Conduction anesthesia in obstetrics

A. SCOTT WHEELER, MD
Winston-Salem, North Carolina

What are some of the important considerations of conduction (regional) anesthesia during labor and delivery? This question is answered in this article, with special focus on the anatomic, physiologic, psychologic, and pharmacologic influences, as well as anesthetic choice and technique.

Although spinal and epidural anesthesia were first described in the late 1800's, they did not gain widespread acceptance in obstetrics until the middle part of this century. The "saddle" block technique has been the most widely used conduction anesthetic. The description of continuous caudal anesthesia in 1942 and continuous lumbar epidural anesthesia in 1949 were notable advancements in obstetrics. Their use has progressively increased, because they can provide relatively safe, profound analgesia for labor as well as delivery.

In perinatal centers with full-time anesthesia coverage, epidural anesthesia has become the primary mode of analgesia for labor and delivery. Since such coverage is becoming commonplace, the use of systemic, chemical analgesia and anesthesia will become limited. Thus, the objective of this article is to highlight the important considerations of conduction anesthesia for labor and vaginal delivery.

Anatomic considerations

The use of conduction anesthesia during parturition necessitates an understanding of the contributory pain pathways of labor and delivery. The pain of uterine contractions is primarily caused by stretch of the cervix. Visceral afferent sensory fibers from the uterus and cervix coalesce at the posterior cervical plexus (Frankenhäuser's plexus). They accompany sympathetic nerves running through the superior hypogastric plexus and enter the sympathetic chain at the second, third, and fourth lumbar vertebral areas. They ascend the sympathetic chain and enter the spinal cord at the T10 through L1 levels via the white rami communicantes and dorsal horn. A conduction blockade at any point in this pathway will provide analgesia for uterine contractions and is sufficient for the majority of the first stage of labor.

The pain of expulsion (second stage) is a combination of uterine-cervical pain and the pain of distention of tissue in the pelvis and perineum. The sensory innervation of the perineum is from somatic afferent pain fibers, which traverse with the pudendal nerves entering the spinal cord at the S2-4 levels. Therefore, the perineum can largely be anesthetized with a block of the pudendal nerves or the middle sacral segments at the spinal cord or epidural spinal root levels.

However, since sympathetic efferent fibers leave the spinal cord from T1 through T2, the provision of uterine analgesia with lumbar epidural, caudal, or spinal anesthesia can be accompanied by hypotension. Motor blockade can limit the movement of the lower extremi-
Early perineal muscle relaxation may prevent flexion and internal rotation of the fetal vertex, resulting in persistent occiput posterior presentations. The afferent limb of the bearing-down reflex, which comprises nearly 40% of the force of expulsion, runs with the pudendal nerve.

Hence, a blockade of this pathway with pudendal, caudal, epidural, or spinal anesthesia may prolong the second stage of labor, especially when a spontaneous delivery is desired. However, spontaneous delivery can be achieved if the sensory level with spinal or epidural anesthesia is below T10 and the parturient is coached to voluntarily bear down.

Physiologic considerations

Uterine blood flow progressively increases during pregnancy to 500-700 ml/min at term gestation; approximately 95% of this goes to the placental intervillous space. The uterus at term gestation does not autoregulate its blood flow, so that perfusion is related linearly to mean systemic blood pressure. So as to insure adequate fetal oxygenation following conduction anesthetics, systolic blood pressure should not fall below 100 mm Hg in normotensive patients or be reduced by more than 20% in hypertensive patients. The distressed fetus may not tolerate any reduction in maternal blood pressure; thus, normotension must be maintained during fetal distress.

Although circulating blood volume and cardiac output increase during pregnancy, significant reductions in cardiac output can occur when the supine horizontal position is assumed near term gestation. The gravid uterus compresses the inferior vena cava in a majority of patients, of which 3-11% develop the supine hypotension syndrome. The others remain normotensive because: (1) adequate collateral flow through the vertebral venous plexus occurs, keeping venous return, stroke volume, and cardiac output normal; or (2) collateral flow is inadequate, but blood pressure is kept normal by reflex medicated increases in peripheral vascular resistance.

Approximately 50% of term gravidas have a reduction in cardiac output when supine. These patients are very susceptible to hypotension after receiving sympatholytic conduction anesthetics, such as epidural or spinal. Since the uterus can also occlude the sub-renal aorta and reduce uterine blood flow, patients should labor in the lateral position.

The parturient may have a contracted extracellular space, as insensible fluid losses increase and digestion is deferred. Intravenous hydration with a balanced salt solution will aid in preventing hypotension. The ultimate volume prior to anesthesia depends upon the fluid intake history, but at least 500 ml are usually required. With proper positioning (lateral) and intravenous hydration, significant maternal hypotension can be kept minimal.

The effect of epidural and caudal anesthesia on labor has been controversial. Decreased uterine activity has been reported, whereas other studies have noted little effect. Conductance anesthesia may inhibit or ablate uterine contractions when administered during the latent phase of labor. If instituted during the active phase, as described by Friedman, a significant effect rarely occurs. Important contributing factors are hypotension, the use of epinephrine, and obstetrical problems such as cervical dystocia. Effects on labor are minimized if conduction anesthesia is instituted when the cervix is 4-5 cm dilated. a contraction occurs less than every 3 minutes, and the duration of contraction exceeds 30 seconds. Epidural anesthesia has little effect upon and can be started in any stage of an oxytocin-induced labor.

Psychological considerations

The success of any analgesia technique for labor and delivery depends upon the psychological profile and emotional status of the parturient. The subjective response to pain is greatly influ-
enced by cultural, social, and emotional factors, as well as the intensity of sensory input.

In the past, obstetric patients have played a passive role during labor and delivery. Education about childbirth and obstetrical anesthesia was not available, and the parturient was generally fearful, apprehensive, and anxious. Such an emotional state facilitates pain by lowering the pain threshold. It should be emphasized that prenatal childbirth education and the establishment of confidence in the patient care team can deter the transmission of pain and modulate overt pain responses. 

This writer’s experience has been that patients with childbirth education are the least likely to refuse conduction anesthesia when indicated. They are generally more cooperative at induction of anesthesia and do not require as profound analgesia as those without childbirth education. If possible, the obstetrical anesthetist should conduct lectures or personal interviews about obstetrical anesthesia prior to term gestation. This allows the patient time to consider the anesthetic alternatives and sets the tone for an early rapport. Anesthetic risk factors can be identified and properly evaluated before admission.

Pharmacologic considerations

Due to the vascular engorgement of peridural veins in pregnancy, dose requirements for spinal and epidural anesthesia are reduced by approximately 40% at term gestation. The local anesthetics being most commonly used for epidural anesthesia are bupivacaine HCl (Marcaine®) and 2-chloroprocaine (Nesacaine®).

Bupivacaine is a local anesthetic amide, which provides reliable sensory blockade of relatively long duration. It causes little motor blockade, allowing patients to move freely and bear-down effectively. Since bupivacaine is 95% bound to maternal serum proteins and is highly ionized at physiologic pH, apparently little placental transfer occurs. Onset of epidural analgesia is 5-6 minutes; peak effect occurs 15-20 minutes after injection. Bupivacaine is four times as potent as Xylocaine®; the subcutaneous toxic dose is approximately 3 mg/kg of body weight. It is important to note that the prodromal systemic symptoms noted prior to seizures with Xylocaine® may not be seen with bupivacaine.

Nesacaine® is an ester, which is nearly equipotent to Xylocaine®. Anesthetic onset is 3-5 minutes with peak effect at 10-15 minutes after epidural injection. Duration of anesthesia is approximately 45 minutes. Nesacaine® is rapidly hydrolyzed by serum pseudocholinesterases; the in vitro maternal serum half-life is 21 seconds. Therefore, placental transfer of Nesacaine® is negligible. The toxic subcutaneous dose is 1200 mg/70 kg.

Xylocaine® and mepivacaine (Carbocaine®) are being less readily used for obstetrical anesthesia due to the higher observed concentrations in umbilical venous blood at delivery. This results from the larger dose requirements, lesser protein binding, and with mepivacaine, less ionization in maternal blood as compared to bupivacaine. In addition, a decrease in neonatal muscle tone demonstrated by neurobehavioral testing occurs following mepivacaine and Xylocaine® epidurals, but not with bupivacaine. Moreover, the neonatal serum half-life of bupivacaine is less than 2 hours, whereas with Xylocaine® and mepivacaine it is 3 and 9 hours, respectively. Etidocaine (Duranest®) is used sparingly for epidural analgesia in labor, due to the occurrence of significant motor blockade.

The use of epinephrine (1:200,000) in local anesthetics for epidural and caudal anesthesia is presently controversial. Epinephrine retards absorption of local anesthetics, reducing maternal serum levels. It will prolong the duration of epidural anesthesia with all local anesthetics except bupivacaine and etidocaine. However, epinephrine may inhibit uterine contractility via beta ad-
renergic stimulation and prolong labor. The clinical significance of this low-dose epidural analgesia is questionable. When present in serum concentrations sufficient to cause alpha adrenergic stimulation, epinephrine can reduce uterine blood flow. However, significant reductions in uterine blood flow have not been demonstrated with the doses used for epidural anesthesia.

Finally, the only vasopressor which can be safely utilized to correct maternal hypotension is ephedrine. Drugs with alpha agonistic predominance, such as Neo-Synephrine® and methoxamine (Vasoxyl®), can reduce uterine blood flow and increase uterine contractility.

Anesthetic considerations

The particular anesthetic utilized in each obstetric patient depends upon: (1) the expertise of the anesthetist; (2) the experience of the obstetrician and obstetrical nurse; (3) the quality of physical, fetal-monitoring, and anesthetic facilities; (4) the patient's medical and obstetrical history; (5) fetal status; and (6) the patient's preference and consent. Cooperation and communication between members of the patient care team is necessary to insure effective anesthesia for each patient. A single anesthetic technique cannot be optimally used for all patients.

Continuous lumbar epidural anesthesia

Continuous lumbar epidural anesthesia has become the most commonly used conduction anesthetic in centers with 24-hour anesthesia coverage. It is relatively easy to administer, provides anesthesia for both labor and delivery, and exposes the mother and fetus to small doses of local anesthetic. With the segmental approach, early perineal muscle relaxation can be avoided, allowing proper fetal descension, and also the incidence of hypotension is low.

The epidural space is identified at L2-3 or L3-4, and the catheter is advanced 2-4 cm cephalad. From 5-8 ml of 0.25% bupivacaine or 2% Nesacaine®, or 4-5 ml of 0.5% bupivacaine, are usually sufficient to achieve a T10 sensory level and uterine analgesia. The segmental approach is particularly advantageous when long labors are anticipated, such as in the primagravida or Pitocin® induction.

The disadvantage of this approach is the occasional difficulty obtaining profound sacral blockade at delivery. This may be a result of the large diameter of sacral spinal nerve roots in addition to the positioning of the catheter. To obtain sacral anesthesia, the patient is placed in the sitting position and 8-15 ml of 3% Nesacaine® or 0.5% bupivacaine are injected.

To avoid such failure during the second stage, Crawford prefers the standard epidural approach. Certainly, it is advantageous for the rapid or advanced labor, such as the multigravida in the active phase. The catheter is passed 2-4 cm cephalad or caudad at the L3-4 or L4-5 interspace. From 10-15 ml of 0.25% bupivacaine or 2% Nesacaine® will usually provide a T10 to S4 block.

Caudal anesthesia

Caudal anesthesia for labor has declined because large masses of a local anesthetic are required to produce a T10 sensory level. Early perineal muscle relaxation is likely. Moreover, the caudal is technically more difficult than lumbar epidural analgesia; 25% of all patients have inappropriate anatomy for needle placement.

When feasible, caudal anesthesia provides excellent analgesia in the late-first or second stage of labor. When delivery is predicted within several hours, a single dose of 20-25 ml of 0.25% bupivacaine will suffice. Otherwise, a catheter is placed with a similar initial dose. Care must be taken to avoid needle placement in the fetal-presenting port or the rectum.

Paracervical block

This block is quite easily adminis-
tered, provides effective uterine analgesia, and causes few maternal side effects. However, its use has become limited because fetal bradycardia occurs in 10-85% of the cases following Xylocaine®, mepivacaine, or bupivacaine paracervical blocks. The bradycardia is usually transient, but fetal acidosis, neonatal depression, and fetal death have been associated with the technique. This effect may result from local anesthetic depression of the fetal myocardium, but recent studies have demonstrated a reduction in uterine blood flow. If administered, fetal electrophysical and scalp pH monitoring is mandatory to evaluate the fetus.

Paravertebral lumbar sympathetic block
This block was investigated 30 years ago and found to be quite efficacious, easily administered, and relatively devoid of maternal side effects. However, duration of anesthesia with the local anesthetics then available rarely exceeded 4 hours, which precluded its clinical acceptance.

Sympathetic blocks with 10 ml of 0.5% bupivacaine injected bilaterally at L2 affords uterine analgesia of approximately 5 hours with a range of 3-9 hours. Notable advantages are the absence of motor blockade and the acceleration of labor in 50% of patients in active labor. However, as compared to continuous techniques, it requires two injections, and a second anesthetic is required for delivery.

Spinal anesthesia (saddle block)
The saddle block is the most certain and reliable conduction anesthetic in obstetrics. The rapidity of onset, paucity of significant side effects, low drug dosages, and profound perineal anesthesia make it an excellent technique for delivery. Since it cannot be used for labor, saddle block usage is limited to centers where continuous techniques are provided.

It is the technique of choice for operative vaginal deliveries without pre-existing continuous conduction anesthesia. A modification of the classical technique is employed, as patients are allowed to sit only 30-60 seconds following intrathecal injection of hyperbaric tetracaine (4 mg) or Xylocaine® (25 mg). This allows a T10 level, thus achieving uterine analgesia. The incidence of post-spinal cephalgias is 1-3% with the utilization of a 25-gauge needle.

Pudendal nerve block
The transvaginal approach was initially described for use in delivery in 1954. It is easily administered, but low success rates have been common. Much depends upon the expertise of the obstetrician and the time between block and delivery. Improved success occurs when the pudendal is given at least 30 minutes prior to delivery.

This time frame allows for maximal diffusion of the local anesthetic and a repeat injection if the initial block has failed. Ten ml of 1% Xylocaine®, 2% Nesacaine®, or 0.25% bupivacaine per side will provide adequate analgesia. Two percent Xylocaine®, 3% Nesacaine®, or 0.5% bupivacaine is indicated if perineal relaxation is desired for the use of forceps.

Contraindications and complications
Coagulation defects, infections near the site of injection, and patient refusal are contraindications to any conduction anesthetic. Those causing sympathetic blockade, such as epidural, spinal, caudal, or sympathetic blocks, are ill-advised during hypovolemia. Back and neurologic disease are relative contraindications to epidural, spinal, or caudal anesthesia, depending upon the site, extent, and activity of the processes. If used concurrent to nervous system disease, precise neurological examination and documentation should precede anesthesia.

Following sympatholytic conduction anesthetics, blood pressures must be taken every 5 minutes for 30 minutes and every 15 minutes thereafter. Close observation is essential during periods

498 Journal of the American Association of Nurse Anesthetists
of fetal distress. Leg elevation in the lateral position (or with manual uterine displacement), rapid infusion of Lactated Ringer’s solution in 5% dextrose, and if necessary, 12-25 mg of intravenous ephedrine will promptly correct hypotension. Oxygen should be administered until this occurs.

Intravascular injection of local anesthetics resulting in systemic toxicity can occur with conduction anesthetics. Convulsions must be arrested to prevent hypoxia, and the trachea must be protected to prevent gastric aspiration. Seizures are treated with 50-100 mg of thiopental and 40 mg of succinylcholine to control muscular hyperactivity. If necessary, the pharynx is cleared by suction, the trachea intubated to prevent aspiration, and ventilation provided with an enriched oxygen mixture.

High or total spinal blockade may result from drug overdose in spinal anesthesia or inadvertent intrathecal injection of drugs intended for epidural administration. Ensuing respiratory failure occurs not by drug depression of the respiratory centers, but by inadequate perfusion resulting from reductions in cardiac output. Restoration of normal blood pressure will usually resume spontaneous ventilation.

Again, the airway should be protected to prevent acid aspiration and ventilation assisted with 100% oxygen via an endotracheal tube to ensure adequate maternal and fetal oxygenation. In continuous techniques, complications from intravascular or intrathecal catheter placement may be largely prevented by a 2-ml test dose prior to the main injection. These complications can only be managed well if anesthetics are given in the presence of suction, wall oxygen, and the drugs and equipment necessary to perform cardiopulmonary resuscitation.

Neurologic sequellae to epidural, caudal, or spinal anesthesia are rare. Neurologic damage from epidural anesthesia most commonly follows anterior spinal artery compression secondary to an epidural abscess or hematoma. If neurologic deficits occur, thorough neurologic evaluation is mandatory to exclude coincidental pathology.

Summary

Conduction anesthesia can provide profound obstetrical analgesia, allowing the mother to be awake and aware. To ensure a safe maternal and fetal environment, an understanding of maternal anatomy, physiologic changes, and pharmacology is mandatory. This knowledge will allow for a good outcome, especially when cooperation among the patient care team, sound clinical judgement of the anesthetist, and patient education prevail.

Meticulous attention to detail will also aid in the prevention of complications, which can be managed effectively in the presence of good facilities. Finally, the achievement of profound, safe conduction anesthesia can be quite rewarding to obstetrical anesthesia personnel.

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**AUTHOR**

A. Scott Wheeler, MD, received a BA degree from Eastern Oregon State College, La Grande, Oregon and a Doctorate of Medicine from the University of Oregon Medical School, Eugene, Oregon. He interned at the Los Angeles County-USC Medical Center in Los Angeles, California and did his residency in anesthesiology at Naval Hospital, Philadelphia, Pennsylvania. He has taught anesthesiology at two medical schools. He is a member of several professional organizations, and has co-authored six articles in professional publications. Formerly with the U.S. Navy, he is presently serving as Assistant Professor of Anesthesia, Bowman Gray College of Medicine, Winston-Salem, North Carolina.

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