CHAPTER 2

NEURAXIAL BLOCKS IN OBSTETRIC ANALGESIA

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Birth pain is one of the most severe pains that women can experience. The American Society of Anesthesiologists (ASA) and the American Society of Obstetrics and Gynecology (ACOG) stated that labor pain should be treated (1). It is known that providing quality analgesia benefits the fetus by reducing maternal morbidity and mortality. Many pharmacological and non-pharmacological methods have allowed painless delivery (2). Neuraxial blocks are spinal, epidural, and caudal blocks applied to block pain transmission at the spinal cord level.

The first use of neuraxial blocks began in the 1900s, when Oskar Kreis (1872-1958), an obstetrician and gynecologist, created spinal blocks to provide labor analgesia in 6 pregnant women (3). Walter Stoeckel applied caudal block for labor analgesia in 1909. The epidural block was first performed in 1936 by Charles Odom for a cesarean section. Charles Flowers applied the catheter technique for continuous epidural analgesia in obstetric cases in 1949 (4).

The interest in painless delivery has increased with the development of neuraxial block techniques in obstetric anesthesia and analgesia. Especially in the last two decades, with the addition of opioids to local anesthetics, the quality of analgesia has increased, and local anesthetic consumption has been reduced. At the same time, patient comfort has increased with local drugs that cause less cardiotoxic and motor blockade, combined spinal-epidural block techniques, and new techniques such as patient-controlled analgesia. Thus, neuraxial methods have become safer and preferred in obstetric anesthesia and analgesia.

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PAIN PATH DURING BIRTH

Labor pain is caused by the contraction and compression of the perineum and pelvis structures resulting from the contraction of the myometrium and progressive dilation of the lower segment of the uterus and the cervix. Pain from the first stage of labor is visceral pain from uterine contractions and cervical dilation. While this pain is initially limited to the thoracic 11-12 (T11-T12) spinal cord segments during the latent phase, it encompasses the T10-L1 dermatomes as labor progresses into the active phase. The pain is mainly in the lower abdomen. It is felt in the lumbosacral area, gluteal region, and thighs, increasing with labor progression. The severity of pain increases with increasing cervical dilatation and increasing frequency and severity of uterine contractions.

The latent phase of labor is characterized by progressive cervical effacement and small dilatations (2-4 cm). The active phase is characterized by more frequent contractions (30-60 seconds every 3-5 minutes) and progressive cervical dilation up to 10 cm. The first stage lasts 8-12 hours in nulliparous patients and 5-8 hours in multiparous patients. Nulliparous women feel more pain in the first stage of labor than multiparous women. At the end of the first delivery stage, the onset of perineal pain indicates the beginning of fetal descent and the second stage of work. Stretching and compression of the structures in the pelvis and perineum increase the severity of pain. The pudendal nerves provide sensory innervation of the perineum (S2-S4), and pain in the second stage involves T10-S4 dermatomes.

PHYSIOLOGICAL EFFECTS OF BIRTH PAIN

Pain causes some physiological changes in the body. In proportion to the severity of the pain, hyperventilation, and increased minute ventilation, hypocapnia and respiratory alkalosis occur in pregnant women; cardiac and respiratory work increases with the development of tachycardia and hypertension. Pain, stress, and fear cause an increase in catecholamine levels. High catecholamine discharge may cause uteroplacental insufficiency by causing vasoconstriction in the uterine artery. However, severe hypocapnia due to hyperventilation is also a significant cause of vasoconstriction. As a result, fetal hypoxia and acidosis may develop, especially in prolonged deliveries. Catecholamine discharges are known to cause dysfunctional uterine contractions and prolongation of labor. Pain and anxiety during active labor are known to cause significant increases in adrenaline, noradrenaline, cortisol, corticosteroid, and Adrenocorticotropic hormone (ACTH) levels. Plasma levels of catecholamines reach their highest values at or immediately after birth (5).

The resulting stress response causes decompensation, especially in pregnant women with cardiovascular, respiratory, and metabolic problems. Because of all these adverse effects, labor pain should be treated effectively.

NEURAXIAL BLOCKS

Many pharmacological and non-pharmacological methods have been applied until today to allow painless delivery. Neuraxial blocks (spinal, epidural, combined spinal-epidural, and caudal blocks) are the most commonly used methods today because they are effective in all birth phases, suppress the stress response better, and adapt to the stages of labor. The basic principle in labor analgesia; is the delivery that does not cause a motor block in the mother, does not cause fetal position defect, and does not require instrumental techniques. For this purpose, local anesthetic and opioid combinations have been used in recent years, thus increasing the quality of analgesia and decreasing maternal and fetal side effects. For this purpose, local anesthetic and opioid combinations have been used in recent years, thus increasing the quality of analgesia and decreasing maternal and fetal side effects. When a catheter is placed in the subarachnoid or epidural space, the patient's duration of analgesia can be extended as needed. In addition, if cesarean section indication is given, surgical anesthesia can be provided in pregnant women planning for vaginal delivery with analgesia provided by an epidural catheter. Drug administration can be done with a single dose, intermittent bolus, continuous infusion, or patient-controlled analgesia.

Catheter insertion is required to provide analgesia throughout labor and, if necessary, for episiotomy. Muscle weakness may occur due to local anesthetics' blockade of motor fibers. The sympathetic blockade may cause vasodilation and hypotension. Hypotension may cause fetal acidosis by reducing uteroplacental blood flow. Therefore, it should be treated with intravenous fluid replacement and vasoconstrictor drugs such as ephedrine and phenylephrine. It has been shown that performing fluid loading before neuraxial blockade is ineffective in preventing hypotension in dehydrated pregnant women.

CONTRAINDICATIONS OF NEURAXIAL BLOCKS

Contraindications for neuraxial blocks are classified into three groups absolute, relative and controversial. Absolute contraindications are the patient's rejection, infection at the injection site, coagulopathy and bleeding disorders, severe hypovolemia, aortic and mitral valve stenosis, and insufficiency. Sepsis, inability

to cooperate, neurological disorders, demyelinating lesions, hypertrophic obstructive cardiomyopathy, and severe spinal deformity are contraindications. Prior back surgery, lack of experience in epidural analgesia, prolapse of the cord, placental abruption, uterine rupture, or waiting for a long surgery are controversial contraindications.

CHARACTERISTICS OF OBSTETRIC ANESTHESIA

Many physiological and anatomical changes that occur due to pregnancy are standard adaptation mechanisms necessary for the development of the fetus. As the gestational week progresses, changes occur in the central nervous system, respiratory system, cardiovascular system, renal and gastrointestinal functions, and metabolic and hematological systems. When applying neuraxial block in pregnant women, these changes should be considered. The decrease in cardiac output in the supine position is seen after the 20th week of pregnancy. It develops secondary to decreased venous return to the heart due to the enlarging uterus putting pressure on the inferior vena cava. This condition, characterized by pallor, sweating, nausea, and vomiting in approximately 5% of pregnant women at term, is called Supine Hypotension Syndrome (Aortokaval compression). Fetal asphyxia can quickly occur due to aortocaval compression with the neuraxial blockade. In this situation, turning the patient to the left side typically improves venous return from the lower part of the patient, contributing to the resolution of hypotension. This maneuver can also be performed by placing an elevation of >15 degrees below the right hip of the pregnant woman.

Peripheral vascular resistance decreases during pregnancy due to hormonal changes. Therefore, vasodilation that occurs with the blockade of sympathetic fibers during neuraxial block may cause severe hypotension in pregnant women. The addition of supine hypotension syndrome can lead to more severe problems.

Minute ventilation increases during pregnancy due to oxygen consumption and hyperventilation. In the term period, increases of up to 50% can be seen in oxygen consumption and minute ventilation. With the enlargement of the uterus, the maternal respiratory pattern changes. A decrease in functional residual capacity occurs. In pregnant women, the residual capacity decreases more than the closing capacity in the supine position. Thus, the small airways can collapse, and hypoxia can be observed rapidly. Therefore, it may be necessary to give oxygen to pregnant women who stay on their backs for a long time, especially considering the increased oxygen requirement during labor.

Increased sensitivity to local anesthetics is observed in pregnant women during neuraxial anesthesia and analgesia. A neural blockade occurs at reduced doses of local anesthetics. The local anesthetic requirement may decrease by 30% in epidural analgesia, which is known to be hormone-mediated. Local drugs and adjuvants may pass through the placenta to the fetus. They may cause depression in the newborn, so those with low placental transmission should be preferred. In addition, the motor-blocking effect of local anesthetics may slow labor's progression and negatively affect the active participation of the pregnant woman in labor. Local drugs must be used in concentrations that will not cause motor blockade. It is preferred to be used in labor analgesia with the addition of lipophilic short-acting opioids (fentanyl, sufentanil) as an adjuvant to local anesthetics. Adjuvant opioids accelerate the onset of analgesia, increasing the quality and duration of analgesia. Thus, they reduce the need for local anesthetic.

Neuraxial blocks can cause urinary retention, especially when opioids are added to local anesthetics. They can also block bladder innervation. Bladder distension caused by urine accumulating in the bladder may cause symptoms such as discomfort, hypertension, and tachycardia. The atonic bladder can be seen in pregnant women. The atonic bladder may create a mechanical barrier during delivery and cause bladder injury during vaginal delivery. Urine output should be monitored in neuraxial blocks. A urinary catheter should be inserted in pregnant women who cannot urinate.

SPINAL (SUBARACHNOID) BLOCK

Local anesthetics and opioids can induce spinal analgesia in the subarachnoid space. The epidural block creates belt-like anesthesia that covers several segments above and below the area where the local anesthetic is given. All details below the area where local anesthetic is given are blocked in the subarachnoid block. Epidural block can be applied to cervical, thoracic, lumbar, and sacral regions. The subarachnoid block can be used from L2-3, L3-4, and L4-5 levels below L1, which is the level where the spinal cord ends.

The onset of action in the spinal block is faster than in the epidural block. Since the motor block effect is more pronounced than the epidural block, it is helpful to initiate analgesia quickly with opioids rather than local anesthetics in labor analgesia. However, a spinal block can be applied in the exit phase to cover the sacral segments requiring rapid analgesia or muscle relaxation, such as forceps. Since the sympathetic block is minimal, it does not cause sudden and

severe hypotension. Spinal analgesia is administered using a minimal dose of pure opioid or an opioid-local anesthetic mixture. 1-2.5 mg of hyperbaric bupivacaine and 10-25 μg of fentanyl or 5-10 μg of sufentanil will be sufficient.

In subarachnoid block, opioids can be given as a single dose injection or intermittently through an intrathecal catheter. Intrathecal opioids require relatively high doses when used for labor analgesia. For this reason, combinations of local anesthetics and opioids are often used. The pure opioid technique is generally beneficial in high-risk patients who cannot tolerate sympathectomy due to spinal or epidural block. Except for meperidine, which has a local anesthetic property, spinal opioids alone do not cause motor blockade, hypotension, or sympathectomy. Thus, the straining of the pregnant woman is protected, and active participation in labor is ensured. The disadvantages are a lack of perineal relaxation, itching, nausea, vomiting, sedation, and respiratory depression. Side effects may improve with low dose naloxone (i.v. 0.1-0.2 mg). It is also possible to apply a continuous spinal block by placing a catheter in the subarachnoid space. However, it has been reported that the incidence of cauda equina syndrome increases, mainly when microcatheters and hyperbaric local anesthetics are applied in this technique. One of the significant complications of the spinal block is a post-spinal headache. Its incidence has decreased with fine and pen-point spinal needles (26-29 G). It occurs when the meningeal structures are stretched due to cerebrospinal fluid leakage into the epidural space through the hole made by the spinal needles in the dura mater. Accordingly, the decrease in the amount of fluid acts as a cushion in the intracranial space. It can occur within hours or days after the spinal block. Pain is usually felt in the frontal region and the neck. Pain that increases with standing up and decreases when lying down is characteristic. It is usually treated with ample hydration, caffeine, analgesics, and bed rest for a few days. An epidural blood patch provides effective treatment in resistant cases. Applying the epidural blood patch within the first 24 hours is not recommended. 15-20 mL of blood taken from the patient is given to the epidural space from the procedures or the next level.

Other essential complications are transient neurological symptoms and cauda equina syndrome. Temporary neurological symptoms are where neurological symptoms such as pain in the hips and legs, paresthesia, and dysesthesia are seen. It regresses spontaneously within days or weeks. In cauda equina syndrome, there is permanent neurological damage such as bladder and anal sphincter defect, paresis, and paralysis. These complications increase significantly in cases where high concentration and hyperbaric local anesthetics (5% lidocaine, 0.75%

bupivacaine) or spinal microcatheters are used. Therefore, concentrations of 2% of lidocaine and 0.5% of bupivacaine are available in hyperbaric solutions for spinal anesthesia.

EPIDURAL BLOCK

After obstetrician examination, epidural analgesia for delivery can be applied in the preterm labor phase. Increased intra-abdominal pressure in pregnant women causes epidural venous plexus enlargement, narrowing the epidural and subarachnoid spaces. Therefore, less local anesthetic is sufficient for pregnant women than non-pregnant women of the same age. In addition, since the sensitivity of pregnant women to local drugs has increased, the dose requirement has also decreased. Block should be provided in dermatomes that include the T10-L1 segment in the first stage of labor and the S2-4 components in the second stage. Epidural analgesia does not increase the intervention rate. Epidural analgesia has little effect on delivery when diluted mixtures of a local anesthetic and an opioid are used. The epidural catheter should be placed early when the patient is comfortable and can be easily positioned. In addition, surgical anesthesia can be provided through the epidural catheter when an emergency cesarean section is required.

Pregnant women can be placed in a lateral or sitting position for the procedure. A sitting position increases the chance of success by making it easier to distinguish between the midline and the vertebrae, especially in obese individuals. When epidural anesthesia is administered for vaginal delivery in the second stage of labor, the sitting position aids sacral extension. The epidural is entered through the L3-4 or L4-5 interspinous space with a Tuohy needle for the lumbar epidural block. Placement of the catheter in the subarachnoid area of the vein may cause undesirable complications. A test dose should be made with 2-3 ml of 2% lidocaine and 15-20 micrograms of adrenaline. Numbness and muscle weakness in the legs indicates that the catheter is in the subarachnoid space. Increases in the heart rate of 20-30 beats/minute compared to baseline values within 30-60 seconds suggest the intravascular location. The incidence of dripping taps in obstetric patients is 0.25-9%, depending on the clinician's experience. The catheter should be corrected in this case because it is not in the epidural space. An opioid, local anesthetic or opioid-local anesthetic mixture may be administered into the epidural space. Opioid use alone is effective only in the latent phase; It will be insufficient when the active phase is passed. As local anesthetics, 0.5-1% lidocaine, 1-2% chloroprocaine, 0.0625% - 1.25% bupivacaine or levobupivacaine or 0.1-0.2% ropivacaine can be

used in analgesic concentration. Lidocaine is short-acting, has a high placental crossing, and has a high motor blocking effect. On the other hand, Ropivacaine is a stereoisomer of bupivacaine and is preferred because it is less cardiotoxic and causes less motor blockade. Levobupivacaine is the L-isomer of bupivacaine and is less cardiotoxic.

With the addition of opioids to local anesthetics, fewer side effects occur, and the onset of analgesia is accelerated. The quality and duration of analgesia are increased. The most commonly used opioids are sufentanil and fentanyl. 50-100 micrograms of fentanyl and 10-25 micrograms of sufentanil provide 1-2 hours of analgesia during labor. Besides opioids, adjuvants such as clonidine and neostigmine have been used in regional analgesia and anesthesia. In addition, adding adrenaline at a ratio of 1:200,000-800,000 to local anesthetic and opioid mixtures slows absorption and reduces systemic side effects. However, it can negatively affect uterine activity.

Epidural drug administration can be achieved by intermittent bolus injection, continuous infusion, or patient-controlled epidural analgesia (Patient Controlled Analgesia-PCA). In intermittent bolus injection, after the epidural test dose, an initial dose of 7-10 ml can be followed by 5-7 ml epidural injections as the patient is relieved of pain. 4-8 ml/hour infusion can be applied following the initial dose in continuous infusion. When using low concentrations of local anesthetics, volumes should be increased. In both methods, the patient should be monitored for analgesia. In patient-controlled analgesia, on the other hand, a special programmable infusion pump helps the patient administer epidural medication himself as needed. In this method, the patient's control will provide psychological relief. It has also been reported to reduce drug consumption (7). During labor, the pregnant should be closely monitored in terms of the cardiovascular and respiratory system, contractions and fetus should be followed, and complications and undesirable effects should be intervened promptly.

COMBINED SPINAL-EPIDURAL BLOCK

Combined spinal-epidural analgesia and anesthesia methods benefit pregnant women with severe pain in the early stage of labor. It combines the advantages of both block techniques. While rapid-onset analgesia is provided with subarachnoid block, analgesia can be prolonged for desired time with an epidural catheter. Especially in the latent phase of the first stage of labor, long-term analgesia can be provided by subarachnoid administration of pure opioids. At this stage, contractions are not prevented by not administering a local anesthetic.

In an inactive phase of pregnant women, adding low-dose local anesthetic to subarachnoid opioids may be necessary for pain palliation. The epidural local anesthetic dose to be used in this technique should be lower as it can rapidly increase the level of spinal block. Most clinicians use bupivacaine 2.5 mg or ropivacaine 3-4 mg with opioids in the first stage of labor. Typical intrathecal doses of opioids for the combined technique are 10-12.5 mcg fentanyl or five mcg sufentanil. Patient satisfaction with combined spinal-epidural methods is known to be higher than epidural analgesia alone. At the same time, post-dural puncture headache is less. At the same time, mobilization of the pregnant is possible thanks to low local anesthetic consumption. A 24-27 gauge pen-tipped needle (Whitacre, Sporette, or Gertie Marx) is used to minimize headaches.

COMPLICATIONS OF NEURAXIAL BLOCKS

Complications are classified as acute, subacute, and chronic. Acute complications; include hypotension, bradycardia, nausea, vomiting, tremor high or total spinal anesthesia due to subarachnoid injection, local anesthetic intoxication, itching, and insufficient analgesia. Horner syndrome can be seen as a rare complication (8). IV fluid resuscitation is usually sufficient to prevent hypotension. Adrenergic vasoconstrictors such as ephedrine or phenylephrine can be administered to increase peripheral resistance. Bradycardia may be observed due to hypotension and a decrease in the filling volume of the heart or high-level blockage involving the cardiac accelerating nerves. It responds well to atropine and iv fluid resuscitation. Nausea and vomiting due to hypotension and decreased cerebral hypoperfusion can be treated with relief of hypotension and oxygen. It is thought that shivering occurs due to the stimulation of cold-sensitive receptors in the spinal cord with cold local anesthetics. It is beneficial to warm the injector in the palm and inject it into the epidural space.

The volumes required to be given to the epidural space are higher than in the subarachnoid block. High spinal anesthesia or total spinal block may occur with accidental administration of the drug into the subarachnoid space. It may cause respiratory and cardiac arrest. Rapid resuscitation, mechanical ventilation, and cardiovascular support are lifesaving. The epidural test dose should be done after catheter placement. Before repeating the amount, the catheter should be aspirated to check for cerebrospinal fluid or blood. In addition, cardiovascular and central nervous system toxicity may develop with the intravenous administration of large amounts of local anesthetics without being noticed. Cardiovascular toxicity may occur in hypotension, hypertension, bradycardia, tachycardia, and cardiac

arrest. Central nervous system toxic symptoms can be seen in a wide range, from drowsiness around the mouth, metallic taste in the mouth, restlessness, delirium, and convulsions. Treatment is symptomatic. Subacute complications occurring within hours or days following epidural block include urinary retention, back pain, and prolonged segmental block. Chronic complications, which are rare, may occur days or weeks later and cause permanent neurological damage. These include epidural hematoma or abscess, meningitis, spinal cord ischemia (Anterior spinal cord syndrome), chemical irritation, and traumatic neurological injury. Findings such as prolonged paralysis, hypoesthesia or pain in the hips and legs, fever, headache, and neck stiffness suggest epidural or subarachnoid hemorrhages. A neurological examination must be done. Radiological imaging methods are helpful in the differential diagnosis. Catastrophic outcomes can be avoided with early surgery.

CAUDAL (SACRAL EPIDURAL) BLOCK

The caudal space is the sacral portion of the epidural space. Caudal analgesia or anesthesia can be administered with a needle or catheter inserted through the sacrococcygeal ligament covering the sacral hiatus formed by the S4 and S5 laminae. Although it can be used for second-stage labor analgesia, it is unsuitable for first-stage pain relief. Because to obtain T10 level analgesia from S2-S4, where the catheter tip is located, it is necessary to give a high amount (20-25 ml) of local anesthetic. Since all the segments in between will be blocked, severe sympathetic and motor blocks may develop, and the possibility of toxic reactions has increased. Caudal block is not preferred in today's labor analgesia.

CONCLUSION

In summary, labor pain; is one of the most severe pains women can experience in their lifetime. It should be treated effectively because of the harmful effects on the mother and the fetus. It can be safely and effectively eliminated by developing neuraxial analgesia techniques today. Although maternal mortality and morbidity are reduced, it also benefits the fetus.

REFERENCES

1. American College of Obstetricians and Gynecologists Committee on Practice Bulletins—Obstetrics. ACOG Practice Bulletin No. 209: Obstetric Analgesia and Anesthesia. *Journal of Obstetrics and Gynaecology.* 2019;133(3):e208-e225. doi:10.1097/AOG.0000000000003132
2. Lally JE, Murtagh MJ, Macphail S, et al. More in hope than expectation: a systematic review of women expectation and experience of pain relief in labor. *BMC Medicine*. 2008;6-7. doi:10.1186/1741-7015-6-7
3. Schneider MC, Holzgreve W. [100 years ago: Oskar Kreis, a pioneer in spinal obstetric analgesia at the University Women's Clinic of Basel]. *Anaesthesist*. 2001;50(7):525-528. doi:10.1007/s001010100161
4. Seyhan TÖ. Doğum Analjezisinde Nöroaksiyal Bloklar. *Klinik Dergisi*. 2008;28(1):167-172.
5. Mc Donald JS, Obstetric pain. In: McMahon SB, Koltzenburg M, editors. Wall and Melzack's Textbook of Pain. 5th ed. Edinburgh: Churchill Livingstone 2006: pp.793-816.
6. Butterworth J.F., IV, & Mackey D.C., & Wasnick J.D.(Eds.), (2013). Morgan & Mikhail's Clinical Anesthesiology, 5e. McGraw Hill.
7. Caetano AMM, Schmidt AP. Epidural analgesia in the obese obstetric patient. *Braz J Anesthesiol.* 2021;71(3):207. doi:10.1016/j.bjane.2021.04.026
8. ARSLAN K, ÇETİN ARSLAN H. Epidural analjezi ile vajinal doğum sırasında gelişen Horner sendromu. *Agri.* 2021;33(4):272–275. doi: 10.14744/agri.2019.71354C