

Epidural Anesthesia for Labor and Delivery

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Abstract

Epidural anesthesia has cemented itself as a mainstay in the process of maximizing patient safety and comfort during childbirth or similar measures of pain. The research reviewed in this paper highlights the efficacy and safety of epidural anesthesia while also discussing new advances in optimization of anesthesia. Further discussion of this topic is pertinent to standardization of technique as well as consolidating existing information on the benefits and potential pitfalls of epidural anesthesia treatment as well as the mechanism of action and dosing compounds of epidural anesthesia within the context of pain management for laboring women. The review of clinical literature and large-scale data collection is essential for investigating and confirming any claims, negative or otherwise. Exploration of the literature was categorized into techniques of administration, mechanism of action, and risks associated with epidural anesthesia use for both the fetus and mother. Ultimately, the evidence uncovered in this research points towards safe and replicable standard procedures with continued efforts to perfect anesthetic administration. Notably, possibilities for further research could be discussing the specific variables factoring into the physician's decision of epidural anesthesia technique and dosing blend as well as comparing single-dose spinal analgesia to epidural analgesia.

Keywords: autism; cerebrolysin; cures

Introduction

Labor is consistently rated as one of the most painful life experiences.¹ Labor pain consists of the visceral and somatic components, the former occurring during the first two stages of childbirth and the latter taking place during the last two stages of labor.¹ Painful labor may be a problem for both the mother and the fetus by adversely affecting several physiological processes, such as hypertension in pre-eclampsia, insensitivity to angiotensin II, and compensated respiratory alkalosis.² Changes in these physiological processes can be detrimental to not only the mother, but the infant as well. This necessitates ensuring adequate analgesia during labor.

There are several pain management options available to ease the pain of labor and delivery. These include pharmacological solutions, such as epidural anesthesia, and non-pharmacological options, such as iyengar yoga, acupuncture, and warm packs.³ Epidural anesthesia is among the foremost strategies for pain management during labor and delivery.⁴ Epidurals are employed as an anesthetic for thoracic, major intra-abdominal, or spine surgery.⁵ Studies have revealed lower pain scores following epidural analgesia leading to higher maternal satisfaction.⁴ Epidural anesthesia is also associated with better maternal cardiovascular, pulmonary, and fetal physiology.^{6,7} Epidural anesthesia decreases pain of the uterine contraction and assists in controlling blood pressure.² Additionally, the peripheral vessels are enhanced by the sympathetic blockade, which reduces the cause of peripheral vasodilation.⁸⁻¹⁰ Spinal administration of local anesthetics in combination with opioids is utilized for pain management in labor and

delivery due to its dose limiting effects and reduced adverse effects.¹¹⁻¹³ Possible disadvantages with epidural anesthesia are prolonged labor, increased financial burden, intrapartum fever, dural puncture, postpartum headache and limitation in the mother's participation and sense of control in the birth of her child.³ Because this method has a 8.5% failure rate and there is no agreed upon standard technique, it is vital to continue discussing the intricacies of epidural anesthesia in this use of labor/delivery analgesia.^{3,14} Additionally, there are no medications that are the gold standard for labor and delivery patients, contributing to the variability and increased negative outcomes for patients choose not to receive epidural pain control.^{3,14} This paper will discuss the utilization of different types of epidural anesthesia for labor and delivery, as well as their mechanisms, potential drawbacks, and the patient's perception of their use.

Different types/techniques

The efficacy of epidural anesthesia stems from the anatomy and physiology of the spinal cord and the recesses in which therapeutic medication can be administered. The spinal cord is about 45 cm shorter than the spinal canal in the adult. It ends at L1 in 50% of adults and L2 in approximately 40% of adults.⁵ This discrepancy in the length of the spinal canal and spinal cord gives way to selection of different spinal levels for injection, most commonly L4, to circumvent spinal cord injury. The spinal cord is covered by three layers called meninges, which are the dura mater, arachnoid mater, and pia

mater from outermost to innermost.¹⁵ The epidural space is a space between the dura mater and vertebral wall containing fat, vessels and cerebrospinal fluid.¹⁵ Undoubtedly, safety is of utmost importance in any invasive procedure, especially with regards to the spinal cord. To maximize patient safety, tools and techniques have been developed to increase accuracy of needle placement and decrease iatrogenic complications. In particular, the loss of resistance (LOR) syringe has been developed to indicate when the epidural space has been reached.⁵ The epidural needle must puncture through the skin, subcutaneous tissue, supraspinous, and interspinous ligaments.⁵ At this point, the stylet must be removed, and the Loss of Resistance syringe (filled up with saline, air, or both) must be attached to the needle.⁵ As the needle is advanced, pressure is applied to the plunger; once there is a loss of resistance in the pressure applied to the plunger, the epidural space has been reached.⁵ While the LOR technique is widely used in practice today, other techniques such as electrical stimulation are being studied to assist novice practitioners in anesthetic procedures.¹⁶ In a study conducted in 2020, a comparison was drawn between the LOR technique and electrical stimulation to identify the epidural space.¹⁶ The study was aimed specifically at mothers going through elective cesarean sections and showed a higher rate of success, maternal satisfaction, and sensitivity to finding the epidural space.¹⁶ Other techniques used are classic epidural, the combined spinal-epidural (CSE) technique, or dural puncture epidural (DPE).¹⁷ Epidural anesthesia, a type of neuraxial anesthesia, can contain local anesthetics, such as lidocaine 1%, bupivacaine, or tetracaine, as well as alpha agonists or epidural additives, such as epinephrine.¹⁷ Opioids or other pharmacological substances are often combined with or administered independently of epidural anesthesia.¹⁸ The most common substances used include remifentanyl, pethidine, and Entonox, which consists of nitric oxide and oxygen.¹⁸ Both remifentanyl and pethidine are both opioids; the former is extremely short acting with a half-life of three minutes, requiring constant IV infusion, whereas the latter is more potent yet yields unfavorable side effects, such as nausea, vomiting, and respiratory depression.¹⁸

Mechanism of action & Pain reduction

Epidural anesthesia is a neuraxial anesthesia, which is particularly useful for abdominal, pelvic, and lower extremity procedures.¹⁹ Epidural anesthesia is typically performed as a classic epidural, combined spinal-epidural (CSE) technique, or dural puncture epidural (DPE).¹⁷ Classic epidural is conducted without additional local anesthetics.¹⁷ This would be the technique which is associated with the LOR needle as previously discussed.¹⁴ On the other hand, CSE and DPE require the delivery of local anesthetics as well as coadjuvants in the case of CSE.¹⁷ CSE has faster onset than epidural analgesia by approximately 12-15 min as well as blocking a larger range of sensory pain signals in the sacral dermatomes uniformly.²⁰ This could be secondary to clear visualization of the injection site within the cerebrospinal fluid as possible with the spinal needle.²⁰ In DPE, the spinal needle would only go down to the dura mater.¹⁷ The mechanism of this technique is hypothesized to be as such- the hole in the dura acts to enhance epidural medication transportation into the intrathecal space, yielding intensified interaction at the sacral nerve roots.²⁰ DPE can be indicated in cases that are at risk for mild hypotension or in looking to side-step alterations in fetal heart tracing.²¹ Drug delivery can be done via intermittent bolus, continuous infusion, patient-controlled epidural analgesia (PCEA), and computer integrated patient-controlled epidural analgesia (CIPCEA).¹⁴ Intermittent bolus delivery has been shown to reduce pain and drug dosage as well as yielding superb patient experience.¹⁴ This is likely due to greater area of coverage and disbursement of medication spread in the epidural space.¹⁴ However, PCEA is currently the standard of care as it provides the most patient autonomy and overall satisfaction.²¹ Pain alleviation via classic epidural begins approximately 15 minutes following the standard dose and can be augmented with boluses either upon patient request or an ordered time schedule.²² Moreover, CSE tends to have a faster onset of pain relief and fewer assisted vaginal deliveries.²² Nonetheless, it is associated with increased fetal heart racing, which is why it is critical to assess the risks and benefits of each method depending on the patient.²² When compared to opioid use (non-

epidural pain relief), epidural anesthesia was shown to have significantly greater pain relief while having no impact on the risk of cesarean section or admissions to neonatal intensive care.²³

Risks associated with epidural anesthesia usage.

While epidural anesthesia has greatly improved intra and postoperative pain for patients, it is not without its drawbacks and risks.²⁴⁻²⁷ Placement of an epidural catheter is essential for prompt administration of additional anesthesia in the case of returning or increased pain.²⁵ The most common complication from placement of epidural catheters is dural puncture followed by post-dural puncture headache.²⁵ While incidence of dural punctures is as low as 0.16% to 1.3%, subsequent headaches can range from 16% to 86% of cases.²⁵ Even rarer, but more serious complications, are cases of paraplegia following epidural anesthesia.²⁵ Paraplegia can result from puncture of epidural vessels and subsequent epidural hematoma.²⁵ Although a potentially disastrous complication, quick surgical decompression of the hematoma can prevent permanent disease.²⁵ In addition, a combined series study of over 100,000 epidural anesthetics showed no incidence of symptomatic epidural hematoma.²⁵ Patients that are undergoing anticoagulant therapy or have coagulopathy are at higher risk for development of hematoma but these conditions are not considered absolute contraindications.^{24,25} Studies have shown that patients have undergone safe anesthesia while on antiplatelet therapy, warfarin, and low/high dose heparin.^{24,25} In regards to patient stability during operation, hemodynamics are critical to patient safety and uncomplicated surgery.^{25,27}

Common hemodynamic changes include decreased chronotropy, inotropy, dromotrope, systemic vascular resistance, cardiac output, and myocardial oxygen consumption.^{25,26} Close monitoring of vital signs intraoperatively for dose adjustment is standard to keep them within normal limits.²⁶ In reference to labor and delivery outcomes, epidural anesthesia has significantly less contribution to neonatal morbidity when compared to opioid analgesics.²⁶ In the analysis by Halpern et al 9, analgesic method did not affect the occurrence of fetal heart rate abnormalities, intrapartum meconium, severe asphyxia, or early or 24 hour Neuroadaptive and Adaptive Capacity scores.²⁷ The infants of women randomized to epidural analgesia had less need for neonatal naloxone and lower rates of Apgar score < 7 at 1 minute and at 5 minutes than the infants of women randomized to parenteral opioids.²⁷

Discussion:

Painful labor is detrimental for the mother and fetus alike; as such, it is critical to employ effective measures towards pain reduction in childbirth.² Epidural anesthesia provides this solution and is often used for pain management during labor and delivery.^{4,24} Epidural anesthesia decreases pain of the uterine contraction via sympathetic nervous signal blockage.^{2,8-10} Epidural anesthesia is administered in the epidural space of the spinal cord, which lies between the outermost meningeal layer, the dura mater, and vertebral wall.¹⁵ A catheter is inserted in the epidural space, which lies distal to L1 surrounding spinal nerve roots, and the epidural needle is placed for the administration of analgesic substances.¹⁷ Results from the various studies discussed in this paper reiterate the benefits of epidural anesthesia.

Techniques developed for administering epidural anesthesia have advanced in their efficacy and accuracy. LOR and, more recently, electrical stimulation have shown promise in greatly reducing the variability in success rate of epidural anesthesia in relation to the practitioner's experience by shrinking the margin of error when identifying the epidural space.¹⁶ As more studies are being conducted, this technique is being refined and evidence is steadily being gathered to categorize the LOR technique as a low to zero risk procedure. In addition to the alterations in techniques and tools, there are variations in depth of anesthetic administration as well as different drug combinations based on perceived pain and risks associated with the specific patient.¹⁷ Further, patients are highly involved in treatment with the use of patient-controlled epidural analgesia, and computer integrated patient-controlled epidural analgesia leading to more accurate pain control and greater patient satisfaction.¹⁴ While there are advances being made in the

safety of this treatment, there are also possible risks associated with epidural anesthesia.²⁵ Current patient condition, medications, and history of previous disease can increase risk of developing post-dural puncture headaches.²⁵ Nevertheless, the benefits of epidural anesthesia extend to even the fetus, illustrated by reduced need for medical intervention following birth in comparison to children whose mothers are administered predominantly opioids during childbirth.²⁷

While synthesizing existing research on epidural anesthesia, the development of standard technique and efforts made to perfect this safe and constructive procedure are evident. The results included in this paper demonstrate tangible evidence of positive correlation between patient outcomes and the advancement of epidural anesthetic usage. As the risks and benefits of epidural anesthesia use are carefully examined over years of research and experience, the refining process for this procedure is much more effective and tailored to the patient. While the LOR technique, a widely successful and accepted technique, is preferred for the classic epidural, studies on supplemental pain management methods, such as electrical stimulation are also showing promising results in terms of improving procedural success.¹⁶ With improvement in overall patient experience and efficacy, instances of births complicated by maternal distress should continue to fall and more patients feel comfortable with the procedure. Childbirth, or similar states of pain that require extensive measures to alleviate, is a very vulnerable state for a patient to be in. The incorporation of real time patient involvement with their own care in terms of pain control yields higher patient satisfaction and experience.¹⁴ While epidural anesthesia has proven to be efficacious, providers must use caution and consider the condition of the patient while selecting the best form of anesthesia.²⁵ This is the first step in granting the patient autonomy with respect to their healthcare.

With the amount of research on epidural anesthesia, it is hard to imagine any bias being incorporated into the studies. However, the data on the demographics of the women sampled was not present in most studies. It would be interesting to explore the socioeconomic status of patients as well as specifics of the pregnancy, such as mother age and fetus gestation. These changes would allow the data to be more reflective of the population and definitively portray epidural anesthesia as a safe and effective procedure regardless of the aforementioned variables. There are also questions as to why there isn't one technique that has been identified as being the gold standard. Further research on each technique's efficacy in different populations of pregnant patients would be beneficial in uncovering the most optimal technique across any variance in patients. Additionally, it could be an interesting and particularly relevant avenue to explore the risks and benefits of single-dose spinal analgesia, compared to epidural analgesia as it has been mentioned as a safe and efficient alternative for labor analgesia.⁴

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