Analgesia and Anesthesia for Labor and Delivery

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The author delineates the currently employed methods of regional and systemic analgesia for vaginal and abdominal delivery. Emphasis is placed on the effects of maternal position, maternal hyperoxia and the pathophysiologic differences between vaginal and abdominal delivery.

Obstetric anesthesia is unique in that it involves two recipients, the mother and her baby. Both must be considered in the choice and safe administration of analgesia and anesthesia.

General considerations
Maternal position
Modern obstetric practice favors recumbency of the parturient in early labor to facilitate fetal monitoring, and the lithotomy position for delivery of the infant to facilitate forceps application. This trend to recumbency has led to a complication—aortocaval compression. During the latter part of pregnancy, the enlarged uterus compresses both the inferior vena cava and the lower aorta whenever the gravida lies flat on her back. Obstruction of the inferior vena cava leads to reduced venous return to the heart; however, most women are capable of compensating for the resultant decrease in stroke volume by increasing their peripheral resistance and/or heart rate. Only when a high regional block is administered style as for cesarean section—and near-total sympathetic blockade prevents vasoconstriction, does significant hypotension ensue with frequency. Obstruction of the lower aorta causes diminished blood flow to kidneys, the uteroplacental unit, and the lower extremities; compensation for these effects is unpredictable. In most gravidae, kidney function and urine output are significantly lower in the supine than the lateral position.

Uterine activity during labor is influenced as follows: when the parturient lies on her back, contractions occur more frequently but have lower intensity and are, thus, less efficient for the progress of labor than when she lies on either side. Most importantly, the fetus may be compromised; decreases in fetal oxygenation have been shown to be caused solely by the mother’s assuming the supine position, while fetal arrhythmia indicative of uteroplacental insufficiency has been completely alleviated after the mother was turned from the supine to a lateral position.

Fortunately, aortocaval compression and its sequelae are preventable. During labor, the parturient woman should be encouraged to lie on either side. When the supine position becomes necessary prior to delivery for any indication including cesarean section, the uterus

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must be shifted away from the great pelvic vessels with dispatch. For short periods of time, such as for an examination, uterine displacement may be accomplished manually. Otherwise, the uterus can be displaced by elevation of the contralateral hip, by a 15° to 30° down-tilt of the delivery table, or by a combination thereof. Most frequently, displacement should be to the left, and only in rare cases to the right.

Studies during cesarean section have demonstrated increased fetal oxygenation, decreased fetal acidosis, and higher Apgar scores when uterine displacement was instituted as soon as the mother was placed on the operating table. Similarly, during vaginal delivery, the supine position was associated with a time-related decrease in fetal pH, whereas the left-down tilt position was not.

**Maternal hyperoxia**

Serial fetal scalp blood sampling has proven that the oxygenation of the infant in utero corresponds significantly with that of the mother. In obstetrically normal cases, as well as in those with clinical abnormalities, fetal blood oxygen tension varies in direct relation to the maternal level. Compared to values on room air, blood oxygen tension in both mother and fetus decline during maternal inhalation of 10% oxygen, rise with administration of 50% oxygen, and increase further with 100% oxygen.

Because of the characteristics of the fetal circulation, which are the two shunts across the heart (ductus arteriosus and foramen ovale), the increase in oxygen tension of the carotid blood—supplying the brain—is greater than that of the blood supplying other parts of the fetal body.

During cesarean section, under general as well as under regional anesthesia, a significant correlation has been observed between the oxygenation of the mother and the oxygenation and clinical condition of the infant. In a comparison of three groups of 25 parturients receiving low (28%-33%), medium (65%), or high (93%-97%) oxygen concentrations during inhalation anesthesia for elective repeat section, the highest fetal oxygenations and shortest intervals to sustained neonatal respiration resulted when the maternal oxygen tension was 300 torr or more. There was no further fetal or neonatal improvement as the maternal oxygen tension rose above 300 torr, a level of oxygenation attained during general anesthesia with an inhaled oxygen fraction of about 0.6 and during regional analgesia with 100% oxygen administered through a loosely applied face mask. However, the increase in administered oxygen must not be accompanied by either hyper- or hypoventilation, as both hypo- and hypercarbia are potentially harmful. Hypocarbia reduces fetal oxygenation, primarily by shifting the oxygen-dissociation curve to the left (thus decreasing the release of oxygen from hemoglobin), while hypercarbia causes secondary metabolic acidosis in mother and infant. Therefore, the maternal respiratory minute volume should be kept at a normal level.

**Cesarean section versus vaginal delivery**

There are significant differences between abdominal and vaginal delivery in maternal and neonatal physiologic responses and in anesthetic requirements. Cesarean section is an intra-abdominal procedure with the same risks of wound complications and gastrointestinal problems as are associated with other abdominal surgery. Average blood loss is more than double that of vaginal delivery and is accompanied by moderate to marked sequestration of extracellular fluid into the “third” space. The infant born by cesarean section is less well prepared for extraterine life than the baby delivered vaginally. Its blood volume, blood pressure and hemoglobin content are gen-
erally lower, partly because of decreased blood flow to the placenta following incision of the uterus, and partly because of return of blood from fetus to placenta during the delivery process. In contrast, its intracellular water content is expanded and elimination of this excess water is slow. Most important, conditioning is lacking.

Conditioning of the infant during labor and vaginal delivery pertains to both the circulatory and respiratory systems. Uterine contractions cause rhythmic increases in fetal arterial pressure which prepare for the change-over from the intrauterine preponderance of the right heart to the extrauterine preponderance of the left heart. Compression of the fetal thorax during passage through the birth canal leads to the development of a pressure gradient which forces fluids from the airway and stomach; pressure changes following delivery of the upper half of the infant's body result in "passive" inspiration. Absence of these pressure differences in the abdominally delivered baby account for the increased amounts of tracheopharyngeal and gastric secretions as well as the frequently delayed aeration of the lungs.

As to regional analgesia, the sensory level required for cesarean section (T6 through L2) necessitates the use of larger amounts of drug than the sensory blockade needed for vaginal delivery (T10-L1 for the first stage; S2-S4 for the second stage) and is associated with significantly greater sympathetic blockade. The sacral innervation, S2-S4, is parasympathetic.

With regard to systemic anesthetic methods, most vaginal deliveries can be accomplished with inhalation or ketamine analgesia, particularly when combined with pudendal block or local infiltration of the perineum. Cesarean sections, in contrast, require "surgical" analgesia which is associated with three distinct risks: (1) vomiting or regurgitation by the mother with resultant pulmonary aspiration of gastric contents; (2) difficulty in placing the obligatory endotracheal tube with resultant maternal—and consequently fetal—hypoxia; and (3) neonatal central nervous system depression.

Labor and vaginal delivery, on the other hand, are stressful, energy-consuming processes for the parturient associated with marked circulatory, respiratory, and metabolic responses. Augmented catecholamine output may cause incoordinate labor as well as decreased uteroplacental blood flow resulting in fetal impairment (bradycardia, acidosis). Both maternal and fetal reactions can be mitigated by pain relief.

In cesarean section, adequate intravenous hydration with a balanced electrolyte solution is necessary to compensate for blood loss; in vaginal delivery, it is necessary to provide glucose for energy and to replenish electrolytes lost by perspiration.

Regional analgesia

Regional analgesia is the optimal anesthetic method for both vaginal and abdominal delivery, provided there are no medical contraindications. The method is associated with one possible adverse effect, that of maternal hypotension secondary to the vasodilation of sympathetic blockade. This complication, however, need not be feared any longer as it can be prevented in most parturients and treated readily should it occur.

Post-regional block hypotension

Vasodilation leads to postarteriolar pooling of blood; in turn, effective circulating blood volume is decreased, and venous return to the heart is reduced. Hypotension can be prevented (or treated) by increasing the circulating blood volume with an intravenous infusion of a balanced electrolyte solution containing 5% dextrose. Both the salt and dextrose content of the solution are necessary to elevate the osmolality of the fluid in order to prolong the duration

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of its presence in the intravascular compartment.

As a higher level of analgesia is necessary for cesarean section, the degree of sympathetic involvement and, thus, the occurrence of hypotension will be greater; consequently, augmentation of the circulating blood volume is more urgent. For vaginal delivery, an ongoing intravenous infusion usually suffices. In the case of cesarean section, on the other hand, it is important that hydration be forced and acute, that is, shortly before administration of the regional block.

The blood volume must be increased maximally at the time of sympathetic blockade, as water moves rapidly between body compartments to maintain osmotic equilibrium. However, for hydration to be fully effective, it must be combined with adequate displacement of the uterus from the inferior vena cava; hydration is of little value if venous return from the lower part of the body is impeded.

In a study of healthy women undergoing elective cesarean section under spinal analgesia (that is, with sensory levels of T2 to T6) and with appropriate uterine displacement, the intravenous administration of one liter of lactated Ringer's solution with dextrose within 30 minutes of the institution of the block prevented the development of clinically significant hypotension, while the rapid infusion of the same volume of solution was effective in reversing postspinal hypotension in the non-prehydrated controls.

Central venous pressure measurements in the two groups of gravidae revealed an equal decline following onset of anesthesia. In the prehydrated women, however, central venous pressure had become elevated during the course of the infusion; as a result, it fell only to the levels obtained in the non-prehydrated gravidae prior to anesthesia, whereas in this latter group, that is, the controls, venous pressure decreased to abnormally low levels.

A small dose of ephedrine, a vaso-pressor with predominantly cardiac action, is a safe and dependable adjunct to hydration. This is in contrast to the peripherally acting vasopressors (such as, metaraminol, methoxamine, phenylephrine) which may be harmful to the fetus as they increase uterine vascular resistance and, therefore, decrease uterine perfusion. However, without hydration, ephedrine is not consistently effective. Of 16 normal gravidae who were not prehydrated but given 25 mg of ephedrine intravenously immediately after lumbar puncture and before injection of the local anesthetic, nine experienced hypotension which was reversed readily by the rapid infusion of lactated Ringer's solution with dextrose.

Intravenous administration of 10 to 12.5 mg of ephedrine in addition to prehydration is a rational approach for the prevention or treatment of post-regional block hypotension. The intravenous injection of a small dose is preferable to the intramuscular use of a larger dose (25 to 50 mg). Why? An intravenous injection results in faster and more predictable action, and a small dose is less likely to potentiate the hypertensive properties of ergot oxytocics.

Local anesthetics

There are significant differences between the two groups of local anesthetics. The ester-type drugs, such as procaine, chloroprocaine (Nesacaine®), and tetracaine (Pontocaine®), are metabolized almost instantaneously by hydrolysis accomplished by plasma cholinesterases. In contrast, the amide-type drugs, lidocaine (Xylocaine®), mepivacaine (Carbocaine®), prilocaine (Citanest®), bupivacaine (Marcaine®) and etidocaine (Duranest®), are metabolized by hepatic microsomal enzymes at a much slower rate. There are also notable differences among the various amide-structure drugs.

After clinical epidural analgesia, fetal blood concentrations of mepiva-
Caine are significantly higher than those of lidocaine, and lidocaine levels are higher than bupivacaine levels. Not only are these differences evident at birth, but they are demonstrable for the first 24 hours after birth. The neonatal half-lives of the commonly employed anesthetics have been calculated as follows: mepivacaine—9 hours; lidocaine—3 hours; bupivacaine—less than 2 hours; and chloroprocaine—43 seconds. Although these pharmacologic differences do not affect the neonates' Apgar scores, they do influence their neurobehavioral scores.

Neurobehavioral assessment, a rather recent addition of our armamentarium, has demonstrated subtle behavioral changes in newborns whose mothers had received various sedatives, analgesics, or anesthetics during labor or delivery. The examination is based on standard neurologic testing and involves the evaluation of the infant's state of wakefulness, certain reflexes, their muscle tone and power, as well as their responses to various stimuli including pinprick, light, and sound. In addition, the examiner notes response decrement behavior, this is the ability of the baby to modify his/her behavior in response to repetitive stimulation.

It is of interest that the alert infant will not react more than twice or three times to the same stimulation, whereas the non-alert neonate will become startled each and every time the stimulus is applied. Neurobehavioral testing of healthy newborns whose mothers had received lumbar epidural analgesia for labor and vaginal delivery has revealed significantly higher scores following the use of chloroprocaine or bupivacaine than after the use of lidocaine or mepivacaine.

I consider chloroprocaine and bupivacaine the local anesthetics of choice in obstetrics. I believe that lidocaine is acceptable, not optimal, but that mepivacaine, prilocaine and etidocaine are contraindicated—mepivacaine because of its slow degradation in the neonate, prilocaine because of the resultant maternal and fetal methemoglobinemia, and etidocaine because of associated motor blockade that is too profound and too prolonged. Chloroprocaine is characterized by a rapid onset and short duration of action, and complications, should they occur, are generally short-lived. Thus, a convulsion resultant from inadvertent intravascular injection usually persists for less than one minute, while an inadvertent spinal block lasts, on the average, 20 minutes.

**Techniques**

Delineation of the pathways involved in transmission of the pains of labor has made it possible to achieve specific blockade of pain fibers during each stage of labor. Pain of the first stage is transmitted to the spinal ganglia of the tenth thoracic through the first lumbar segments and can be alleviated by a paracervical block or a lumbar epidural block with the catheter threaded cephalad. With paracervical block, the local anesthetic is injected in close proximity to the fetal environment, and the associated high incidence of fetal bradycardia and acidosis has been explained by drug-induced uteroplacental vasoconstriction as well as by high fetal drug concentrations.

Paracervical block is, therefore, not considered the method of choice.

Pain of the second stage of labor is conducted to the second through fourth sacral segments of the spinal cord. A segmental epidural block employed during the first stage of labor can be extended to provide perineal analgesia by injecting additional anesthetic solution with the gravida in the sitting position during administration and for at least three minutes thereafter, or it can be combined with a low caudal, a low spinal, or a pudendal block. It is most important to realize that although fetal and neonatal blood drug concentrations do not differ significantly between segmental lumbar epidural and pudendal block, pain...
relief is much more complete with the former.

Blockade of specific pain pathways during each stage of labor offers advantages to both the mother and fetus. These are: the total dose of the anesthetic is reduced; sensation in the mother's legs is maintained; premature relaxation of the pelvic floor with its inherent risk of posterior arrest of the fetal head is avoided; and the number of affected sympathetic fibers is decreased. In this context, it is noteworthy that a significant difference has been found in the spread of sympathetic blockade comparing epidural and spinal analgesia. With epidural block, sympathetic involvement exceeds sensory blockade by zero to two spinal segments; whereas, with spinal analgesia, sympathetic involvement is two to six segments higher than is sensory blockade.45,46

At our institutions, all epidural blocks are initiated with chloroprocaine for the reasons outlined earlier. Once the block is established, it is continued with either 2% chloroprocaine or with 0.25% or 0.375% bupivacaine. For the perineal block, only 3% chloroprocaine is employed, as prolonged sacral anesthesia results in the increased necessity of bladder catheterization and, consequently, there is a greater incidence of postpartum urinary infection.

The catheter-technique obviates the necessity of adding epinephrine to the local anesthetic solution. This is beneficial, since epinephrine may cause circulatory reactions in the mother and may suppress uterine activity. A properly administered segmental lumbar epidural block does not prolong the course of labor, as is evidenced by labor curves which showed constant acceleration in cervical dilation in both nulliparae and multiparae.47 Similarly, the claim of an increased incidence of fetal bradycardia during epidural analgesia was disproven by continuous monitoring which revealed no heart rate abnormality when the supine position was avoided.48

Despite the overall advantages of segmental epidural block, there are also indications for spinal block. Spinal analgesia is preferred if rapidity of action is essential or if obesity or anomalies of the back suggest difficulties with the performance of an epidural block. Furthermore, the small dose of drug needed for spinal analgesia may be beneficial in premature as well as compromised, acidotic infants.

For cesarean section, lumbar epidural block has also become the preferred method of regional analgesia. Three per cent chloroprocaine, 0.5% bupivacaine, and 0.75% bupivacaine have been used successfully. Although the total dose of anesthetic is considerably greater than that required for spinal block, there are three definite advantages of epidural analgesia. Extension of sympathetic blockade, as pointed out earlier, is less than with spinal block. The hazard of post-lumbar puncture headache is absent. And the injection of 0.25% bupivacaine, about 10 ml. with epinephrine in a ratio of 1:200,000, prior to removal of the catheter at the end of surgery, obviates the need for narcotics in the postpartum period. This, in turn, hastens the recovery of the mother and facilitates the interaction between her and the baby.

Neurobehavioral tests have revealed better scores when regional analgesia was administered for elective cesarean section than when an up-to-date general anesthesia was employed. The differences were evident on both the first and second days of the infant's life.49

Recent studies in surgical patients have confirmed the clinical observation that gravity plays a role in determining the extent and intensity of blockade in epidural analgesia; that is, on the dependent side, anesthesia appeared earlier, spread two segments higher, and lasted considerably longer.50 Therefore, if uterine displacement is to be achieved by left-down tilt, the epidural block should be initiated with the gravida lying on her right side, unless it is
elected to perform the block with the woman in a sitting position.

Whether epidural or spinal analgesia is chosen for cesarean section, oxygen should be inhaled by the mother until the time of delivery (supra vide). In a comparison of epidural-air and epidural-oxygen analgesia for elective section, infants born in the latter group demonstrated higher venous and arterial oxygen tensions and lower degrees of metabolic acidosis; they also initiated sustained respiration at a significantly shorter interval after birth.16

**Systemic analgesia-anesthesia**

With the increased demand for regional analgesia in obstetrics, systemic analgesia and anesthesia are employed less frequently. Nevertheless, there are indications for both analgesia and anesthesia.

**Systemic analgesia**

Systemic analgesia provides satisfactory relief of pain in spontaneous, low forceps, or vacuum extraction delivery, particularly when combined with pudendal block or local infiltration of the perineum. The doses of the agents used are small enough to preserve maternal protective reflexes and effect no newborn depression.

**Inhalational analgesia.** Inhalational analgesia may be achieved by administering anesthetic concentrations of the agent(s) intermittently during uterine contractions or by administering subanesthetic concentrations continuously. The intermittent method is most effective when inhalation is started at the very onset of the contraction. Since contractions are perceptible by abdominal palpation when their intensity exceeds 10 torr but do not become painful until their intensity exceeds 15 torr, they can be recognized by manual palpation prior to pain perception.51 In general, continuous administration of the agent(s) produces better overall results than does intermittent use.

Most of the commonly-employed inhalation anesthetics can be utilized for inhalational analgesia, but nitrous oxide, trichloroethylene and methoxyflurane used to be the preferred agents because of their non-flammability and lack of undesirable side-effects. Recently, enflurane-oxygen has been shown to be safe and effective as a continuously-administered analgesic for vaginal delivery.52

For intermittent inhalation, concentrations of nitrous oxide in oxygen range from 50% to 70%, those of trichloroethylene and methoxyflurane, in air or oxygen, from 0.3 to 0.6 volume%. For continuous administration, inhaled concentrations vary from 30% to 50% for nitrous oxide, from 0.2 to 0.4 volume% for trichloroethylene and methoxyflurane, and from 0.25 to 1.25 volume% for enflurane.52-56

The combination of nitrous oxide with methoxyflurane, both in reduced concentrations, has been shown to increase the incidence of satisfactory pain relief and amnesia.55 It is advisable to begin with a low concentration of the agent(s) and raise it slowly until the maximum level is reached at which the parturient is still cooperative, oriented and conversant. Continuous conversation with the patient aids in the assessment of her level of consciousness.

**Ketamine analgesia.** The trend in the use of ketamine for vaginal delivery has been towards lower dosage. Employed as the sole analgesic agent in 80 women, doses of 12.5 to 25 mg (0.2 to 0.4 mg/kg maternal body weight) injected intravenously immediately before delivery resulted in complete pain relief in 78 of these women, with maintenance of some muscular movement but without unpleasant dreams, respiratory complications or neonatal depression.57 Maintenance of minor muscle activity is desirable, as this suggests continued presence of laryngeal competence. Women who have received a narcotic during labor require lower doses than unmedicated parturients. Recently the administration of two 5 to 10 mg increments has been
found to provide adequate analgesia lasting from five to eight minutes as well as complete amnesia. A continuous infusion of ketamine at a rate of approximately 8 μg/kg/minute has also been used successfully.

Ketamine produces an increase in maternal oxygen consumption and a decrease in respiratory function. Therefore, it is wise to administer a high oxygen fraction. A mixture of 40% nitrous oxide and 60% oxygen is optimal, as the analgesic effect of nitrous oxide augments that of ketamine.

**Systemic anesthesia**

A surgical plane of general anesthesia, accomplished by inhalation agents with or without intravenous drugs for induction or relaxation, is required for rotation and midforceps delivery as well as for cesarean section whenever regional analgesia is medically inadvisable, has failed, or is refused by the patient. General anesthesia is also indicated when obstetric complications demand rapid anesthetization for immediate delivery, when cessation of uterine contractility is needed, or when eclamptic convulsions are imminent at the time of parturition.

**Maternal considerations.** As a result of the cardiopulmonary and metabolic changes of pregnancy, certain aspects of inhalation anesthesia are modified in the gravid woman. Her increased alveolar ventilation and reduced functional residual capacity enhance the replacement of lung air by inhalation anesthetics, accelerating the rate of induction and change in depth of anesthesia. A significant increase in oxygen consumption may cause hypoxemia during endotracheal intubation unless it is prevented by adequate preoxygenation (denitrogenation). And, a marked decrease in total and chest wall compliances increases the work of breathing so that assisted ventilation becomes necessary during prolonged antepartum anesthesia.

The administration of anesthetic planes is associated with two specific maternal hazards, that of pulmonary aspiration of gastric contents and that of hypoxemia secondary to difficulty in endotracheal intubation. The risk of aspiration, with subsequent pneumonitis, can be reduced by patient education regarding food intake, by routine use of oral antacids during labor and prior to elective cesarean section, and by rapid endotracheal intubation utilizing cricoid pressure (Sellick’s maneuver).

If difficulty in insertion of the endotracheal tube is anticipated because of anatomic characteristics of face, neck or upper airways, placement of the tube should be undertaken while the patient is awake or regional analgesia should be considered. When difficult intubation is encountered without forewarning, anesthesia should be discontinued and the mother should be permitted to awaken so that a different anesthetic technique can be employed. A means of instituting transtracheal ventilation, that is, a sterile tracheostomy tray as well as an angiocath-endotracheal tube adaptor setup should be available instantaneously in every delivery room.

**Neonatal considerations.** Neonatal central nervous system depression may result from the rapid placental transfer of the inhalation agents and/or the intravenous drugs used for induction. With any inhalation agent, including nitrous oxide, the percentage of depressed neonates proportionately is greater, the deeper the plane of anesthesia and the longer the duration of administration. However, with modern techniques (that is, a single induction dose—“analgesic” plane and increased oxygen fraction during maintenance), Apgar scores are similar with systemic and regional methods.

In contrast, neurobehavioral assessments have revealed significant differences in vaginally as well as in abdominally delivered newborns. Scores on both the first and second days of life were found to be lower following thiopental-nitrous oxide or ketamine-nitrous oxide.
oxide anesthesia than after regional (lumbar epidural or spinal) analgesia. Although the full implications of these new testing procedures are still to be assessed, it is possible that depression of certain responses may interfere with the parent-infant relationship in the first few days of life.

**Technique and drugs.** In consideration of the previously discussed maternal and neonatal factors, the following basic technique has evolved for the management of “general” anesthesia for cesarean section or complicated vaginal delivery. Premedication with atropine or glycopyrrolate is optional. Anesthesia is commenced with an intravenous injection of a small dose of non-depolarizing relaxant (to prevent muscular fasciculations) and denitrogenation with a high flow of oxygen without positive pressure for at least three minutes. Then, a single intravenous sleep dose is administered, using either thiobarbiturate (not exceeding 300 mg), methohexital (not exceeding 100 mg), ketamine (not exceeding 100 mg) or a ketamine (50 mg)-thiobarbiturate (100-125 mg) sequence.

Ketamine-induction has consistently produced better neurobehavioral scores than thiopental-induction on both the first and second days of life, suggesting that barbiturates are broad-spectrum nonspecific neonatal neurobehavioral depressants for at least 48 hours, whereas the effects of ketamine are less pronounced and less prolonged.

As soon as loss of consciousness occurs, cricoid pressure is applied by a knowledgeable assistant and succinylcholine is injected. Once paralysis develops, an endotracheal tube is inserted, the cuff is inflated, and adequacy of pulmonary ventilation is assured. At this stage, cricoid pressure is released and the obstetrician should be instructed that the procedure may be started (all skin preparation and draping having been completed before induction). Unless a section is performed for urgent maternal indications, the operation should not begin (nor should cricoid pressure be released) until correct placement of the tube has been verified (supra vide).

During the period before delivery, anesthesia is maintained with nitrous oxide and oxygen (40%-60% or 50%-50%). Low concentrations of a volatile agent (halothane up to 0.5 volume%, enflurane up to 1.0 volume%) may be added to the inspired mixture to decrease maternal awareness (if ketamine has not been employed) and to improve uteroplacental blood flow (by decreasing maternal norepinephrine output). The patient should be permitted to return to spontaneous respiration before any further muscle relaxant is administered, since this will serve as a guide to her sensitivity to succinylcholine and reduce the amount of relaxant transmitted across the placenta.

Hyperventilation should be avoided for two reasons: First, it can delay the mother’s return to spontaneous respiration, and second, it can impair oxygen transport to the fetus. Once the umbilical cord has been clamped, placental transfer of anesthetics is no longer a problem and the only considerations are avoidance of maternal hemorrhage secondary to depressed uterine contractility and prevention of significant postoperative respiratory depression. As a consequence, high concentrations of volatile anesthetics and large doses of narcotics or major tranquilizers are not administered.

Postpartum uterine pressure measurements have clarified the effects of ketamine and those of halothane and enflurane on the activity of the human term-pregnant uterus. The effects of both types of drug are dose-related. Ketamine, in a dose of 25 mg, did not alter the contractile pattern, while 50 mg increased the amplitude of the first contraction after the injection. Doses of 75 and 100 mg resulted in an increase in the amplitude of the following one to three contractions, but resting (base)
pressure of the uterus remained unaffected. With halothane and enflurane, frequency as well as amplitude of contractions diminished markedly when blood concentrations of the agents exceeded the equivalent of 1/2 MAC (Minimum Alveolar Anesthetic Concentration which produces immobility in one-half of subjects exposed to a noxious stimulus), but normal contractile patterns returned promptly on lightening the anesthetic plane. These findings should help to avoid undesired uterine depression with its inherent risk of bleeding. Similarly, they should aid in selecting appropriate concentrations of the agents in order to provide rapid cessation of uterine contractility when indicated for obstetric reasons.

Conclusions

Although lumbar epidural block has become the preferred anesthetic method for both vaginal and abdominal delivery, there remain obstetric, medical and psychologic indications for other types of pain relief. The provider of obstetric anesthesia must, therefore, be proficient in all accepted anesthetic techniques.

In the administration of anesthesia, emphasis must be placed first and foremost on maternal and fetal-neonatal safety, but the importance of early mother-infant bonding should also be considered.

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