that it is unlikely that air in any significant volume could cross through the pulmonary vascular bed. In a dog study using neon, the amount of gas injected in the venous system was almost completely recovered in the expired air, indicating little or no passage through the pulmonary vascular bed. In another study, in sheep, a bubble trap was interposed in the aortic outflow tract and 60 ml air were injected in the venous side. In two animals no air was captured on the systemic side, and in a third animal, only a 2-ml volume of air was trapped. In a fourth animal, 30 ml of the injected air were recovered in the bubble trap; at necros, this animal alone was found to have a patent foramen ovale. It would appear that paradoxical embolization of air is unlikely to occur, at least in any significant quantities, unless a cardiac defect exists.

Thus, air embolism in the presence of a patent foramen ovale could occur in about 10 per cent of patients operated on in the sitting position. When such a patient experiences prolonged or repeated episodes of air embolism, paradoxical embolization becomes increasingly likely. While its true incidence is unknown, it should be suspected in any patient who manifests an unexpected neurologic deficit following a surgical procedure known to be associated with the risk of air embolism. The intraoperative use of a Doppler monitor over the internal carotid artery is not feasible because of the likely detection of venous air in adjacent vessels.

References


Racial Differences in Sacral Structure Important in Caudal Anesthesia

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Our clinical experience in 250 cases suggested that during caudal anesthesia the needle needs to be inserted more steeply in black than in white patients. We measured this angle to determine whether there is a structural difference between the pelvis of black and white patients that might necessitate different angle of needle insertion. The advisability of avoiding unnecessary exposure of living persons to irradiation precluded making these measurements in obstetric patients. We therefore studied 200 pelvis from the Hamann–Todd collection of the Cleveland Museum of Natural History. The two anatomists after whom this collection is named prepared more than 3,000 skeletons, all of which are carefully labeled and available for study.

Methods

We chose the first 200 skeletons that satisfied the following criteria: age at death, 20–60 years, 100 from black, 100 from white people. Half of each group was female. Altogether we examined 217 pelvis, 17 of which were discarded because of anomalies such as obliteration in the sacral canal (13 of 217) or no roof on top of the canal (4 of 217).

Since the preparation of these pelvis had caused dissolution of the ligaments, it was necessary to

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reassemble the pelvic bones so that the articulating surfaces matched well. The reassembled pelvises were then held together with rubber bands providing a stable preparation for study.

The following measurements were made:

*Angle of the Sacral Canal.* For this purpose a long needle was inserted into the sacral canal of a pelvis, which was resting on its iliac spine and the brim of the symphysis (fig. 1). This position of the pelvis on the table is an approximation to the prone position in life.

The greater this angle, the more vertical would be the position of the needle for insertion into a patient lying prone for caudal anesthesia (fig. 2).

*Height of the caudal canal* at the hiatus (fig. 3).  
*Width between the cornua* of the hiatus (fig. 4).

**Results**

The results of these measurements are summarized in table 1. A comparison of figures 1 and 2 shows an example of the difference between pelves from black
and white women. Analysis of variance showed that the described angle was larger in black than in white people and larger in black women than in black men. This implies that needle insertion for caudal anesthesia would require different angles in the two races. The height of the caudal canal was greater in black than in white people. In black women the height was, on the average, 6 mm compared with 5 mm in white women. These numbers are in agreement with the results by Trotter,1,2 who also measured the heights of the canal in black and white people. There was no difference between the widths of the canal in black and white people. The average width was 1 cm.

**DISCUSSION**

The black population of North America is often thought to be quite heterogeneous, because of the admixture of white and Indian blood.3–5 But several investigators who measured large numbers of black and white people (alive or as skeletons) showed that the black population was less varied in physical dimensions than the white population.6,8 These studies dealt primarily with features of the face and pelvis. Some morphologic features of black people are very stable, and are expressed even when mixed with other races.

What causes the structural differences of the sacrum of the two races is not known. A pronounced lumbar lordosis in black people has been well described,10,11 and we assume that this hyperlordosis is connected with a slightly greater forward tilt of the pelvis. However, the forward tilt is not simply a matter of posture, but rather is determined by structural features of the vertebrae and the pelvis.

The results of our measurements may have clinical implications. On the average, in the black patient, the insertion of a needle for caudal anesthesia should be a little easier, because the caudal canal is higher and the needle will be at a steeper angle than in white patients.

**REFERENCES**


**Table 1. Dimensions of the Sacral Canal**

<table>
<thead>
<tr>
<th></th>
<th>Black</th>
<th>White</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angle (cm)</td>
<td>42.5 ± 1.0†</td>
<td>36.0 ± 0.9</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>0.6 ± 0.02†</td>
<td>0.5 ± 0.03</td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angle (degrees)</td>
<td>43.4 ± 1.3*</td>
<td>38.3 ± 1.1</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>0.5 ± 0.02*</td>
<td>0.4 ± 0.02</td>
</tr>
</tbody>
</table>

* Significantly different between black and white, $P < 0.05$.
† Significantly different between male and female, $P < 0.05$.

There was also a significant difference between black and white sacral canal angles and heights when data from males and females were combined.

Cardiac Arrhythmias during Coronary-artery Operations with Halothane or Enflurane Anesthesia

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Halothane and enflurane, two commonly used halogenated anesthetic agents, have been shown to potenciate ventricular arrhythmias.1–4 In this study a retrospective evaluation was undertaken to compare the incidences of ventricular arrhythmias occurring during coronary-artery operations with halothane and with enflurane anesthesia.

The influence of halogenated anesthetics upon cardiac electrical activity has been attributed to numerous factors, including endogenous and ex-