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Delayed Respiratory Arrest in Combined Spinal-Epidural Anesthesia

Case Report

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Background and Objectives. A case of delayed respiratory arrest in the combined spinal-epidural anesthesia (CSEA) is described. This event was likely due to morphine injected through the epidural catheter, unintentionally entering into the subarachnoid space through the hole in the dura that was made previously by the spinal needle in the needle-through-needle technique. *Methods.* The CSEA is a popular new regional anesthesia that combines the benefits of the spinal and epidural injections. The needle-through-needle technique, which is only one of the various techniques to accomplish CSEA, may increase the risk of unintentionally allowing the entry of the epidural catheter into the subarachnoid space because the spinal needle and epidural catheter have the same pathway. *Results.* This is the second case report of this event with the needle-through-needle technique. The FDA has recently approved this needle-through-needle technique. *Conclusions.* Careful attention to technique is necessary with utilization of CSEA. *Reg Anesth 1994: 19: 418–422.*

Key words: anesthesia, spinal, combined spinal-epidural, morphine-spinal, epidural.

Delayed respiratory arrest caused by morphine injected through the epidural catheter, unintentionally protruding into the subarachnoid space through the dural hole previously made by the spinal needle, in the needle-through-needle technique for combined spinal-epidural anesthesia, is described.

Attention should be exercised in all such cases, because the epidural aspiration test is not helpful in detecting cerebrospinal fluid (CSF) leaking into the epidural space through the dural hole.

The safety of the needle-through-needle technique is questioned.

Myint et al.[1] recently described a 31-year-old parturient who developed a cardiorespiratory arrest following combined spinal-epidural anesthesia (CSEA) for cesarean delivery. This case report of delayed respiratory arrest in CSEA is the second in the literature (to the best of our knowledge) describing this event. Possible causes and precautions are discussed.

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Case Report

A 54-year-old woman, weighing 75 kg, was scheduled for abdominal hysterectomy. Her past history revealed hypertension treated by nifedipine 20 mg twice daily. Blood pressure measured on the day before the operation was 150–160/85–100 mm Hg. Hemoglobin was 15 g/dL. Blood biochemistry, including liver and kidney functions, were within normal limits. On the morning of the operation she took a 20 mg nifedipine tablet. No premedication was prescribed. In the operating room the blood pressure monitor showed 200/130 mm Hg. She received 25

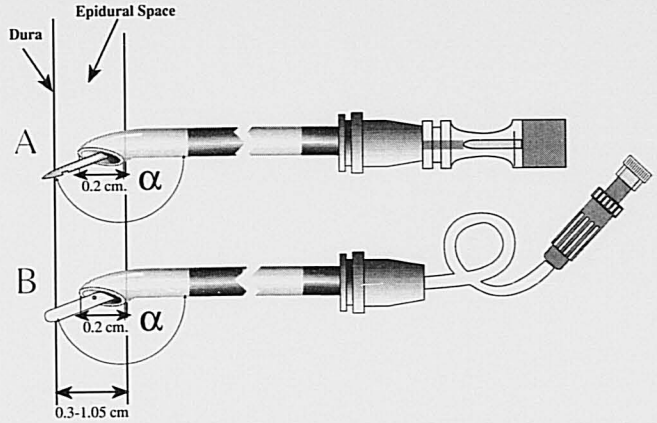

Fig. 1. (A) A spinal needle-through-epidural needle technique. (B) An epidural catheter inserted into the dural hole made previously by the spinal needle-through-epidural needle technique.

mg hydralazine and 2 mg midazolam, intravenously. Blood pressure decreased to 160/100 mm Hg.

The patient was turned on her left side and an 18 gauge Tuohy epidural needle (Portex minipack, UK) was inserted into the epidural space at the L3–4 level. Through the epidural needle a 25-gauge spinal needle 120 mm (Polymedic, USA) was introduced (Fig. 1A). After obtaining CSF she received 2 mL of 0.5% bupivacaine through the spinal needle. The spinal needle was removed and an epidural catheter was inserted caudad through the epidural needle, uneventfully (Fig. 1B). Blood pressure decreased to 110/90 mm Hg and she received ephedrine 10 mg intravenously. During the operation, which lasted for 2 hours, she received another two boluses of 10 mg ephedrine intravenously because of blood pressures of 100–110/80 mm Hg. The patient received 3 liters of Lactated Ringer's solution and 1 liter of 5% glucose during the operation. She also received an intravenous infusion of ketamine 1 mg/mL with midazolam 0.02 mg/mL. The total dose of ketamine was 100 mg and that of midazolam was 5 mg.

During the operation she received repeated injections of 2 mL 0.5% bupivacaine through the epidural catheter. The delay time between the injections was 15–20 minutes and the total amount was 5 injections. The highest level of anesthesia was T3. At the end of the operation she received 3.5 mg morphine through the epidural catheter and was transferred to the recovery room. The epidural catheter was withdrawn. Because of a low blood pressure in the recovery room (90/49 mm Hg), she received another injection of ephedrine 10 mg intravenously with another liter of Lactated Ringer's solution. The blood pressure rose to 116/61 mm Hg. Another injection of ephedrine 10 mg intravenous raised the blood pressure to 136/77 mm Hg.

Six hours after the end of the operation, a decrease in oxygen saturation to 82% was noticed. Before that the patient was receiving oxygen 4 liters/minute by a mask and her oxygen saturation was 97%. An anesthesiologist was called by the attending nurse. The patient was sleeping but could be aroused. She could move both her hands and legs and her pupils were reactive to light. Blood pressure was 126/68 mm Hg with pulse of 84 beats/minute. The amount of oxygen given by mask was raised to 10 L/minute. Within 20 minutes her condition deteriorated. She became cyanotic. Blood gases revealed PCO_2, 91.7 mm Hg; PO_2, 44.2 mm Hg; and pH, 7.106. The patient was rushed into the nearby operating room, her mouth was suctioned and an endotracheal tube was immediately inserted. For intubation she received only 100 mg thiopental intravenously. The oxygen saturation rose to 100%. F_tO_2 was gradually decreased to 0.5.

The patient awoke and could communicate. She received an infusion of naloxone 4 μg/mL and was more awake. However, the endotracheal tube was left in place for 12 hours after the incident. Five days later she left the hospital in good condition.

Discussion

Unintentional protrusion of the epidural catheter through the dural hole, made previously by the spinal needle, in the needle-through-needle technique for CSEA has been discussed. The delayed type of respiratory arrest presented in our patient is most probably caused by subarachnoid morphine (dose undetermined). Three and a half milligrams of morphine injected properly into the epidural space should not cause respiratory arrest. Subarachnoid or subdural penetration by the epidural catheter must be considered but it would appear there was a high-dose subarachnoid injection of morphine. The rapid deterioration in her condition after increasing the F_IO_2 can be explained by abolishing the respiratory drive of the low oxygen saturation with an increasing arterial CO_2 that was demonstrated by the first blood gases taken in the recovery room.

The aspiration test is not helpful in such cases. It has been shown that after a dural hole was made there is CSF in the epidural space that can be aspirated, complicating the situation whether the epidural catheter is in the subarachnoid or the epidural space.[3,4] The five 2 mL top-up injections made during the operation could have been injected into the subarachnoid space. Such test dose injections do not cause a total spinal anesthesia especially when injected caudally. (The anesthesiologist attempted to pass the catheter caudally but this was not documented by any test).

Myint Case

Myint et al.[1] described a 31-year-old parturient who developed a cardiorespiratory arrest following CSEA for cesarean delivery. They located the epidural space with a 16-gauge Tuohy needle via the L2–3 interspace with the bevel facing caudad using the loss-of-resistance-to-saline technique. They inserted a 24-gauge Sprotte spinal needle through the Tuohy needle. Two milliliters of 0.5% bupivacaine in 8% dextrose hyperbaric was injected through the Sprotte needle. Then the Tuohy needle was rotated through 180° to place the bevel cephalad and an epidural catheter with three lateral holes was inserted, leaving 3 cm of the catheter inside the epidural space (Fig. 2). Another injection of 2 mL of 0.5% isobaric bupivacaine with epinephrine 1:200,000 was administered through the catheter. At the end of the operation 2.5 mg of diamorphine in 5 mL of 0.25% plain bupivacaine was given through the catheter. Forty minutes later the patient was found in a cardiorespiratory arrest on the postnatal ward. The patient responded to cardiopulmonary resuscitation and regained consciousness within 2 minutes of the first administration of intravenous naloxone 0.4 mg.

Myint et al. found no blood or CSF in the epidural catheter after its insertion. They did not check it again before the 2.5 mg diamorphine in 5 mL of 0.25% plain bupivacaine epidural injection. After the first injection, through the epidural catheter of 2 mL 0.5% isobaric bupivacaine with epinephrine 1:200,000, the patient complained "a few minutes later of some numbness in her fingers." This can only be a sign of rapid rostral spread by the subarachnoid route. "Her hand grip was strong and she was able to breathe deeply and strongly on request." If Myint et al. had given the patient another bolus of 2 mL these vital signs would have disappeared. "After the birth of the baby" (we suppose 5–10 minutes later), "she again

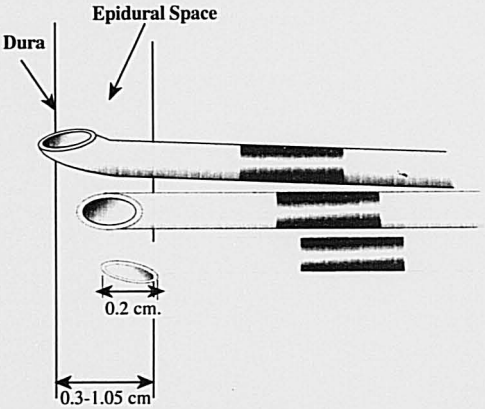

Fig. 2. Rotation of the epidural needle and penetration of the dura mater.

became restless and apprehensive," which can also be a sign of spinal rostral spread of the anesthetic solution.

It is a common practice after an unintentional dural puncture by an epidural needle to make another epidural attempt with injection of 20 mL or more of anesthetic solution into the epidural space for cesarean delivery. Then an opioid is injected through the epidural catheter for postoperative analgesia. We also have used epidural opioid injections for treating patients with post dural puncture headache,[5] with no case of respiratory depression, despite the fact that the dural hole is wider with the 18 gauge epidural needle than with the 24 gauge Sprotte spinal needle that was used by Myint et al.

Needle-through-needle Technique

Myint et al.[1] suggested that the spinal opioid overdosage occurred with diamorphine penetration into the subarachnoid space; by its passage through the breach in the dura caused by the 24 gauge spinal needle; so the diamorphine passed directly through the hole into the CSF and then spread cephalad.

However, we used this technique of CSEA in hundreds of patients using the *double space approach* with no case of respiratory depression. Brownridge[6] reported more than 1,000 cesarean deliveries using the double space approach without the occurrence of respiratory depression.

We warned in 1989 that one of the disadvantages of the needle-through-needle technique is the risk of the epidural catheter penetration through the dural hole made previously by the spinal needle.[7]

Rotation of Epidural Needle

Nickalls and Dennison[8] found that the distance the spinal needle has to be advanced past the end of the Tuohy needle in order to just puncture the dura ranges from 0.3 to 1.05 cm.

Carter et al.[9] abandoned the technique of epidural needle rotation because it increased the chance of unintentional dural puncture by a factor of 5.6. There was also a 16.6% incidence of the epidural catheter protruding through the hole made previously by the spinal needle.

Meiklejohn[10] found that "postmortem dura mater demonstrated that rotation of the epidural needle significantly decreases the force required to puncture the dura." He concluded that "once the needle has been inserted into the epidural space . . . it should not be moved for any reason other than to remove it." Rawal, who advocated rotation of the epidural needle, has changed his mind about this rotation.[11,12]

In a recent overview, Bromage[13] mentioned the risk of subdural catheter penetration due to epidural needle rotation, "If the epidural needle is gently rotated, the sharp tip of the slanted needle arcs around and scribes a cut in the dura to open up the subdural space beneath . . . Clearly, a routine habit of rotating the epidural needle (as is still taught in many centers)is likely to produce a high yield of accidental dural incisions and subdural cannulations. Such a maneuver is fundamentally undesirable in surgical and obstetric practice."

Dural Penetration of Epidural Opioids

Following epidural opioid injection, there are at least three competing processes: transfer across the meninges, vascular uptake, and distribution into extradural adipose tissue. Epidurally administered opioids cross the dura to act on opioid receptors in the substantia gelatinosa of the spinal cord.[14,15] Molecular weight, lipid solubility, and molecular shape influence the rapidity with which diffusion across the dura occurs. Dural permeability increases with age and have a linear relationship to the initial concentration.[16]

Clinical studies have demonstrated that opioid CSF bioavailability following epidural injection is approximately 4%.[17,18] After epidural morphine, only 2% enters the CSF compartment.[19] Transfer of the hydrophilic morphine across arachnoid granulations is slow, with a peak at 90 minutes.[20] Presence of the lipophilic fentanyl in cervical CSF was demonstrated within 20 minutes of injection into the lumbar epidural space.[21] Diamorphine is a moderately lipophilic drug and as such can be expected to have a rapid onset of action and limited rostral spread.

Monitoring—Pulse Oximetry

The potential for delayed onset of respiratory depression caused by epidural opioids is the most important side effect. Patient monitoring to avoid this potential fatal event is done by counting the respiratory rate[22] as ordered by the doctors treating Myint's parturient, ventilatory response to a known $PaCO_2$,[23] or by continuous pulse oximetry.[24]

Haynes et al.[25] used continuous pulse oximetry, for 12 hours after the operation, to monitor 17 parturients following cesarean delivery who had received 5 mg diamorphine epidurally. One or more episodes

of significant desaturation (<90% for 30 seconds) occurred in nine patients. Desaturation to 90%–92% occurred in three additional parturients. It was decided that patients receiving epidural diamorphine should be carefully monitored for hypoxemia using pulse oximetry and given supplementary oxygen if necessary.

The CSEA is popular, it combines the best of the two techniques (spinal and epidural). However, by using the spinal needle-through-epidural-needle technique, one may encounter problems that belong to the technique and not to CSEA. There may not always be enough vigilance to recognize delayed respiratory arrest, especially when the patient is out of the recovery room or the intensive care unit but in a regular patient room.

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