

and securing the proximal end in an upright position to a nearby stationary object. Oxygen fresh gas flow is provided by a portable oxygen source connected to the fresh gas inlet of the CPRAM or Bain circuit. PEEP valves (Boehringer Laboratories, Wynnwood, Pennsylvania) are mounted in 2.5 cmH₂O increments on the upright proximal end of the circuit, providing a safe and controllable source of CPAP. Oxygen flows of 3 to 4 l/min have proven to be adequate, and levels of CPAP can be evaluated by visual examination of the lung, reexpansion of atelectatic segments, arterial blood gases, and the tolerance of the surgeon of the distended but nonmoving lung. It has been my experience that the mild distension of the lung obtained using CPAP of 5 to 7.5 cmH₂O has caused no difficulty for operating surgeon and consistently has improved intraoperative oxygenation.

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(Accepted for publication March 2, 1984.)

Anesthesiology
61:217-218, 1984

Epinephrine Should Be Used with the Therapeutic Dose of Bupivacaine in Obstetrics

To the Editor:—Dr. Marx should be commended for her recent editorial “Cardiotoxicity of Local Anesthetics—The Plot Thickens,”¹ which is an appropriate follow-up to my editorial in 1979.² It is unfortunate that the recent warning, “0.75% bupivacaine is no longer recommended for obstetrical anesthesia because of reports of cardiac arrest and death where resuscitation has been difficult or impossible despite apparently adequate preparation and appropriate management,” was not included as an addendum. This warning was sent as a “Dear Doctor Letter” by the manufacturers of bupivacaine in August, endorsed by the FDA’s Anesthetic and Life Support Drugs Advisory Committee in October, and promulgated by the FDA Drug Bulletin in November 1983. During the 5 months subsequent to the “Dear Doctor Letter” there have not been any new cases of bupivacaine-induced seizures and cardiac arrest, which is in contrast to the 10 cases reported to the FDA over the previous 2 years.

I cannot agree with Dr. Marx’s statement that “epinephrine 5 μg/ml should not be added to the full dose because of its propensity for decreasing uterine blood flow.” This controversy is more than just of academic interest. Potentially false-negative epidural test doses of bupivacaine 0.75% (plain) have occurred with 2, 3, 4, and 5 ml.* Even if a negative epinephrine test dose is administered, the needle or catheter may enter a blood

vessel just before the therapeutic dose. Incremental bupivacaine 0.75% (plain) epidural injections of 2 + 1 + 4 ml, 2 + 4 + 15 ml, 2 + 5 + 10 ml, 3 + 4 ml, 3 + 5 + 8 ml, 3 + 5 + 10 ml, 10 + 10 ml, 5 (needle) + 5 (catheter), and 3 + 3 + 3 + 3 ml have resulted in cardiac arrest in obstetric patients.* Therefore, incremental doses of bupivacaine 0.75% without epinephrine as a marker to warn of an intravascular injection are potentially unsafe and may result in cardiac arrest. Incremental epidural injections of lesser concentrations of bupivacaine (plain) may be less hazardous, but 15–27 ml of bupivacaine 0.5% (10 cases) and 30 ml of bupivacaine 0.25% have resulted in maternal cardiac arrest.*

Dr. Marx discussed three parturients (out of 12) from my previous work, who had a decrease in intervillous blood flow (IBF) following the epidural administration of 10 ml chloroprocaine 2% with epinephrine 5 μg/ml.³ Two of these patients had calculated mean blood pressures below 75 mmHg, and the third patient with the greatest decrease in IBF has a coupled contraction at the time of the IBF measurement that may have invalidated it. An unreported patient during this study had intravenous ¹³³Xe injected unintentionally in a solution containing 11 ml of chloroprocaine 2% with epinephrine 5 μg/ml. When the patient’s dramatic increase in blood pressure and heart rate returned to preinjection values 20 min later, ¹³³Xe diluted in saline was injected for a “control” IBF measurement. The IBF measurement during the intravenous epinephrine injection (55 μg) demonstrated only a 15% decrease from the “control” value.

* Transcript of the Fifth Meeting of the Anesthetic and Life Support Drug Advisory Committee, held on October 4, 1983.

Jouppila *et al.*, 1978,⁴ measured IBF after epidural anesthesia with 4 ml bupivacaine 0.5% in eight patients and with 4 ml bupivacaine 0.5% with epinephrine 5 $\mu\text{g}/\text{ml}$ in 10 patients. The addition of epinephrine 20 μg produced no significant effect on IBF, although four of the patients who received epinephrine had decreases in IBF. Thus, 4 ml of local anesthetic solution containing epinephrine 5 $\mu\text{g}/\text{ml}$ (compared with a 3-ml recommended test dose) would be unsafe by Dr. Marx's rationale. However, Jouppila *et al.*, 1978,⁵ studied the effect on IBF of lumbar epidural anesthesia for cesarean section in nine patients administered 16–20 ml lidocaine 1.5% with epinephrine 5 $\mu\text{g}/\text{ml}$. There was a mean decrease of 13% from the control value that was not statistically significant. The largest decrease in IBF occurred in two patients with simultaneous arterial hypotension. The mean decrease in IBF in the other seven patients was 8 $\text{ml} \cdot 100 \text{ g}^{-1} \cdot \text{min}^{-1}$ (reproducibility of the technique is $\pm 20 \text{ ml} \cdot 100 \text{ g}^{-1} \cdot \text{min}^{-1}$).

There are no clinical studies that have demonstrated any adverse effects on the neonates of mothers who received local anesthetics epidurally that contained epinephrine 5 $\mu\text{g}/\text{ml}$. Conversely, there is a large clinical series of 1,946 patients who received large volume (20 to 25 ml) caudal anesthetics (mepivacaine = 748 patients; mepivacaine with epinephrine = 658 patients; and lidocaine with epinephrine, 515 patients) that had no differences in neonatal outcome between the three groups.⁶

Based on my knowledge of bupivacaine cardiotoxicity

in obstetrics, I believe that epinephrine should be added to all doses of epidural bupivacaine where total incremental dosage exceeds 50 mg.

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(Accepted for publication March 6, 1984.)

Anesthesiology
61:218–219, 1984

In reply:—Dr. Albright's contention that epidural epinephrine can be used safely in obstetric practice is based primarily on three studies of intervillous blood flow (IVBF) undertaken at the same institution by a radioisotope method that limits the number of tests permitted.^{1–3} Thus, according to the protocol, only one postepidural determination was performed, immediately after a uterine contraction and 10–15 min following the injection of the anesthetic. Epinephrine is a rapidly acting drug of limited duration so that its peak effect well may have subsided at the time of determination. Nonetheless, in only one of the three studies¹ did IVBF remain unchanged in all cases—following injection of bupivacaine 20 mg with epinephrine 20 μg , a dose that approximates that recommended as a test dose. In the second study,² 10 ml of local anesthetic containing 50 μg of epinephrine was administered to 12 parturients, and IVBF declined markedly in three of these. In one instance, this was explained as

secondary to an unanticipated uterine contraction. In the other two cases, however, the fall was associated with a decline in maternal mean blood pressure to below 75 mmHg in the presence of a systolic pressure above 100 mmHg; the underlying severe decrease in diastolic pressure obviously points to an epinephrine-induced loss of vascular resistance. In the third study,³ epinephrine 80–100 μg was added to 16–20 ml lidocaine in nine gravidae scheduled for elective cesarean section, and in seven of these, the subsequent decline in IVBF ranged from 4 to 58%. The mean decrease of 13% was “statistically” not significant, but the clinical importance was not ascertained as fetal ECG was not recorded.

In these investigations, epinephrine was used to prolong the action of the local anesthetic, not to rule out accidental intravascular injection. Despite its administration into the epidural space, decreases in IVBF were demonstrable in at least 18% of cases following addition of epinephrine