Hematoma, trauma, or extravasation of fluid or drugs may damage vulnerable neurologic structures in the neck and superior mediastinum. Significant neurologic deficits resulting from attempted percutaneous puncture of the internal jugular vein have been reported. In one patient both carotid arteries were punctured during attempts to locate the jugular veins. The resulting hematomas caused recurrent laryngeal nerve paresis and firm apposition of the vocal cords. A tracheostomy was necessary until normal cord function returned in several weeks. In another case, extravasation around an indwelling internal jugular catheter damaged the sympathetic chain, cervical plexus, and the last four cranial nerves on the left side. The neurologic deficits resulted in chronic pulmonary aspiration and were major factors in the patient’s eventual death.

Direct ocular trauma, topical mydriatics, and concomitant neurologic disease were considered as other possible causes of unilateral mydriasis in this patient. The most plausible explanation for the clinical findings, however, would be sympathetic pupillodilator stimulation, due to direct trauma or pressure from hematoma around the carotid puncture. While the finding of unilateral pupillary dilatation seemed somewhat ominous when first discovered during anesthesia, it resolved, with no permanent neurologic deficit.

REFERENCES

Dextrose Affects Gravitational Spread of Epidural Anesthesia

YOUNG R. PARK, M.D.,* AND DOUGLAS W. EASTWOOD, M.D.†

Gravitational influence on the spread of local anesthetics in the epidural space has been identified by several investigators.1–4 However, as a result of other factors, lumbar epidural anesthesia tends to spread to the thoracic area to a greater extent than to the caudal area. This is disadvantageous for the patient who needs perineal anesthesia for the second stage of labor. Many factors may influence the extent and direction of spread of anesthesia in the epidural space. This study was designed to determine whether administering the local anesthetic in a dextrose, 5 per cent, solution would decrease the thoracic spread of lumbar epidural anesthesia in pregnant women at term.

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Materials and Methods

In a double-blind design, 60 patients for whom epidural anesthesia had been selected for vaginal delivery or for cesarean section were randomly assigned to control or study groups. The Human Research Review Committee approved the study protocol, and informed consent was obtained from each patient. Obese patients (weighing more than 100 kg) and patients whose progress in labor was so rapid that determination of the anesthetic level was not feasible were excluded.

Chloroprocaine, 0.5 per cent; was used to provide analgesia for labor, and 2.7 per cent was used for delivery or cesarean section. Patients in the study group received anesthetic solutions containing dextrose, 5 per cent, while solutions for the control groups were diluted with physiologic saline solution. Solutions were prepared and numbered according to a random table by the hospital pharmacist. Anesthesiologists selected the desired anesthetic con-
Table 1. Highest Sensory Levels of Analgesia

<table>
<thead>
<tr>
<th></th>
<th>Physiologic Solution</th>
<th>Dextrose, 5 Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chlorproprazine 0.5 Per Cent (n = 109)</td>
<td>Chlorproprazine 2.7 Per Cent (n = 14)</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>1.007</td>
<td>1.018</td>
</tr>
<tr>
<td>Osmolarity (mOsm/l)</td>
<td>283</td>
<td>283</td>
</tr>
<tr>
<td>Level achieved</td>
<td>T6</td>
<td>T8</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>7</td>
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<td>1</td>
<td>1</td>
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</tbody>
</table>

* Number of patients.

Concentration but did not know whether dextrose had been added.

Specific gravity, osmolarity expressed as milliosmols/liter (mOsm/l), and pH were determined for mixtures of the local anesthetic with dextrose or saline diluent. The specific gravity at room temperature was measured by use of an optical densitometer. Osmolarity was determined by freezing-point depression, and pH was measured at 37°C on a Radiometer® analyzer. Measurements were made in triplicate and repeated by a second observer.

With the patient in the seated position, the epidural space was identified through the second or third lumbar interspace, using the loss-of-resistance technique with local anesthetic in the syringe. A total of 10 ml of solution was injected through a 17-g Tuohy needle, bevel directed cephalad, at the rate of 1 ml/sec. A catheter was inserted with the patient remaining in the seated position for 4 min. The patient was then returned to the supine position, tilted to the left, and a wedge placed under the right hip. A fluid load was administered prior to or during the administration of anesthesia.

The dermatome level of analgesia to pin pressure was determined every 5 min for 15 min and the maximal level recorded. Once these determinations had been completed, additional anesthetic was added through the epidural catheter as selected by the anesthesiologist to provide satisfactory anesthesia. In the initial phases of the study, temperature sensitivity was measured with ice. This was discontinued in later studies because the level of obtundation was found to be the same as that obtained by use of the pin pressure level. The Wilcoxon rank-

sum test was used to determine whether a significantly lower anesthetic level resulted when dextrose, 5 per cent, was added to chlorproprazine.

Results

The pH values of all study and control solutions remained in the range of 3.14 to 3.30, which is the same as that of commercially prepared chlorproprazine. The highest sensory anesthetic level attained was usually identified at 5 min, and did not change in most patients during the subsequent periods. For this reason, only the highest level attained on each patient is presented in table 1. Chlorproprazine, 0.5 per cent, with physiologic saline solution, which had the lowest specific gravity (1.007) and osmolarity (283 mOsm/l), resulted in a level of anesthesia at or above the sixth thoracic dermatome in nine of 19 patients. Only one of the 19 had a level at or below the twelfth thoracic dermatome. Chlorproprazine, 2.7 per cent, with dextrose, 5 per cent, had a higher specific gravity (1.034) and greater osmolarity (524 mOsm/l). Only one of 14 patients with this concentration had an anesthesia level above T6, while seven had level at or below T12. A significantly lower anesthetic level resulted when dextrose, 5 per cent, was added to chlorproprazine (P < 0.05 for 0.5 per cent and P < 0.01 for 2.7 per cent chlorproprazine).

Discussion

Gravity has been shown to play a definite role in anesthetic distribution when the patient is in the lateral position during injection of the anesthetic into the epidural space.

The dependent side has a more rapid onset and a longer duration of action. When the pregnant patient is in the seated position, however, a number of other factors influence the height of the anesthetic. The pressure in the lumbar subarachnoid space is higher than that in the thoracic region. The veins in the lumbar epidural space are more distended, especially when the patient is flexed forward over a contracting, full-term uterus. Pressure in the lumbar epidural space is therefore higher than in the thoracic area, which tends to displace the injected fluid in an upward direction.

Dextrose increases the specific gravity and the osmolarity of the local anesthetic solutions, as can be seen in table 1. The highest anesthetic level obtained is lower with the increase in specific gravity and osmolarity. The higher osmolarity of the injected solutions (524–542 mOsm/l) will draw fluid from the intracellular spaces (281.3 mOsm/l) and expand the volume of the interstitial gel. The inter-
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strial fluid, which is held in a gel state under normal conditions, will swell to 30 to 50 per cent with the addition of liquid, after which any further increase in fluid volume is not absorbed by the gel and is highly mobile. The fluid is free to flow downward in the tissue influenced by the pull of gravity. The higher the specific gravity, the greater the pull.

SUMMARY

Chlorprocaine, 0.5 per cent, with physiologic saline solution, has a specific gravity of 1.007 and a osmolality of 283 mOsm/l, which increase to a specific gravity of 1.025 and an osmolality of 542 mOsm/l when chlorprocaine is prepared in dextrose, 5 per cent. Chlorprocaine, 2.7 per cent, shows similar increases in specific gravity and osmolarity with dextrose 5 per cent. The highest sensory anesthesia level attained in pregnant patients following epidural injection of 10 ml of each of these solutions was determined. Chlorprocaine in dextrose, 5 per cent, produced a significant lowering of the highest sensory anesthesia level attained, compared with solutions to which dextrose was not added.

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7. Ibid.: p 408

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Leg Lift and Maximum Inspiratory Force, Clinical Signs of Neuromuscular Blockade Reversal in Neonates and Infants

LINDA J. MASON, M.D.,* AND EUGENE K. BETTS, M.D.†

Clinical signs of adequate neuromuscular blockade reversal in adults are based on voluntary actions (head raising, grip strength) that often are not applicable to the neonate and infant. Reflex leg lift has been used for more than ten years in the evaluation of neurologic development in neonates and infants.1 We propose that leg lift might also serve as a criterion of adequate neuromuscular blockade reversal in this age group. Values of maximum inspiratory force (MIF), an established test for identification of adequate neuromuscular block reversal in adults, have not been reported for healthy infants, and were determined in this study. Reflex leg lift was then correlated with MIF measured before and after anesthesia and reversal of neuromuscular blockade. Correlation of reflex leg lift with train-of-four stimuli was found to be impractical in awake neonates and infants because they would not maintain a resting (relaxed) thenar muscle tension for 2 sec at the time they reflexly raised their legs, or for any two-second period soon thereafter.

METHODS

This study was approved by the Committee for Protection of Human Subjects. We determined MIF according to the method of Westcott and Bendixen,2 except that airway occlusion was maintained for only 15 sec.3 A 16-gauge tapered catheter, inserted into a 90-degree elbow connector, was connected by high-pressure tubing to a Hewlett Packard 1280C pressure transducer, and the negative inspiratory effort recorded. The transducer and recorder were calibrated, in centimeters of water, against a Wallace and Tierman Penwalt Series 6150 Portable Pneumatic Calibrator.

The patients were divided into two study groups. Group 1 consisted of 20 infants (aged 1 day to 12 weeks) who were premedicated with only atropine

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