namic and ECG changes, one-third of the patients had a pulmonary artery catheter in place. Rao *et al.*[6] showed that this intensity of perioperative management was associated with a lower than expected reinfarction rate in patients with recent myocardial infarctions. We believe that the CRI in its present form is not helpful in estimating cardiac risk in patients undergoing elective aortic surgery. This type of surgery seems to impose a higher cardiac risk to the patient than predicted by criteria developed from a broad base of surgical patients. Prospective evaluation of the CRI as a predictor of postoperative cardiac complications is warranted for other surgical procedures before it is used.

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The Advantage of the Prone Position Approach to the Lumbar Epidural Space

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The prone position has been used for many years for the administration of hypobaric spinal anesthesia. The merits of using this position for entering the spinal canal (epidural or subarachnoid spaces) have not been documented previously. One of the authors (K.M.) has experienced many years of success using the prone "jack-knife" position for lumbar epidural block. Our experience, comprising 260 patients, was reviewed to determine the success of lumbar epidural analgesia using the prone jack-knife position. Additionally, a computerized axial tomographic study of the lumbar spine was performed to assist in explaining the merit of this approach.

Materials and Methods

This study was approved by our local Committee for Protection of Human Subjects. Epidural anesthesia was administered to 260 patients in the prone position. Before each patient was positioned for epidural block, an inflatable plastic bag, approximately 45 cm long × 30 cm wide, was placed crosswise on the operating table. The patient laid in a prone position with the bag under the lower half of the abdomen.§ The table then was angulated into a slight "jack-knife" tilt. The bag was connected to the common gas outlet of the anesthesia machine and inflated by using the oxygen flush. A pressure manometer was inserted in the circuit as a safety device. The pressure in the bag was permitted to rise to 60 mmHg at which point the patient's lower abdomen was elevated approximately six inches above the table. The "jack-knife" angulation combined with the elevation of the lumbar spine rendered the spinous processes more conspicuous and the interspinous spaces more palpable. Any voluntary curvature or splinting of the spine tends to be straightened by the effects of gravity. After prone jack-knife positioning, the interspinous space was palpated and infiltrated with local anesthetic agent. The epidural needle was advanced into the epidural space which was identified by either the hanging drop technique or the air/liquid column device.[1]

Anesthetic agents were injected, and the catheter was introduced and secured. The bag was deflated, and the patient positioned appropriately for the surgical procedure.

In order to confirm the advantage of the prone po-

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§ The "E-Z-M Carotid Pillow" obtained from the E-Z-M Co. Portland Avenue, Westbury, New York 11590.

sition approach to the lumbar epidural space, a computerized axial tomographic (CAT) study was performed on one of the authors (K.M.) in both the prone position with lumbar elevation and the lateral decubitus flexion position. The CAT technique was constant throughout. L3–4 level was localized with a digital lateral scout radiograph of lumbosacral spine. Two digital lateral scout views were obtained while the subject was in the left lateral position and also in the prone position after placing the pillow forward of the anterior abdominal wall. Multiple 3.0-mm thick contiguous slices were performed through the L3–4 level. Measurements of the posterior epidural space were computer-generated for both positions. In the sagittal reformat, the distances between adjacent spinous processes were identified visually.

Results

Our patients ranged in age from 16 to 95 years (mean, 47.8 ± 21.4 SD years), in body weight from 49.5 to 136.4 kg (mean, 71.8 ± 20.1 kg), and in height from 138 to 178 cm (mean, 143.9 ± 32.5 cm). Epidural puncture was accomplished successfully in all patients. Twenty-two patients (11.8%) required a second attempt at epidural puncture in an adjacent interspace. There was no incident of dural puncture in this series.

Measurements of the posterior epidural space in the lateral decubitus and prone positions were made using computerized axial tomography. The lateral position (fig. 1) measurement was approximately 5 mm and the prone position lumbar elevation (fig. 2) was approximately 7 mm. Sagittal reformatting (fig. 3) displayed an increase in the interspinous distances in the prone position lumbar elevation *versus* the lateral decubitus position.

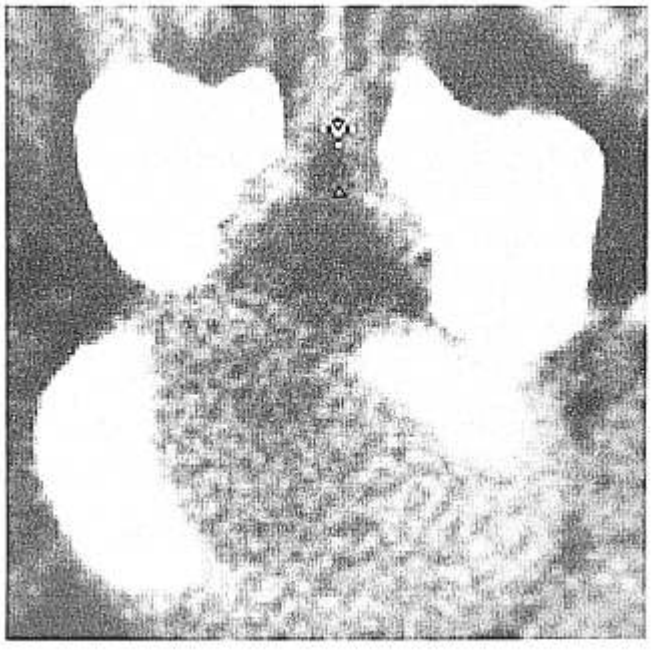

FIG. 1. Lateral decubitus flexion position CAT scan. The two computer cursors, highlighted, measuring the posterior epidural space are 5 mm apart (computer-generated measurements).

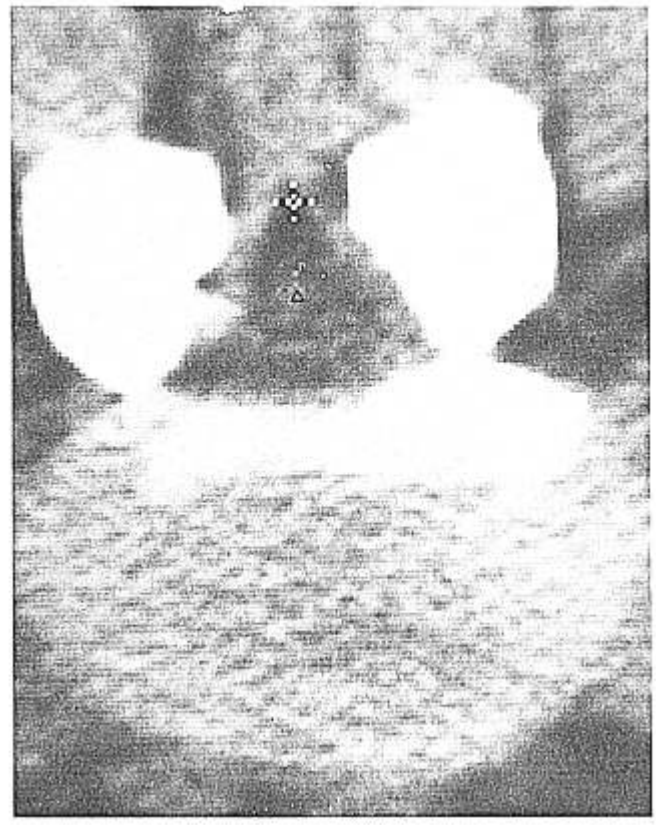

FIG. 2. The prone position with lumbar elevation position CAT scan. The two computer cursors, highlighted, measuring the posterior epidural space, are 7 mm apart (computer-generated measurement). The measurements were done on the same interspace as figure 1.

Discussion

We believe that the prone position, combined with elevation of the lumbar spine, offers several advantages over the conventional lateral decubitus position for entry into the epidural space. The prone position requires less active cooperation on the part of the patient. This is particularly helpful in patients who are unable to cooperate because of language barrier, lack of comprehension, or excessive sedation. Further, the presence of an experienced assistant is not required. The flexion of the lumbar spine is augmented by the gravitational pull of the upper torso and head on one side, and the pelvis and lower limbs on the other. The passage of a needle is facilitated as the interspinous and interlaminar spaces are maximally opened. In overly obese subjects, the

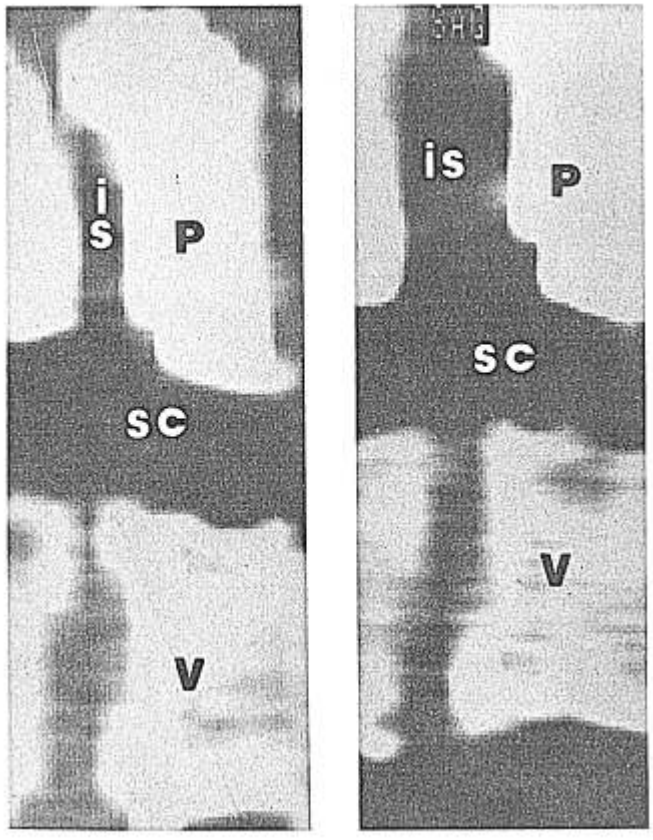

FIG. 3. These are two CAT scan sagittal reformatting views of the lumbar spines. The left half of figure 3 was done in the lateral decubitus flexion position and the right half in the prone position with lumbar elevation. From the bottom to the top of each view, each vertebral body (V), with the intervertebral disc space, the spinal canal (sc) and two adjacent spinous processes (P) with the interspinous space (is) between them are apparent. An increase in the interspinous space is evident in the right side (prone position) compared to the left half (lateral decubitus flexion).

puncture in the lateral decubitus position is technically difficult as the landmarks are distorted by the sagging rolls of pendulous fat.[2] The prone position appears to obviate this difficulty and should prove particularly suitable for such patients.

Cadaveric studies reveal that the dural sheath is closely anchored to the wall of the spinal canal anteriorly by short strands of fibrous tissue.[3] However, posteriorly, the fibrous tissue is sparse and loose. As evident from our CAT study, the dural sac tends to fall away from the posterior wall of the spinal canal, thus increasing the width of the posterior epidural space. As the patient lies in the prone position with an elevation of the lumbar spine, the cerebrospinal fluid will gravitate to the dependent parts, *i.e.*, the cranium on one side and the sacral canal on the other. This should result in shrinkage of the dural sac in the lumbar region. All of these factors would combine to help easy identification of the epidural space and reduction in the risk of dural puncture. If the epidural needle enters the epidural space in the midline, then an equal distribution of local anesthetic solution should occur bilaterally in the prone position in contrast to the lateral decubitus in which the dependent side may be blocked preferentially.

The prone position is obviously unsuitable for patients in late pregnancy. It also is not recommended for orthopedic patients with unstable fractures of the pelvis, hip, or the lower extremity. While in prone position patients must be observed and monitored very closely and constantly for early detection of any untoward reactions. Adequate assistance and facilities must be available immediately to straighten the table and turn the patient to a supine position for resuscitation if necessary.

The results of this study are encouraging, but the real proof of superiority of the prone position approach, both in terms of successful identification of the epidural space and avoidance of dural puncture must await the outcome of a larger series. Further, additional CT scans on the lumbar spine would be needed in order to clearly establish the anatomic basis of the advantage of prone position for the administration of the epidural block.

In summary we have described the prone position with lumbar elevation for the performance of epidural analgesia. This position produces a better separation of the spinous processes as well as increased depth of the posterior epidural space. We believe that the prone position is preferable to the lateral decubitus for entry to the epidural space; however, the technique has some important limitations and would need further evaluation in order to establish its relative superiority.

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