air injected subcutaneously in the lumbar area may have migrated cephalad in this compartment, eventually to localize in the neck (fig. 2).

Subcutaneous emphysema may be alarming to the patient, and in large quantities has embolization potential. It may also produce extrinsic compression of vital neck structures, resulting in hoarseness or airway obstruction. Additionally, air injected into the epidural space may prevent uniform spread of local anesthetic solutions in this compartment and result in an uneven epidural block. Finally, air injected into the body requires a very long period for resorption. Since as long as 16 hours is necessary for absorption of air from a nonventilated but well-perfused alveolus, an even longer period might be expected for resorption of air from poorly perfused subcutaneous tissues.

In contrast, selection of a liquid for the loss of resistance technique will avoid the problems associated with the use of air and may also allow for more sensitive transmission of pressure changes. Finally, the sudden forceful ejection of a liquid from the needle once the epidural space is entered may push the dura away from the needle and lessen the likelihood of inadvertent dural puncture. Sterile physiologic saline solution is preferred to local anesthetic solutions as a liquid injectate for loss of resistance, since its use eliminates the possibility of local anesthetic toxicity from inadvertent intravascular injection.

The case of a patient who had cervical and supravacular subcutaneous emphysema after lumbar epidural anesthesia is reported. Theories explaining this event and modifications of technique to prevent its future occurrence are suggested.

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REFERENCES


Comparison of Epidural Saline Placement and Epidural Blood Placement in the Treatment of Post-lumbar-puncture Headache

ALEX J. BART, LCDR, MC, USNR* and A. SCOTT WHEELER, LCDR, MC, USNR†

The occurrence of headache following lumbar puncture is rarely a major complication, but it is frequently distressing. In addition to the conservative measures of bedrest, hydration and analgesics, more direct methods have been developed to counteract cerebrospinal fluid leakage through the dural puncture site. Epidural or caudal injection of saline solution has been shown to be an effective countermeasure,1–3 with success rates of 71 to 84 per cent

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Table 1. Relief after 24 Hours, 25-gauge Dural Punctures

<table>
<thead>
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<th>Saline Solution</th>
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<th>Total</th>
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<tbody>
<tr>
<td>Relief</td>
<td>9</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>No relief</td>
<td>6</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>11</td>
<td>26</td>
</tr>
</tbody>
</table>

Table 2. Relief after 24 Hours, 17-gauge Dural Punctures

<table>
<thead>
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<th>Blood</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relief</td>
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<td>8</td>
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</tr>
<tr>
<td>No relief</td>
<td>6</td>
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<td>9</td>
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<tr>
<td>Total</td>
<td>6</td>
<td>11</td>
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</tr>
</tbody>
</table>

reported. Treatment by epidural blood placement was advocated by Gormley and popularized by DiGiovanni and Dunbar. Some have adopted the technique with enthusiasm, with success rates of 89 to 98 per cent. Others have been critical, and its use has been challenged on the grounds that epidural placement of saline solution is equally effective.

We therefore proposed a prospective randomized study comparing the efficacies of epidural placement of saline solution and epidural blood placement in relieving post-lumbar-puncture headache.

**Methods**

Patients were selected from the obstetric service only. We recognized that our study population included patients who had received spinal anesthesia and those in whom an inadvertent dural puncture had been created during attempted epidural anesthesia administration. We therefore elected to consider two specific populations, one with 25-gauge dural punctures, one with 17-gauge punctures. Criteria for selection into the study included subjective evaluations of the extent of disability—severity of headache, visual disturbance, accompanying nausea, inability to care for newborns effectively, and delay in discharge from the hospital. In most instances, there was also failure of headache relief with conservative measures. Patients selected also had to have no contraindication to receiving either treatment, and had to give informed consent. Patients in whom a lumbar epidural catheter had been left in place following inadvertent dural puncture were excluded from the study, since it is our belief that this could introduce bias.

Assignment to the study groups was made on the basis of the hospital sequential registry number, those patients with odd numbers being assigned to receive saline solution, those with even numbers, to receive autologous blood. Saline solution was administered according to the recommendation of Usugi et al., with 30 ml being chosen as a standard dose. Blood administration was according to the technique of DiGiovanni and Dunbar, injecting 10 ml of aseptically obtained autologous blood at the site of suspected dural puncture. It is true that the volumes differed, but we were attempting to compare existing techniques. Those who use saline solution usually advocate the larger amount; in fact, some would recommend amounts even larger than we chose. Those who use blood usually advocate smaller amounts.

Efficacy was judged both according to the extent of relief obtained within the first hour after treatment and according to the persistence of relief, as evaluated approximately 24 hours after treatment. When a headache recurred after successful initial treatment, further management was not bound to protocol, and appropriate clinical judgment was exercised.

Data were analyzed by the Fisher test for exact probability. P < 0.05 was considered significant.

**Results**

Forty-three patients were included in our study. When evaluated an hour after treatment, 42 patients had experienced dramatic, complete or nearly complete relief. The single exception was one of the blood recipients. This finding has no statistical significance.

Twenty-six patients developed their headaches after receiving spinal anesthesia with a 25-gauge needle. Table 1 indicates the types of treatment received and the numbers with and without relief 24 hours after treatment. Subjecting the data to analysis with the Fisher test for exact probability gives P = 0.022.

Table 2 categorizes the 17 patients whose headaches followed inadvertent dural puncture with a 17-gauge needle during attempted epidural anesthesia administration. The Fisher test gives P = 0.007.

When a headache persisted or recurred after successful initial treatment, subsequent management was not bound to protocol. Of the 11 saline solution recipients who no longer had relief at 24 hours, nine received an epidural blood patch and did achieve permanent relief thereafter. Two elected not to accept further therapy. Of the three blood recipients who remained symptomatic, one received a second blood patch with subsequent relief, one elected not to accept a repeat injection, and the third patient received two saline solution placements and then another blood
placation over the ensuing six days before her symptoms finally abated.

Discussion

The use of epidural blood placement, despite its documented efficacy, has been associated with considerable controversy. There has been concern that patients would be refractory to subsequent epidural anesthesia. Follow-up studies, however, suggest that this does not occur. The efficacy of epidural blood placement has been questioned because of the absence of comparative studies, including comparison with placebo epidural needle placement. Placebo treatment may be scientifically sound, but in this circumstance, we did not feel it would be clinically justified. With a comparative study, we felt our patients were not offered a treatment with little likelihood of success.

In our study, epidural placement of saline solution has success rates at 24 hours of 60 per cent for 25-gauge dural punctures and 0 per cent for 17-gauge dural punctures. These success rates are somewhat lower than those reported by other investigators. There was, however, a 100 per cent success rate when evaluation was made shortly after treatment. Our epidural blood placement had success rates of 100 per cent for 25-gauge punctures and 73 per cent for 17-gauge punctures. These rates are also somewhat lower than those reported by others. The prospective randomized nature of our study, however, permitted us to demonstrate that blood placement is more efficacious than placement of saline solution. This superior efficacy was most apparent in the population having 17-gauge dural punctures.

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Morphologic Abnormalities in a Case of Malignant Hyperthermia

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Malignant hyperthermia is an inherited, metabolic disease of obscure etiology and pathogenesis. Since

Denborough, in 1960, in Australia, saw no fewer than ten deaths in one family due to anesthesia, much attention has been devoted to this disease. Frequency is estimated at one per 14,000 anesthetic events. Britt reported a mortality rate of 64 per cent. Denborough established the genetics: autosomal dominance with incomplete penetrance. Recently, investigators have suggested that malignant hyperthermia is associated with a subclinical myopathy that often is manifested by elevated resting creatine phosphokinase (CPK) levels in susceptible individuals. Extramuscular abnor-