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A Parturient With Scoliosis and Harrington Rods

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Stem Case and Key Questions Content

29 year old G2P0 at 32 weeks' gestation is referred to the Anesthesia Preoperative Assessment Clinic by her Obstetrician for consultation. She has a history of adolescent idiopathic scoliosis and underwent the Harrington Procedure at 16 years of age, in India. Surgery and anesthesia were uncomplicated as far as the patient knows, but she does not have access to her medical records. She is interested in receiving labor epidural analgesia, but is concerned about the risks. Her laboratory values are as follows: Hct 31.2%, platelet count 102,000 mm-3. Her chemistries and coagulation parameters are normal.

1. What else do you want to know about her history?
2. What else would you want to determine from her physical examination?
3. How well does the surgical scar correspond to the level of spine instrumentation?
4. Would you request any imaging studies prior to delivery? If so, which one(s)?
5. Are pulmonary function tests necessary?

The patient has chronic intermittent exacerbations of back pain, which have worsened during pregnancy. She was told that she should avoid non-steroidal analgesic drugs late in pregnancy, and was recently prescribed tramadol 50 mg daily by her family practitioner.

1. Are you concerned about her history of tramadol use?
2. Would you suggest the patient discontinue tramadol use prior to delivery?
3. What are the effects of chronic opioid use on the fetus?
4. How will you counsel the patient regarding her options for labor analgesia?
5. Is this patient at above normal risk for cesarean section?
6. What would be your plan for anesthesia if she requires a cesarean section?

Nine weeks after your initial consultation, the patient is admitted to the labor and delivery suite for induction of labor, because she is post-term. In recent weeks, she has been experiencing shortness of breath when lying supine. She thinks that when her contractions become painful, she will prefer intravenous patient-controlled opioid analgesia (IV-PCA).

1. Which opioid is preferable for IV-PCA for labor?
2. Does she need any special monitors? Continuous pulse oximetry? Continuous end-tidal carbon dioxide monitoring?
3. Should she receive supplemental oxygen during opioid administration?

4. Does the nursing staff need to change the nurse-to-patient ratio for this case?
5. Is a continuous infusion preferable to the IV-PCA technique?
6. Will you adjust your opioid dosing because of her use of tramadol?
7. What will you advise the Obstetrician regarding the effect of the systemic opioids on the fetal heart tracing?

Eventually, the obstetrician performs artificial rupture of membranes and initiates oxytocin intravenous infusion. After the development of painful contractions, you begin systemic opioid analgesia. The patient is initially comfortable, but two hours later complains of 8/10 pain, which is intolerable. Her cervical dilation is 5 cm.

1. Is there a maximal dose of opioid which should be administered?
2. Would you consider any analgesia adjuncts? Ketamine? Dexmedetomidine?
3. Is it appropriate to change the anesthesia plan, with the patient now experiencing severe pain?
4. Would you suggest converting to neuraxial analgesia? What are your options?
5. For neuraxial block, is a midline or paramedian approach preferable?
6. What is the utility of spine ultrasound prior to block placement?
7. Can you use povidone iodine as the skin disinfectant for neuraxial block or should you use anything different for this case?
8. What is the patient's risk of infection in the spine?
9. Would you modify your usual dose of neuraxial local anesthetic or opioid in this case?

The patient agrees to neuraxial analgesia. Physical examination of her back reveals a midline surgical scar extending from the lower thoracic to lower lumbar region. You make multiple attempts at epidural placement, at L3-L4 and L4-L5. You eventually obtain a loss of resistance to saline at the L4-L5 level and are able to insert the epidural catheter. Following epidural administration of a total of 10 ml 0.125% bupivacaine and 100μg of fentanyl, the patient reports improved pain relief; however, when testing the sensory level of the block with ice, you find the block is significantly patchy.

1. Will you remove the catheter and repeat the procedure?
2. Would it be preferable to place a spinal catheter?
3. Would her risk of post-dural puncture headache be lower with repeated intrathecal injections or an intrathecal catheter?

The patient does not want the neuraxial procedure repeated at this time and is willing to tolerate her current levels of pain (4/10). Six hours later, the patient is noted to be febrile (T = 38.7°C) and the fetal heart tracing has poor variability. The obstetrician decides that urgent cesarean delivery is necessary.

1. What further information would you like with respect to the patient's development of fever?
2. Will you attempt to use the labor epidural catheter for surgical anesthesia?
3. If not, what type of anesthesia will you select - neuraxial or general?
4. What are the risks of general anesthesia in a patient with scoliosis?
5. Will general anesthesia increase her risk of uterine atony?
6. Is neuraxial anesthesia contraindicated because she is febrile?

Airway Exam: Mallampati class 3 airway with 2 finger-breadth thyromental distance and full

range of neck motion, teeth are intact.
7. Does her airway exam influence your decision?
8. Do you think she will be able to tolerate lying supine for cesarean delivery under neuraxial blockade, considering her history of shortness of breath?
9. Which uterotonics will you avoid in this patient?
10. Will you administer neuraxial morphine for postoperative pain?
11. How would you manage a post-dural puncture headache in this patient?

Model Discussion Content

Scoliosis is a lateral deviation of the spine in the vertical axis. The deformity is complex and is also associated with axial rotation of the vertebrae. The spinous processes rotate away from the convexity of the curve towards the midline. Other vertebral changes include narrowing and thinning of the pedicles and laminae, as well as narrowing of the vertebral canal on the concave side in severe cases. Scoliosis severity is defined by the degree of spinal curvature and is measured by the Cobb angle. The estimated prevalence of scoliosis with a Cobb angle >10 degrees among adolescents is about 2%,[1] with a prevalence in females approximately twice that of males.[2] A prevalence as high as 9.2% has been reported, but only 0.2% of that cohort required treatment.[3] Females are more likely to develop severe disease- the ratio of females to males with a Cobb angle >21 degrees is 5.4 to 1.[4]

Current treatment methods include bracing and surgery. The indications for surgical correction are based on the severity of the Cobb angle and rate of progression of the disease. Surgery is warranted where the Cobb angle exceeds 50 degrees, as it is linked to a high risk of progression throughout adulthood;[5] however, treatment decisions are individualized and milder degrees of severity may be corrected. Surgical management involves correction of the deformity via distraction of the concave side of the curvature and rod insertion, followed by fusion of the spine. The surgeon may choose an anterior or posterior approach; however, the posterior-only approach is the preferred technique in many centers worldwide, due to its simplicity.[6]
Patients with untreated scoliosis are at a higher risk of respiratory failure and premature death. The impairment in lung function has been demonstrated to be primarily due to restriction of lung volume.[7,8] Patients may develop pulmonary hypertension, which may lead to cor pulmonale in rare cases.[9] Patients who have undergone corrective procedures which violate the chest wall also have a greater likelihood of long term detrimental pulmonary effects than those who had chest sparing procedures.[10]

Pregnancy may exacerbate pre-existing cardiopulmonary compromise. Normal physiologic changes involve increases in minute ventilation and oxygen demand. Furthermore, the enlarging uterus restricts movement of the diaphragm, decreasing functional residual capacity, closing capacity and residual volume. Deterioration may occur during late gestation, manifesting as increasing ventilation/perfusion mismatch and arterial oxygen desaturation. Noninvasive ventilatory support has been successfully used to treat ventilatory failure during pregnancy.[11]
Cardiac output also increases by 40 -50% during pregnancy. Patients with pulmonary hypertension lack the reserve to increase stroke volume and heart rate, which may ultimately progress to right ventricular failure and even sudden death.[12] Patients with severe spinal deformities impacting heart and lung function should undergo evaluation by a Pulmonologist and Cardiologist, beginning early in pregnancy. Antepartum pulmonary function testing and echocardiography may provide useful information, which may guide management decisions.

Intrapartum, special monitors (e.g. invasive arterial and central venous pressure monitoring) may be indicated in severely affected patients.
Patients with scoliosis are regarded to be at higher risk of operative delivery,[13] with greater potential for cephalopelvic disproportion and labor dystocia. Studies utilizing varying methodologies, have had conflicting findings, with several reports concluding there is no difference in cesarean delivery rates.[14] Conflicting findings may be the result of the inclusion of patients with differing disease severities and variability in obstetric management practices.

Neuraxial Anesthesia/Analgesia:
Neuraxial anesthesia is technically more difficult in the parturient who has undergone corrective surgery for scoliosis. Rod insertion necessitates decortication of the laminae as far as the facet joints and removal of spinous processes along the length of the curve, which distorts anatomic landmarks. The main impediment to needle placement is scar tissue and bone grafts. Below the level of fusion, difficulty may also be encountered because degenerative changes, leading to retrolisthesis and spondylolisthesis may occur. The cutaneous scar usually extends slightly below the level of the fusion. Fusions are performed as low as L4 or L5 in 20% of cases of idiopathic scoliosis and should not involve the sacrum, in keeping with the surgical goal of preserving lumbosacral joint mobility.[15]

Access to operative reports and spine radiographs may provide useful information about the vertebral levels involved and the extent of the correction. Ultrasound imaging of the spine has been described to be useful in facilitating needle placement.[16,17] Available interspaces may be identified. The rods appear as a hyperechoic shadow[17] and may be the only visible images. Yeo and French[16] found it useful to assume midline to be located close to the rod at either end, where it is anchored to the vertebrae, and the greatest lateral displacement to be in the middle part of the rod.

One literature review reported the rates of successful neuraxial anesthesia in parturients with scoliosis to be 69% and 79% in the surgically corrected and uncorrected patient populations, respectively.[15] The greatest difficulty was encountered with epidural placement (90%). Other challenges included inability to place neuraxial block (22%), multiple attempts at placement (13%), patchy analgesia (10%), high local anesthetic requirements (9%), and inadequate analgesia or inadvertent dural puncture (4%). Spinal anesthesia success rates were similar to epidural anesthesia in the corrected population.[15] Local anesthetic doses for both epidural and spinal anesthesia are variable in patients with scoliosis. Inadequate or patchy epidural anesthesia likely occurs secondary to post-operative adhesions or obliteration of the epidural space, which may prevent adequate local anesthetic spread. The Harrington rod hooks pass into or through the ligamentum flavum where they are anchored to the lamina.[18] Obliteration of the epidural space also creates a higher risk of unintentional dural puncture.
The Anesthesiologist should examine the extent of the surgical scar and attempt to palpate spinous processes, which if palpable, would indicate an uninvolved area. Insertion through the scar is associated with a greater number of attempts.[19] Epidural anesthesia has been successful above or below the surgical site.[20,21] Caudal anesthesia has also been successfully utilized.[22,23]

Since the intrathecal space is preserved post-surgery, continuous spinal analgesia or sequential spinal analgesia blocks may be effective alternatives to epidural anesthesia/analgesia.[24] It has been suggested that the L5-S1 interspace is optimal since it is less frequently involved, is the

widest space and least likely to have undergone degenerative changes.[18] A midline or paramedian approach can be effective. The addition of intrathecal morpine to intrathecal bupivacaine and fentanyl during combined spinal-epidural analgesia, may decrease the rate of breakthrough pain.[25] Dural puncture with a 25-G spinal needle before initiation of epidural anesthesia with bupivacaine and fentanyl may improve onset and spread of analgesia.[26] Little has been reported regarding the incidence and management of post-dural puncture headache in this setting. In a review by Ko and Leffert,[15] from a total of 117 neuraxial anesthetic procedures, there was only one report of post-dural puncture headache in a patient who received continuous spinal analgesia, but it is unclear whether or not the patient's scoliosis had been corrected. Anesthesiologists may have concerns about the effectiveness and safety of epidural blood patch in the patient with spine instrumentation, particularly regarding the risk of infection. Epidural blood patch has been used to treat persistent cerebrospinal fluid leak in patients post-spinal surgery.[27,28]

Alternatives to Neuraxial Labor Analgesia:
Anesthesiologists should be familiar with alternatives to neuraxial analgesia. Although these techniques are less effective, parturients will inevitably be encountered for whom neuraxial anesthesia is contraindicated, difficult or refused, and alternative approaches must be employed. Regional anesthesia techniques include paracervical block, pudendal nerve block and lumbar sympathetic block. Systemic analgesia techniques include inhaled nitrous oxide, and systemic opioids. Nonpharmacologic techniques include emotional support, massage, hypnosis and acupuncture, among many others. A combination of techniques may be considered where one approach is found to be inadequate.

Paracervical blocks have fallen out of favor in the United States because of concern for fetal safety and the tremendous popularity of neuraxial techniques. The needle is introduced submucosally into the vaginal fornix, in proximity to the cervix and 5 - 10 ml of local anesthetic is injected on each side. The goal is blockade of the sensory nerves in the paracervical ganglion, which supply the uterus, cervix and upper vagina; successful blockade provides analgesia for the first stage of labor. The most common complication is fetal bradycardia (a reported incidence of 11 - 24%),[29,30,31] which usually develops within 2 - 10 minutes and may last for up to 30 minutes. Direct injection into the fetal scalp can occur and may lead to systemic local anesthetic toxicity and death.

Pudendal nerve blocks are employed for the second stage of labor. Pudendal nerves provide sensory innervation for the lower vagina, vulva and perineum (S2 - S4). With the transvaginal approach, injection of 7 -10 ml of local anesthetic is performed medial and posterior to the ischial spine on each side. Complications are uncommon, but include maternal systemic local anesthetic toxicity, hematoma and abscess formation and fetal trauma.
Bilateral **paravertebral lumbar sympathetic nerve blocks** are not popular, but have been successfully used to manage pain during the first stage of labor.[32,33] The technique may benefit patients with scoliosis and spine surgery, in whom neuraxial analgesia may be challenging.[34] Needle entry takes place lateral to the vertebral column at the L2 vertebral level, where the transverse process is identified. The needle is walked off 1cm deep to the transverse process, anterior to the medial attachment of the psoas muscle and 5ml of local anesthetic is injected. One advantage of the technique is the absence of motor blockade; the blocks may also speed the progress of labor.[32] The blocks are not continuous, however, and do not provide analgesia for the second stage of labor. Compared to labor epidural analgesia, the blocks may be more

technically difficult and painful.[33] Potential complications include hypotension, Horner's syndrome, systemic local anesthetic toxicity, dural puncture, total spinal anesthesia, postdural puncture headache, and retroperitoneal hematoma.[35]

Only five centers in the United States currently offer **nitrous oxide** as an option for labor analgesia.[36] By contrast, nitrous oxide is used by about 60% of laboring women in the United Kingdom and is frequently used in Australia, New Zealand, Canada and the Scandinavian countries.[37]It is usually administered as a 50% mixture of nitrous oxide in oxygen (Entonox). The patient is encouraged to breathe the mixture from the beginning to the end of the contraction via a mask or mouthpiece with a one-way valve. The mechanism of analgesia is unclear, but is suggested to be secondary to the release of endogenous opioid peptides, stimulation of descending noradrenergic neuronal pathways, and modulation of pain perception. Other pathways may involve dopamine and gamma-aminobutyric acid (GABA)-mediated transduction as well N-methyl-D-aspartate (NMDA) antagonism.[37]

Entonox only partially relieves labor pain and its efficacy has been called into question by some investigators, with reports of little or no benefit in 30-40% of women.[38] Higher concentrations of nitrous oxide (70% versus 40%) by intermittent inhalation have been reported to improve analgesic efficacy,[39] but increase the risk of drowsiness, dizziness and amnesia;[38] greatest benefit was seen with continuous administration of 40%.[39] Intermittent self-administration is an important safety tool, since the patient is unable to apply the mask to her face if significant drowsiness develops. Other advantages of the technique include maternal sense of control, the ability to continue administration through the second stage of labor, as well as to provide supplemental analgesia during genital tract repairs postpartum. Nausea and vomiting is a frequently reported adverse effect. Patients are at risk of hypoxia, particularly when administered in conjunction with systemic opioids. Scavenging systems reduce the risk of occupational exposure.[37]

Systemic Opioids:
Systemic opioids have been extensively used for management of labor analgesia. Meperidine has historically been one of the most frequently used agents, but only provides modest analgesia. Patient self-administration of opioids allows for improved matching of analgesia to patient requirements. A background infusion is usually avoided because the risk of respiratory depression is increased. Favorable outcomes have been seen with IV-PCA-fentanyl.[40,41] A typical fentanyl regimen is a bolus of 25 - 50 µg with a lockout interval of 3 - 6 minutes. A comparison of meperidine, remifentanil and fentanyl in labor showed that PCA-remifentanil provided superior analgesia to PCA-meperidine and PCA-fentanyl, but only during the first hour of treatment. Pain scores reverted to pre-treatment values within 3 hours of treatment.[42] Adjuncts to opioids in labor are infrequently used; many exacerbate maternal sedation and some may cause neonatal depression.

Remifentanil is a potent ultra short-acting synthetic mu-1 opioid receptor agonist with a rapid onset of action and rapid elimination (half-life 9.5 (SD ± 4 min)[43] which makes it well suited to treat the intermittent nature of labor pain. It is subject to hydrolysis by plasma and tissue esterases, which produces inactive metabolites. It easily crosses the placenta, where the drug is also rapidly metabolized and redistributed to the fetus. Timing of administration is critical. Onset of analgesia is about 30 - 60 seconds and the peak effect is seen at 2.5 minutes, so an intravenous bolus at the beginning of a contraction will result in analgesia for the subsequent

contraction.

The drug is typically given by a patient self-administered bolus with a lockout interval. A commonly administered bolus dose is 0.25 - 0.5 µg/kg with a 2 - 3 minute lockout via a dedicated intravenous cannula. Large interindividual variability in responses are seen, so the dose should be titrated to patient response.[44] The patient should be closely monitored for side effects including sedation, hypoventilation, oxygen desaturation, nausea and vomiting. One-to-one nursing care is advised, with continuous oxygen saturation monitoring.
A double-blinded, randomized comparison of PCA-remifentanil versus continuous remifentanil infusion showed lower total remifentanil consumption with the PCA technique, suggesting that PCA provides better pain relief.[45] Tolerance to the analgesic effects of remifentanil develops rapidly (maximal analgesia was seen after 60 - 90 minutes in non-pregnant volunteers) and should be taken into account when titrating patient doses.[46]
Opioid administration may decrease fetal heart rate variability, and reduce fetal breathing movements and fetal activity.[47,48] Few adverse fetal and neonatal effects have been reported with intravenous remifentanil labor analgesia. Evron *et.al.*[49] reported maintenance of a reactive fetal heart rate in 90% in the remifentanil group compared with 38% in the meperidine group.
Chronic maternal opioid use during pregnancy may lead to neonatal abstinence syndrome after delivery. Tramadol is a synthetic analogue of codeine whose analgesic effects are mediated by inhibition of neuronal reuptake of serotonin and norepinephrine. The active metabolite, O-desmethyltramadol also exhibits moderate µ-opioid receptor agonism. There is limited research into the safety of tramadol use in late gestation. Chronic tramadol use during pregnancy places the newborn at risk of neonatal withdrawal syndrome.[50]

Conclusion:
An interdisciplinary team approach is important when caring for the obstetric patient with surgically corrected scoliosis. Anesthesia consultation well in advance of delivery is recommended. A thorough evaluation of the patient's spine, airway and cardiopulmonary status should be carried out. Pulmonologists and Cardiologists may need to be involved in certain cases. The options for anesthesia/analgesia, as well as their risks and benefits should be thoroughly discussed. The patient should anticipate increased difficulty with neuraxial blockade and be aware of the limitations of alternative techniques. Neuraxial analgesia should preferentially be carried out earlier rather than later in the course of labor. The patient should also be counseled about the likelihood of requiring general anesthesia for cesarean delivery if neuraxial anesthesia fails.

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