthetics on the newborn (4). Currently, GA is used almost exclusively in emergency CS or when neuraxial anesthesia has failed or is contraindicated (5). It remains unclear which anesthesia is most appropriate for CS in parturients who have undergone internal fixation surgery for lumbar fracture. Neuraxial anesthesia is not an absolute contraindication in these patients (6,7); however, postoperative distortion of the anatomy makes the block technically challenging and may increase the likelihood of failure, inadvertent dural puncture during epidural anesthesia, paresthesias, or unpredictable spread of the local anesthetic (8). Nevertheless, neuraxial anesthesia should be considered, as it offers undeniable advantages for CS. To date, there have been only a few case reports on the use of this technique in patients who have undergone internal fixation surgery for lumbar fracture (7,9).

In recent years, there has been an increasing interest in the use of ultrasound (US) for assisted or real-time guided neuraxial anesthesia, as it may help to increase the success rate. Preprocedural spinal US assessment can accurately determine the optimum best introduction site, angle, direction of approach, and depth to the epidural space, and subsequently reduce the number of attempts to administer neuraxial anesthesia (10-12). Real-time US guidance may offer the additional advantages of visualizing the needle tip and allowing adjustment of the trajectory (13-15).

Despite these potential advantages, there have been no reports on real-time US-guided neuraxial anesthesia for CS in parturients after internal fixation surgery for lumbar fracture. In this study, we report on our experience with 4 such patients.

Patients and methods

A retrospective case series of 4 patients with a history of internal fixation surgery for lumbar fracture who were scheduled for lower segment CS between March 2017 and March 2020 was conducted. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was provided by the patients for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.
Parturient demographics and labor data

The demographics, labor data, previous surgical site, and anesthesia method are shown in Table 1.

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age, years</th>
<th>Height, cm</th>
<th>Weight, kg</th>
<th>BMI, kg/m²</th>
<th>Gestational age, weeks</th>
<th>Cesarean section indication</th>
<th>Previous surgical site</th>
<th>Anesthesia method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>28</td>
<td>162</td>
<td>68.5</td>
<td>26.1</td>
<td>39</td>
<td>Cephalopelvic disproportion</td>
<td>L1 to L3</td>
<td>CSEA (L3-4)</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>158</td>
<td>70.6</td>
<td>28.0</td>
<td>38</td>
<td>Breech presentation</td>
<td>T12 to L2</td>
<td>CSEA (L4-5)</td>
</tr>
<tr>
<td>3</td>
<td>29</td>
<td>164</td>
<td>85.5</td>
<td>32.4</td>
<td>39</td>
<td>Cephalopelvic disproportion</td>
<td>L3 to L4</td>
<td>EA (L1-2)</td>
</tr>
<tr>
<td>4</td>
<td>25</td>
<td>163</td>
<td>77.8</td>
<td>29.3</td>
<td>38</td>
<td>Fetal macrosomia</td>
<td>T11 to L2</td>
<td>CSEA (L4-5)</td>
</tr>
</tbody>
</table>

BMI, body mass index; CSEA, combined spinal and epidural anesthesia; EA, epidural anesthesia.

History of lumbar fracture and choice of anesthesia

Case 1

The parturient had experienced an L2 vertebral compression fracture 2 years earlier, with no nerve injury complication. A previous radiograph showed bilateral pedicle screw-rod fixation from L1 to L3. The internal fixators were not removed preoperatively. For CS, combined spinal and epidural anesthesia (CSEA) was performed at the L3–4 interspace.

Case 2

Three years earlier, the parturient had undergone an internal fixation of a bilateral pedicle screw-rod from T12 to L2 caused by a L1 vertebral compression fracture without neurologic deficit. The internal fixators remained in her body. For CS, CSEA was performed at the L4–5 interspace.

Case 3

Seven years earlier, the parturient had presented with L3 and L4 open fractures accompanied by left L4 nerve root injury. Five years earlier, the lumbar internal fixators had been removed. Preoperatively, the parturient still had a neurological deficit of the left lower limb with L4 paresthesia and mild motor weakness (grade 4/5) of the left ankle dorsiflexion. The L1–2 interspace was chosen for epidural anesthesia for CS.

Case 4

The parturient had experienced T12 and L1 vertebral fractures without neurological injury 2 years earlier. Bilateral pedicle screws and rods had been fixed from T11 to L2 and were still in the body before delivery. For CS, CSEA was performed at the L4–5 interspace.

Preprocedural spinal US assessment

Routine monitoring (noninvasive blood pressure, pulse oximetry, and electrocardiography) and intravenous access were established after the parturients arrived in the operating room. The parturients were placed in the left lateral decubitus position with the lumbar spine flexed appropriately, which enabled simple control of the needle in a caudad-to-cephalad direction with the right hand for right-handed doctors, while the parturients’ right lateral decubitus position enabled left-handed doctors to control the needle. The lumbar spine was scanned using a curvilinear low-frequency (2–5 MHz) probe (Sonosite®, MicroMaxx, Bothwell, WA, USA; or NextGen LOGIQ™ e, GE Healthcare, Milwaukee, WI, USA). The US image was optimized before the intervention by adjustment of parameters such as scanning depth, focus, and gain.

Previous plain radiographs of the spine showed no congenital vertebral anomaly, such as an L1 accessory rib or sacralization of the L5 vertebra, in any of the 4 parturients. Thus, the lumbar intervertebral space could be accurately identified using a known systematic US scanning protocol combining a counting-up approach from the L5-S1 junction with a counting-down approach from the T12 transverse process (identified by the presence of the 12th rib) in a paramedian sagittal plane (16,17).

The screw and rod fixation system can be easily identified as strong reflectors on US examination. They are shown as highlighted dashes bilaterally in the median transverse view (Figure 1) and a long, strong echogenic line in the paramedian sagittal view (Figure 2).
Figure 1 Median transverse view of pedicle screw-rod fixation in the lumbar spine.

Figure 2 Paramedian sagittal view of pedicle screw-rod fixation in the lumbar spine.

Figure 3 Target lumbar interspace position and needle path in the paramedian sagittal oblique view. The target lumbar interspace is maintained near the caudal edge in the ultrasound image. L1, L2, and L3 represent the corresponding lamina.

Considering the results of lumbar US scanning and previous spine radiographs, the choice of the target puncture site should not include the previous operation area. The main feature of scar tissue on US is an echogenic homogeneous or inhomogeneous irregular area, which may be surrounded by a hypoechoic halo (18). If excessive deep, permanent scar tissue is present, it is difficult to advance the needle. Therefore, we kept the needle away from the scar tissue when selecting a puncture site. The transducer was positioned 1–2 cm lateral to the midline spinous processes on the nondependent (up) side, and the lumbar spine was scanned in a paramedian sagittal oblique plane, as described by Chin et al. (17). The interlaminar space, in which the gap was relatively wide and the posterior complex and/or anterior complex could be visualized, was chosen as the target puncture site. The posterior complex includes the ligamentum flavum and posterior dura mater, which often appears as a single linear hyperechoic structure. Similarly, the anterior dura, posterior longitudinal ligament, and posterior aspect of the vertebral body or intervertebral disc can be visible as a single linear hyperechoic structure, that is the anterior complex (17,19). The target interlaminar space was maintained near the caudal edge (Figure 3) instead of the center of the US image to reduce the length of the puncture path and the probability of touching the lamina with the needle during the procedure. Then, the position of the transducer was marked on the skin.

Real-time US-guided neuraxial anesthesia

After sterilization of the lumbar skin, the US transducer was prepared by applying a thin layer of ultrasonic coupling agent onto the footprint and covering it with a sterile transducer sleeve. The US transducer was placed on the previously marked position. The intended needle insertion site was infiltrated with 2% lidocaine. An 18-gauge Tuohy needle was inserted from the caudal end of the probe and gradually advanced under real-time US guidance using an in-plane approach towards the target interlaminar space until the tip of the needle was seen to be approximately 1 cm away from the posterior complex. Then, the US probe was set aside to avoid an inadvertent dural puncture due to the single-handed needle insertion. The needle was advanced through the ligamentum flavum and into the epidural space using a loss-of-resistance (LOR) to saline technique for identification of the epidural space.
In parturients who were administered an epidural anesthetic for CS, an epidural catheter was inserted into the epidural space using a Tuohy needle, with 4 cm of the catheter remaining in the epidural space, and it was secured to the back. After aspiration of the catheter, 3 mL of 2% lidocaine with epinephrine (1:200,000) was administered as a test dose to exclude intravascular or intrathecal placement. The parturient was then returned to the supine position with a 15° left lateral tilt. A 0.75% solution of ropivacaine was injected through the epidural catheter at a rate of 5 mL every 5 minutes and titrated up to the T5 level of the block. When CSEA was planned for the CS, a 27-gauge pencil-point needle was advanced into the subarachnoid space through the Tuohy needle using a needle-through-needle technique. After confirmation of correct spinal needle placement using aspiration of cerebrospinal fluid, 3.0 mL of 0.5% ropivacaine (2.0 mL 0.75% ropivacaine + 1.0 mL cerebrospinal fluid) was injected. After withdrawal of the spinal needle, an epidural catheter was inserted into the epidural space. If the desired block level was not achieved after 10 minutes of subarachnoid block, rescue epidural injection of local anesthetic was performed.

Results

The internal fixators and deep scar tissue were well-identified using a preprocedural US scan, which was helpful in selecting the puncture site. The posterior and anterior complexes could be visualized in the 4 parturients. Paramedian lumbar epidural access was successfully performed in all parturients on the first attempt (single skin puncture with 1 or more needle passes) (15) by a single operator with real-time US guidance. The tip of the Tuohy needle was successfully advanced by a single operator with real-time US guidance in a paramedian sagittal oblique plane to be at a distance of approximately 1 cm from the posterior complex. Then, the tip of the needle was continued to advance into the epidural space using the LOR to saline technique.

The effect of neuraxial anesthesia was excellent in all parturients. There were no cases of anesthesia complications, such as back pain, postdural puncture headache, or new neurological deficits.

Discussion

General and neuraxial anesthesia are both safe for CS, but neuraxial anesthesia is still recommended as the gold standard anesthetic for most CS when balancing risks and benefits to the mother and her fetus (1,2,20). It is the preferred option due to lower fetal exposure to depressant drugs, lower risk of gastric content aspiration, difficulty of maternal intubation with GA, preservation of maternal consciousness during labor and feeling the joy of birth, and decreased requirement for postoperative analgesia (21,22). GA is currently used in only 5.8% of all cesarean deliveries (CDs) and 14.6% of emergent CDs in the US (23).

Published research suggests that neuraxial anesthesia is technically possible in most patients with a history of previous spinal surgery and may be recommended in obstetrics under certain conditions (24). Preexisting neurological deficits may be a specific concern for anesthesiologists. A retrospective study demonstrated that neuraxial anesthesia in patients with recent stable fractures of the spine was not associated with adverse neurological events (6). Lavell et al. reported on 2 patients who received epidural anesthesia for CS after anterior spinal surgery (25). Majeed et al. and Yeo et al. reported that spinal anesthesia was successfully performed in parturients with scoliosis corrected with Harrington’s rod surgery (26,27). Most parturients may benefit more from neuraxial anesthesia than from GA (24), and therefore, we chose neuraxial anesthesia for CS in parturients after lumbar fracture operations.

Multiple prior case series have suggested that baseline neurologic symptoms of patients with pre-existing spinal canal pathology or nerve injury may worsen after neuraxial anesthesia or analgesia (28-30). However, neuraxial anesthesia can usually be administered safely in most patients with neurologic disease (31). The decision to administer neuraxial anesthetics in patients should be based on risk-to-benefit considerations. The third parturient in this study had baseline neurologic dysfunction and was obese, which presented difficulties to airway management. For this parturient, epidural anesthesia was safer for the mother and newborn than GA, despite the risk of worsening neurological symptoms.

Surgical scar tissue, which can form both extradurally and intradurally after spinal surgery, may block the diffusion of local anesthetic (32). Altered spinal anatomy due to previous surgery, presence of metal rods and screws, poor back flexion, scar tissue, and obliterated epidural space make neuraxial anesthesia technically difficult, and therefore, it frequently has a high failure rate and may lead to patchy or inadequate sensory block (33) and a high inadvertent dural puncture rate (34). Thus, the target puncture site of anesthesia should be chosen above or below the location.
of the previous internal fixation surgery (35), where the
spinal column may be intact, and the lumbar puncture may
be successful and safe. If the previous location of surgery is
above the L3 level, CSEA is performed caudally. Otherwise,
epidural anesthesia is chosen at the upper lumbar interspace.

Many studies have demonstrated that US is helpful in
identifying the puncture site and measuring the puncture
depth when performing neuraxial techniques, which
increases the success rate, particularly in technically difficult
cases (24,36-39). Preprocedural US scanning of the spine
may reduce the risk of technical difficulties in patients
with a previous history of lumbar surgery (26,27,40). The
spinal pedicle screw and rod fixation system can be easily
recognized as strong reflectors in the median transverse
and paramedian sagittal views. It is advisable to circumvent
the previous surgical area and deep scar tissue by using US
scanning. The number of alternative lumbar interspaces to
administer neuraxial anesthesia is reduced in patients with
a history of lumbar surgery. Accurate advancement toward
the target interspace can be performed under real-time US
guidance, which may decrease the number of attempts and
subsequent trauma (15).

Paramedian sagittal oblique sonograms of the
ligamentum flavum and posterior dura are of superior
quality to those obtained in the median transverse plane or
median longitudinal plane (14,16,17,41). Thus, the target
interspace was approached through a paramedian sagittal
oblique plane under real-time US guidance, as described
by Karmakar et al. (14). In the study by Karmakar et al.,
the target interspace was consistently maintained in the
center of the US image (14). In practice, however, this
approach makes the needle trajectory long, and the needle
is easily blocked by the lamina because of the narrow
laminar space. Needle contact with the vertebrae can lead
to a failed epidural procedure and back pain (42). In our
study, the target interspace was maintained near the caudal
edge instead of the center of the US image, which reduced
the length of the needle path and the contact between
the needle and the lamina. The correlation between the
position of the target interspace on US images and difficulty
of the epidural procedure using real-time US guidance
needs further study. Much of the needle tract is guided
by real-time US, which allows the needle trajectory to be
aimed at the target epidural space, and the remaining part is
performed easily using the freehand method.

In conclusion, neuraxial anesthesia can be used carefully
for CS in parturients who have undergone lumbar fracture
operations. Real-time US guidance is helpful for the success
of this type of anesthesia.

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Footnote

Conflicts of Interest: All authors have completed the ICMJEU
uniform disclosure form (available at https://qims.
The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all
aspects of the work in ensuring that questions related
to the accuracy or integrity of any part of the work are
appropriately investigated and resolved. All procedures
performed in this study were in accordance with the ethical
standards of the institutional and/or national research
committee(s) and with the Helsinki Declaration (as revised
in 2013). Written informed consent was provided by the
patient for publication of this case report and accompanying
images. A copy of the written consent is available for review
by the editorial office of this journal.

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