Extradural Pressures in the Parturient Patient

M. W. Galbert, M.D.,* and Gertie F. Marx, M.D.†

Radiologic studies following injection of dye into the femoral veins of term-pregnant women demonstrated a marked difference in vertebral venous filling between the supine and lateral positions. In the supine position, because of occlusion of the inferior vena cava by the uterus, venous return was redirected via the ascending lumbar veins and the complex of veins surrounding the spinal canal. In the lateral position, this obstruction was at least partially relieved, and most of the venous return passed by way of the inferior vena cava.1 The effect of inferior vena caval occlusion on the vertebral venous system has not been considered in earlier studies of extradural pressure in obstetric patients.2,3 The introduction of a mechanical device4 for left uterine displacement in the supine position has made it possible to compare lumbar extradural (and cerebrospinal fluid) pressures with and without compression of the inferior vena cava by the uterus.

Method

Lumbar extradural pressures were measured in 12 randomly selected healthy term-pregnant volunteers at various stages of labor. Each patient was fully informed and consented to the investigative procedures. All women were of normal build; flexion of the back was accomplished with ease, and the extradural space was readily identified by loss of resistance. Pressure recordings were made prior to instituting continuous segmental extradural analgesia. A 19-gauge Teflon catheter was inserted into the lumbar extradural space, at the L3–L4 interspace, and advanced to 1 cm beyond the tip of the Tuohy needle. The catheter was then flushed with 2 ml of heparinized saline solution and connected to a Statham P23 Db pressure transducer (calibrated in cm H2O) and Hewlett-Packard Model 7700 multichannel recording system. Pressures were recorded first in the left lateral decubitus position, with and without uterine contractions, and then in the supine position (with precautions to prevent obstruction of the catheter). After observation of at least three uterine contractions in the supine position, the uterine displacer was applied for a period of three or more contractions, removed for the same duration, and then reapplied. This sequence was repeated after achievement of relief of pain with 50 mg each of meperidine and promazine intravenously (four patients), 0.25 per cent inspired methoxyflurane in oxygen (four patients), or low subarachnoid block (four patients). In two additional parturients, cerebrospinal fluid pressures were measured.

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(in the supine position only) using the same method.

Central venous pressures were determined in four of the women by means of a water manometer and a 16-gauge radiopaque catheter, which was inserted into an antecubital vein and threaded into the great veins of the thorax, as confirmed by manometric responses to changing phases of respiration and the Valsalva maneuver. Arterial blood pressures were determined by the Riva-Rocci method. Left uterine displacement (LUD) was accomplished with the self-supporting device developed by Colon-Morales.

Since all measurements were repeated at least twice, mean values were used for compilation of the data. These are expressed as means ± SEM. Student's t test was used for statistical analyses.

RESULTS

The opening extradural pressure in the lateral position increased progressively during the first stage of labor from a low of 1–3 cm H$_2$O in the early latency phase to 4–10 cm H$_2$O during the period of maximum acceleration. Baseline pressures in the supine position were 2–8 (mean 4.9 ± 0.8) cm H$_2$O higher than those in the lateral position and also increased gradually during the course of labor (fig. 1). Following LUD, baseline extradural pressures decreased 1–5 (mean 2.0 ± 0.4) cm H$_2$O in all patients. Oscillations synchronous with respiration and arterial beats were seen regardless of whether the extradural pressure was low or high.

Prior to institution of pain relief, uterine contractions were associated with peak increases in extradural pressure ranging from 2

TABLE 1. Peak Increases in Extradural, Mean Arterial, and Central Venous Pressures during Uterine Contractions with and without Left Uterine Displacement*

<table>
<thead>
<tr>
<th></th>
<th>EP (cm H$_2$O)</th>
<th>MAP (mm Hg)</th>
<th>CVP (cm H$_2$O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without LUD</td>
<td>8.6 ± 0.7</td>
<td>19 ± 3</td>
<td>2 to 3</td>
</tr>
<tr>
<td>With LUD</td>
<td>4.6 ± 0.5†</td>
<td>21 ± 4</td>
<td>5 to 15</td>
</tr>
</tbody>
</table>

* EP and MAP: means ± SE (EP, 12 patients; MAP, 10 patients). CVP: ranges (4 patients). † P < 0.05.

TABLE 2. Extradural Pressures between (Base) and during (Peak) Uterine Contraction with and without Left Uterine Displacement in a Primiparous Parturient in Advanced First Stage of Labor*

<table>
<thead>
<tr>
<th></th>
<th>Before Analgesia</th>
<th>After Spinal Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without LUD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base EP (cm H$_2$O)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Peak EP (cm H$_2$O)</td>
<td>20 ± Δ10</td>
<td>13</td>
</tr>
</tbody>
</table>

|                |                  |                    |
| With LUD       |                  |                    |
| Base EP (cm H$_2$O) | 8 ± Δ3          | 10                  |
| Peak EP (cm H$_2$O)  | 11 ± Δ1         | 11                  |

* Cervix 8 cm dilated.
CONTRACTION
WITH
BEARING DOWN
NO LUD

CONTRACTION
WITH
BEARING DOWN
WITH LUD

Fig. 3. Extradural pressure tracing of a primiparous patient during the second stage of labor. Peak EP was markedly reduced with left uterine displacement. Paper speed 1 mm/sec.

to 8 (mean 4.5 ± 0.7) cm H₂O in the left lateral decubitus position to 6 to 12 (mean 8.6 ± 0.7) cm H₂O in the supine position. Mechanical left uterine displacement, with the patient supine, resulted in maximum extradural pressure increases during contractions of only 2–9 (mean 4.6 ± 0.5) cm H₂O. The difference between peak extradural pressures during contractions with and without left uterine displacement (fig. 2) was significant, P < 0.05. Mean arterial as well as central venous pressures attained higher levels in the presence of LUD (table 1).

Pain relief, regardless of method, did not significantly alter the baseline extradural pressure, but led to decreased peak pressures.

Fig. 4. Lumbar CSF pressure tracing of a primiparous patient at 8 cm dilation of the cervix. Left uterine displacement produced minimal change. Paper speed 1 mm/sec.
during contractions (table 2). The effect of LUD on extradural pressure was unchanged. Bearing-down efforts produced increases in extradural pressure ranging from 20 to 60 cm H$_2$O, varying with patient effort. In general, the increase was more pronounced when LUD was not applied (fig. 3).

Baseline cerebrospinal fluid pressures were 22 and 28 cm H$_2$O with and without LUD, increasing to 36 and 40 cm, respectively, during contractions. Following relief of pain by spinal analgesia (sensory level T11 and T10), increases during contractions were markedly decreased (peak pressures of 28–30 and 30–32 cm H$_2$O, respectively). Left uterine displacement resulted in minimal changes, both before and after spinal block (fig. 4).

**DISCUSSION**

Our study showed that responses of extradural pressure to pregnancy and labor were more pronounced than those of cerebrospinal fluid pressure. Baseline cerebrospinal fluid pressures have been demonstrated to remain within the usual range throughout pregnancy and labor.\(^5\) In contrast, the opening extradural pressures in our pregnant women were higher (+1 cm H$_2$O or above) than those of nonpregnant patients (−1 cm H$_2$O or below),\(^3\) and baseline pressures increased gradually during the course of labor. Both findings probably indicate progressive engagement of the extradural veins. In view of these positive alterations in extradural pressure, the use of the "loss of resistance" method appears more rational than the "hanging drop" technique for identifying the extradural space in the term-pregnant woman.

The decrease in extradural pressure during uterine contractions following uterine displacement demonstrates a more efficient venous return to the right heart of blood expelled from the uterus during the contraction, both with and without bearing-down efforts. The effect of pain relief on maximal extradural pressures during contractions is similar to that on cerebrospinal fluid pressure and suggests that part of the increase is caused by skeletal muscle movements in response to pain.

Our data thus demonstrate several factors which influence extradural pressure in the obstetric patient. Compression of the inferior vena cava is only one of these factors, and is preventable and treatable by mechanical uterine displacement (or by keeping the patient in a lateral or semilateral position). Another element, that of pain and movement secondary to uterine contractions, can be mitigated by adequate analgesia. On the other hand, progressive engorgement of the extradural veins appears to be a natural phenomenon of labor. We conclude that the "space occupying and massaging effect of the distended extradural veins"\(^2\) is the most important factor in the altered response of the obstetric patient to extradural and spinal analgesia, i.e., in the increased tendency for local anesthetic spread. Finally, our data re-inforce the sound physiologic basis for uterine displacement whenever the term-pregnant woman must lie supine, prior to and during any form of anesthesia.

**REFERENCES**