Anesthesiology
65:331–334, 1986

Surgical Analgesia for Cesarean Delivery with Epidural Bupivacaine and Fentanyl

MARITES P. GAFFUD, M.D.,* PRATIBHA BANSAL, M.D.,† CHARLES LAWTON, M.D.,‡
NORMA VELASQUEZ, M.D.,† WILLIAM A. WATSON, PHARM.D.§

Regional anesthesia is an effective method of providing pain relief during labor. The addition of an opiate to an epidurally administered local anesthetic has been suggested to improve the quality of analgesia provided by 0.5% bupivacaine. In an open evaluation of analgesia for cesarean delivery, the combination of 0.5% bupivacaine and 100 μg of fentanyl administered epidurally was more effective than epidural 0.5% bupivacaine alone.[1] The purpose of this evaluation was to compare the analgesic effects of epidural bupivacaine with the combination of bupivacaine and fentanyl in a randomized, double-blind manner.

METHODS

Patients older than 18 yr of age and ASA Class I or II scheduled for repeat elective cesarean delivery were eligible for inclusion into the protocol. Approval from the Committee on Human Research was obtained, and written, informed consent was obtained from each patient prior to entry into the protocol.

Preoperative medications given at least 30 min prior to cesarean section were glycopyrrolate, 0.3 mg intramuscularly, and sodium citrate (Bicitra^{R}), 30 ml orally. One liter of lactated Ringer's solution was infused *via* a peripheral vein prior to epidural block.

With the patient in the sitting position, lumbar epidural block was performed by the loss of resistance technique at the L2–3 interspace, with the epidural catheter threaded 2 to 3 cm into the epidural space.[2] A test dose consisting of 15 mg bupivacaine plus 15 μg of epinephrine (1:200,000) was injected epidurally, after which fractionated doses of 0.5% bupivacaine with 1:200,000 epinephrine, and 2.0 ml (50 μg/ml) fentanyl or placebo (2.0 ml of 0.9% NaCl) were administered epidurally. Both the investigator and patient were blinded to the drug combination administered. The local anesthetic dose was titrated until a sensory level of T-4 was achieved as determined by pin prick. Skin incision was initiated 30 min after epidural drug administration.

All patients received supplemental oxygen, 40% fractional inspired O_2 concentration, *via* face mask. To avoid aorto–caval compression, a left uterine wedge was maintained during the entire surgical procedure.

Blood pressure, heart rate, and respiratory rate were measured at 5- to 15-min intervals. Adverse effects, including nausea, vomiting, dizziness, changes in mental status, pruritus, and respiratory depression (a rate less than 10/min), were documented. After delivery, the condition and Apgar scores of the newborn was assessed at 1 and 5 min. The patient was observed every 15 min for the first 2 h postepidural block and then at hourly intervals for 4 more h. Standard newborn-nursery monitoring of the newborn for signs of toxicity or respiratory depression occurred until discharge.

The presence of pain was evaluated by the anesthesiologist, based on the patient's response to surgical incision and other stimuli, every 15 min. The response was graded as follows: no pain; and mild, moderate, or severe pain.[3] Supplemental analgesics (nitrous oxide, fentanyl, or Innovar^{R}) were administered as required, when the patient's response to surgical incision or stimulation indicated inadequate analgesia.

Pain occurrence, supplemental analgesic requirements, and adverse effects were analyzed using the Fisher exact test. Apgar scores were compared using the Mann-Whitney U test. Bupivacaine doses were compared using the two-tailed student's *t* test for unpaired samples. A P value of < 0.05 was considered statistically significant.

RESULTS

Twenty-two patients were enrolled in the protocol; two patients were excluded from the placebo group because they required general anesthesia prior to delivery. Twenty patients were included in analysis; ten patients received the local anesthetic–opiate (LA–O) combination; and ten

* Attending Anesthesiologist, Appalachian Regional Hospital, Whitesburg, Kentucky.
† Attending Anesthesiologist.
‡ Resident.
§ Program Director, Anesthesiology Research.

Received from the Department of Anesthesiology and The Clinical Pharmacokinetics Laboratory, Millard Fillmore Hospital, 3 Gates Circle, Buffalo, New York, 14209. Accepted for publication May 2, 1986. Performed while Dr. Gaffud was a Resident, Department of Anesthesiology, Millard Fillmore Hospital.

Address reprint requests to Dr. Watson.

Key words: Anesthesia: obstetric. Anesthetics, epidural: fentanyl, bupivacaine. Anesthetics, local: bupivacaine. Anesthetic techniques, regional: epidural.

TABLE 1. Comparison of Treatment Group Variables

	Bupivacaine and Placebo	Bupivacaine and Fentanyl
Age (yr)	27.8 ± 2.4	26.8 ± 5.5
Blood pressure (mmHg)	125.7/70.4 ± 15.7/7.8	137.5/82.1 ± 31/16.7
Heart rate (per min)	92.9 ± 17.4	97.4 ± 18.9
Respiratory rate (per min)	19.8 ± 0.6	21.2 ± 3.2
Bupivacaine dose (mg)	118 ± 13	109.5 ± 12.5

Preoperative vital signs, patient age, and bupivacaine doses used in the two groups. All values are mean ± standard deviation. There are no statistical differences between the groups in the variables.

received the local anesthetic–placebo (LA–P) combination.

All the patients were multiparous and had had prior cesarean deliveries. Patients were pain-free prior to epidural block. The two treatment groups were similar in age, hemodynamic, and respiratory variables prior to drug administration (table 1).

It was our original intent to evaluate the occurrence of pain at specific time intervals during the surgical procedure and quantitate its severity based on the rating scale described in "Methods." However, the intensity of the first pain reported, on incision, was generally moderate to severe, and required supplemental analgesia. We assessed, therefore, whether pain was present or absent during the 2-h observation period postepidural injection. Over the observation period, 70% of the patients in the LA–P group had pain compared with 20% of the LA–O group. This difference was statistically significant ($P < 0.05$). Comparison of pain based on other time intervals demonstrated no difference (fig. 1). Supplemental analgesic requirements followed a similar pattern (fig. 2). Following the surgical incision, between 30 and 60 min after epidural drug administration, 10% of the LA–O group needed supplemental analgesia *versus* 60% of the LA–P group ($P < 0.05$). Over the total 2-h observation period, fewer patients in the LA–O group needed supplemental analgesia compared with the LA–P group ($P < 0.01$). Surgery was completed approximately 90 min after beginning the study.

The highest frequency of pain within the first hour coincided with the maximal surgical stimulation *i.e.*, incision, uterine manipulation, newborn extraction, and peritoneal retraction. It was also within this time period that the greatest amount of supplemental analgesics was required. Prior to delivery, nitrous oxide was used for supplemental analgesia; intravenous analgesics were used after delivery. The lower incidence of pain over the second hour corresponded to lesser stimuli, *i.e.*, closing of uterus, fascia, muscles, and skin, and the maximal analgesic effects of supplemental analgesics given in the first hour. Patients became drowsy after the administration of supplemental intravenous and analgesics.

Hypotension was defined as: 1) a 30% drop from the initial blood pressure; or 2) a systolic blood pressure less than 100 mmHg. Thirty per cent of the LA–P group and 50% of the LA–O group had hypotensive episodes ($P > 0.05$). Forty per cent of the LA–P group had nausea or vomiting compared with 50% of the LA–O group. No changes in mental status were observed with either treatment. There was no obvious respiratory depression; however, Pa_{CO_2} was not measured. One patient in the LA–O group had mild truncal pruritus. This was not mentioned spontaneously, and was elicited only after questioning the patient.

Mean Apgar scores at one min were 7.9 ± 0.7 for the LA–O group, and 8.1 ± 0.7 for the LA–P group. All Apgar scores were 9 at 5 min. Comparison of Apgar scores revealed no differences between treatment groups ($P > 0.05$).

DISCUSSION

Because of potential cardiotoxicity associated with 0.75% bupivacaine, anesthesiologists have been using the 0.5% concentration of bupivacaine since 1983.[4,5] The

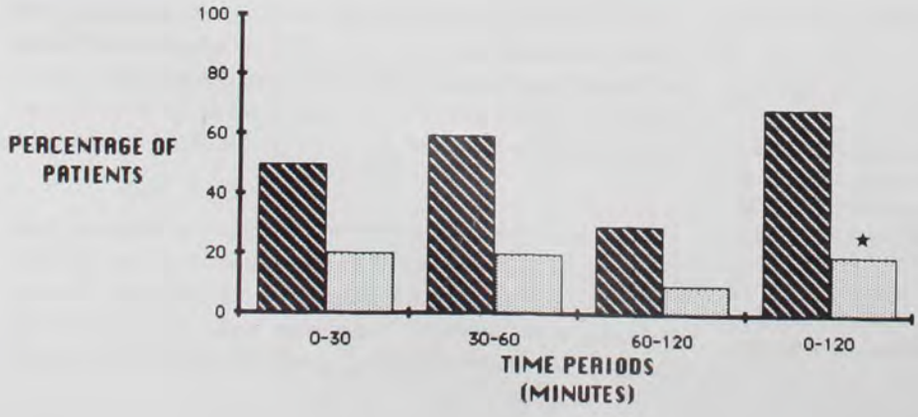

FIG. 1. The per cent of patients with pain during cesarean delivery after epidural drug administration. *Diagonally striped bars* represent patients receiving bupivacaine and placebo; *stippled bars* represent patients receiving bupivacaine and fentanyl. *Star* indicates $P < 0.05$ (Fisher exact test).

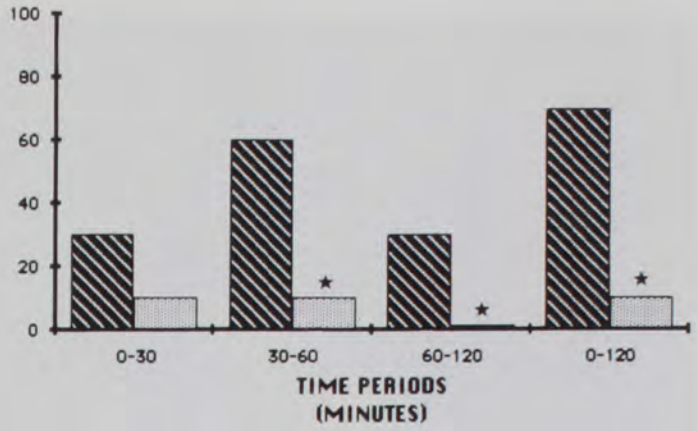

FIG. 2. The per cent of patient requiring supplemental analgesics during cesarean delivery after epidural drug administration. *Diagonally striped bars* represent patients receiving bupivacaine and placebo; *stippled bars* represent patients receiving bupivacaine and fentanyl. *Stars* indicate $P < 0.05$ (Fisher exact test).

lower concentration is adequate for sensory analgesia; however, it does not provide optimal conditions for surgical analgesia.[6] This observation was made by Milon *et al.*,[1] and has been confirmed in our present study. Seven of ten patients given epidural bupivacaine 0.5% plus placebo, despite having a T-4 sensory level block, complained of pain after surgical stimulation. All of the patients who complained of pain required supplemental analgesia, and two patients excluded from analysis required general anesthesia.

Measurement of pain and the effects of analgesics includes a number of quantal and quantitative techniques. In this study a parallel study design was chosen because the pain-causing stimulus was consistent in all patients. A standard four-point scale based on patient reports of pain severity was initially used,[3] but proved inadequate because the pain occurred on surgical stimulation, and was generally severe enough to require supplemental analgesia. The judgement of the anesthesiologist determined whether supplemental analgesics were administered. Therefore, in this situation where the pain is related to a specific, predictable event, a simple quantal determination of the presence or absence of pain based on verbal and physical responses of the patient, and their ability to cooperate with the obstetrician and anesthesiologist was used.

A previous study has shown that the quality of epidural analgesia can be improved by combining 0.5% bupivacaine with fentanyl.[1] In an open comparison, ten women received 0.5% bupivacaine and 20 received 0.5% bupivacaine plus fentanyl, 1.70 ± 0.09 μg/kg. A faster onset of action and more effective analgesia was seen with the combination therapy than with bupivacaine alone. No adverse effects were noted. In the present study, the combination of 0.5% bupivacaine and 100 μg of fentanyl provided superior analgesia when compared to 0.5% bupivacaine and placebo. Only two of ten patients given the combination complained of pain on surgical stimulation. One of the two patients complained of pain severe enough to require supplemental analgesia.

The combination of bupivacaine and fentanyl was not associated with identifiable significant adverse effects in the newborn. A more sensitive evaluation of central nervous system function, such as the early neonatal neurobehavioral score, should be used in future studies to verify and expand our less sophisticated evaluation.[7] Maternal hypotension occurred more frequently than has been reported with epidural bupivacaine.[8] The incidence of hypotension was higher when fentanyl was added. No differences in technique could be identified to explain this finding when compared with previous reports. All hypotensive episodes responded rapidly to treatment. No significant differences in the incidence of nausea or vomiting, pruritus, dizziness, changes in mental status, or urinary retention were seen when combination therapy was compared to epidural bupivacaine alone.

One hundred micrograms of epidural fentanyl for cesarean delivery results in an average umbilical artery concentration of 0.8 ng/ml, below the concentrations implicated in respiratory depression of the newborn.[1] However, recommended dosages and blood levels are only meant to be guidelines, because it is often difficult to correlate blood levels with respiratory effects. A newborn may have an umbilical artery fentanyl level of less than 1.0 ng/ml and yet be depressed from narcotic exposure.[9] Furthermore, in disease or physiologic states such as pregnancy, where raised intrathoracic or aorto–caval compression can occur, unexpectedly high plasma levels may occur even with a recommended dose.[10] The addition of fentanyl to bupivacaine results in better analgesia when compared with bupivacaine alone. Further studies in large populations should be pursued to evaluate the effects of fentanyl on the newborn and to verify the incidence of maternal hypotension.

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Anesthesiology
65:334–338, 1986

Traumatic Pseudoaneurysm of a Pulmonary Artery: Anesthetic Considerations

JAMES A. DINARDO, M.D.*

Traumatic pseudoaneurysm of the pulmonary artery is a rare vascular lesion with only seven cases reported since the enitity was originally described in 1918 by Konjetzny.[1] Surgical resection of these lesions is recommended, as massive hemoptysis from rupture of the aneurysm into the bronchial tree can occur.[1,2] In addition the risk of an infected hemothorax[3] and the potential for development of a propagating clot in the traumatized vessel make resection indicated. Described is the anesthetic management of a patient who underwent resection of a traumatic pseudoaneurysm of the artery supplying the posterior basal segment of the left lower lobe.

REPORT OF A CASE

A 37-yr-old man was admitted to the emergency room following an altercation in which he received two stab wounds to the left posterior chest with a 12-in kitchen knife. His past medical history was remarkable only for a history of alcohol abuse, a penicillin allergy, and a left tube thoracostomy at age 6 weeks for unknown indications. He had a systolic arterial blood pressure of 70–80 mmHg, a heart rate of 100 beats/min, and a respiratory rate of 30/min. A left chest tube, large bore iv cannulae, Foley catheter, and central venous line were inserted and the patient was given 5 l of lactated Ringer's solution and 2 units of packed red blood cells iv. Subsequent chest roentgenogram revealed a left perihilar opacity consistent with a parenchymal hematoma (fig. 1). This impression was confirmed by a computerized axial tomography (CAT) scan obtained later the same day. The patient did well thereafter, with no symptoms and no alteration in his cardiovascular or respiratory status. With a fractional inspired O_2 concentration (FI_{O_2}) of 0.21, Pa_{O_2} ranged from 78 to 85 mmHg. Three days later, a right upper lobe collapse was noted on a repeat chest roentgenogram. The patient was asymptomatic, and the collapse cleared with chest physical therapy.

Four days following injury, chest roentgenogram revealed that the left perihilar mass had increased in size and the diagnosis of a pulmonary artery pseudoaneurysm or arteriovenous (A–V) fistula was considered. A film obtained later that day showed the perihilar mass to be better defined and larger (fig. 2). A CAT scan with contrast on the next day revealed an intensely vascular 5.5 cm left perihilar mass felt to be highly suggestive of a pulmonary artery pseudoaneurysm or A–V fistula (fig. 3). A pulmonary artery angiogram done later that same day confirmed the presence of a pseudoaneurysm of the posterior basal segment artery of the left lower lobe (fig. 4). The patient remained asymptomatic.

The next day the patient was scheduled for resection of the pseudoaneurysm. At that time his hematocrit was 36.1% and his coagulation values were within normal limits. This 70-kg patient was premedicated with 10.0 mg of diazepam iv and brought to the operating room, where he had two peripheral 14-gauge iv cannulae, a 16-gauge right external jugular vein cannula, and a 20-gauge right radial artery cannula inserted. Anesthesia was induced with fentanyl 300 μg, thiopental 500 mg, and pancuronium 7 mg iv. Following ventilation with isoflurane 1% in 100% O_2, the trachea was intubated with an 8.0 mm ID endotracheal tube and flexible fiberoptic bronchoscopy was performed by the surgeon to rule out any bronchial injury. No injury was detected, and the trachea was reintubated with a 37 French OD Bronchocath® left-sided double-lumen endotracheal tube. Proper tube position was verified with use of a pediatric fiberoptic bronchoscope. Differential lung ventilation was verified by auscultation. The patient was positioned for a left thoractomy, and differential ventilation was again verified.

Due to the patient's previous closed tube thoracostomy as a child, the visceral and parietal pleura were adherent and dense adhesions

* Instructor in Anaesthesia, Harvard Medical School, and Co-Director, Division of Cardiac Anaesthesia.

Received from the Department of Anaesthesia and Respiratory Therapy, Beth Israel Hospital, 330 Brookline Avenue, Boston, Massachusetts 02215. Accepted for publication May 5, 1986.

Address reprint requests to Dr. DiNardo.

Key words: Anesthesia: thoracic. Arteries: pseudoaneurysm; pulmonary. Equipment: tubes, endobronchial.