sensitivity of newborn infants to d-tubocurarine may be the result of their immature neuromuscular junctions.

Anesthetists should be aware of the sensitivity to nondepolarizing muscle relaxants in some patients with ALS, and possibly those with other diseases of the lower motor neurons. A normal dose of relaxant may represent a gross overdose in ALS, and thus lead to problems with reversal. However, in view of the hyperkalemia and cardiac arrest that may follow administration of succinylcholine in patients with lesions of the lower motor neurons and pyramidal tracts (cord transaction), the judicious use of nondepolarizing relaxants in patients with ALS would seem preferable.

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Hematoma Following Epidural Anesthesia:
Report of a Case

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Butler and Green recently reported a case of hemorrhage into the spinal epidural space associated with epidural catheterization and anticoagulation. We have had a similar case, a report of which follows.

REPORT OF A CASE

The patient, a 78-year-old man, was admitted with a three-day history of intermittent claudication in the right calf and a cold right foot. About two weeks prior to admission, he had had atrial
flutter with a slow ventricular rate. This converted to slow fibrillation for three days and then to sinus rhythm.

The diagnosis on admission was acute embolic occlusion of the right popliteal artery, with severe peripheral arterial ischemia. Family history, past history, and system review were noncontributory. A femoral arteriogram showed occlusion at the bifurcation of the popliteal artery.

A right femoral popliteal embolectomy was performed using epidural anesthesia. The epidural space was entered at the L3–L4 interspace with a Cheng needle. This was accomplished with one puncture, which produced no undue discomfort, no paresthesias, and no evidence of blood. The anesthetic solution consisted of 20 ml lidocaine, 2.0 per cent, with epinephrine, 1:200,000, and 4 ml tetracaine, 1.0 per cent. Twenty-two milliliters of this anesthetic solution were injected through the needle. In anticipation of a long operation, an epidural catheter was passed about 1 to 2 cm beyond the tip of the needle. During the passage of the catheter a paresthesia was felt in the right leg. No attempt was made to push the catheter further after the paresthesia was elicited. No time was anesthesia administered through the catheter.

An hour and 15 minutes after the epidural anesthesia was given, heparin, 5,000 units, was administered intravenously. At the end of the operation, an hour and 10 minutes after the heparin had been administered, the epidural catheter was removed. There was no sign of blood in the catheter. Two hours postoperatively the Lee-White clotting time was 21 minutes (normal, 5–15). Three hours postoperatively the patient received heparin, 5,000 units, iv. Five hours postoperatively the patient had not recovered from the anesthesia. His first awareness after the operation was one of paralysis, numbness and paresthesias; he complained of numbness of the right foot and a tingling sensation. Seven hours postoperatively he received another 5,000 units of heparin, iv. Twelve hours postoperatively he complained of numbness of the right leg and genitalia, and "pins and needles" of the left foot. The surgeon noted that the patient was unable to dorsiflex the right foot, but was able to plantarflex and move the left foot. Sixteen hours postoperatively the Lee-White clotting time was 60 minutes. Eighteen hours after operation, the neurosurgical consultation stated the following note:

Neurologic history—Numbness and weakness of both legs. Numbness of scrotum and penis area with aching pressure across sacral area. Some increase in ability to move left leg during past 3 hours. Some paresthesia of left foot.

Neurologic examination—Vibration sense decreased in right ankle. Right Achilles tendon and right patellar reflexes decreased. Marked diffuse weakness on the right, especially distal. Quadriceps active. Moderate weakness—left, especially distal. Sensory—saddle hypalgia with mild hypalgia of posterior left leg. Marked hypalgia, posterior and lateral right leg.

The rectum was subsequently noted to be patulous. No further heparin was administered. Twenty hours postoperatively the Lee-White clotting time was 14 minutes.

On the same (first postoperative) day, the patient was returned to the operating room for evacuation of a hematoma in the popliteal incision. This was carried out using general anesthesia. For the next five days he was observed without further diagnostic procedures or treatment.

It was the neurosurgeons' impression, based upon the history of no return of function following epidural anesthesia and the slow improvement of sensation and motion, that this patient was manifesting a prolonged reaction to tetracaine. Although a lumbar epidural hematoma was considered, it was felt to be very unlikely, and on this basis the injection of another chemical known to produce neural irritation, Pantopaque, was considered contraindicated.

Six days after the initial surgery, when it seemed clear that no further improvement was occurring, a myelogram was obtained. Lumbar puncture at the L2–L3 interspace yielded xanthochromic cerebrospinal fluid. Two milliliters of Pantopaque were injected. With the patient in an almost erect position, none of the contrast medium extended below the level of the L2–L3 interspace. Through a second lumbar puncture at the L4–L5 interspace, an additional 2 ml of Pantopaque were injected into the subarachnoid space. Only a trace of the contrast medium extended up to the level of L2, and it appeared to be deviated to the left. The roentgenogram was compatible with a lesion of large mass extending from L2 to at least L4 (see fig. 1A).

Laminectomy revealed a large firm adherent blood clot in the epidural space along the right gutter, compressing the cauda equina to the left from L2 to L4 as visualized in the myelogram. After removal of the epidural hematoma, the cauda was found to be free.

In the next 13 days motor power and sensation improved slightly and the patient was allowed to ambulate with braces. However, he continued to have extensive sensory and motor deficits until his death two years later.

Discussion

Butler and Green 1 have reviewed some aspects of the pathophysiology of hemorrhage into the spinal epidural space associated with epidural catheterization and anticoagulation, and have concluded with some worthwhile suggestions. Some of their comments are repeated and amplified below.

The epidural space is traversed by a rich
plexus of veins, the internal vertebral venous plexus. When these veins are torn, as they frequently are during epidural puncture, there is bleeding in the epidural space. Usually the bleeding is minimal, with the hole in the vein sealing itself off with a clot. However, if the coagulability of blood is impaired, as when an anticoagulant is given, the bleeding may continue for some time. Therefore, administration of epidural anesthesia to patients on anticoagulant therapy is avoided. When anticoagulant therapy has been discontinued, epidural anesthesia is still contraindicated until blood coagulability has returned to normal; prothrombin time should be normal in the patient who has been on Dicumarol therapy, and
the Lee-White clotting time should be normal in the patient who has received heparin.

Sometimes a patient who has not been on anticoagulants must be heparinized during surgery. This presents another problem. If "one-shot" epidural anesthesia is used, veins perforated by the epidural needle will probably form a clot before the heparin is given. However, if "continuous" epidural anesthesia is used, with a catheter in place during the subsequent administration of heparin, it is conceivably that movement or withdrawal of the catheter may dislodge a clot, thus starting fresh bleeding. A catheter can move even when no one lays a hand on it. When an indwelling epidural catheter is anchored to the back, movement of the patient's body, such as flexion, extension, and torsion, can produce a sliding to-and-fro motion of that part of the epidural catheter lying within the epidural space. Conceivably, this movement can dislodge a clot and produce fresh bleeding.

Usually, there are no ill effects of blood in the epidural space. Bleeding in the epidural space is common, and there are no clinical signs or symptoms. Dunbar and DiGiovanni report injecting 10 ml of a patient's own blood into the epidural space as treatment for postspinal headache; this injected blood produced no harm. Even when bleeding in the epidural space is extensive, there need be no damage, because the blood can leak out of the epidural space through the intervertebral foramina, at least in the younger patient. The patient reported by us was 76 years old. In three of the other four cases reported, the patients' ages were 70, 72, and 72 years. The age of the fourth patient, as remembered by one of the physicians involved, was 65 to 70 years.

"With advancing age the loose areolar tissue around the exits of the intervertebral foramina became increasingly dense, blocking off the anatomical escape routes from the epidural space." One reason less anesthetic solution is needed to anesthetize old people may be that less anesthetic is lost through the intervertebral foramina. When there is extensive bleeding in the epidural space in the elderly patient, the blood is more likely to become trapped in the epidural space. Pressure builds and is maintained, compressing the cord or the nerve trunks of the cauda equina.

In the case reported here, the pressure of the blood was sufficient to push the dural sac to one side and compress it, and the cauda equina contained therein, to the extent that little or no spinal fluid or Pantopaque could pass. The hematoma causes deviation and stretching of the nerve trunks not under pressure (fig. 1B). Nerves subjected to pressure or stretching cease to function. The extent and duration of loss of function depend upon, among other things, the extent and duration of the pressure or stretch. This is how blood in the epidural space produces injury. Therefore, it is important to find nerve dysfunction as early as possible. As soon as signs or symptoms are detected, neurologic consultation is indicated. After epidural anesthesia, the patient should be checked at frequent intervals for return of sensation and motion, prolonged numbness or paralysis, paresthesias, and back pain. Back pain in the sacral area was an early sign in this case as well as in the cases discussed by Butler and Green.

At the first suggestion of an epidural hematoma, anticoagulants should be discontinued. The definitive diagnosis can be established by a myelogram, which should be done only after the blood coagulability returns to normal. If the myelogram shows a space-occupying lesion, immediate laminectomy and decompression is indicated. Myelography involves some risk, but it is warranted if signs and symptoms of neurologic dysfunction are present.

Finally, as suggested by Butler and Green, in the selection of an anesthetic technique, when anticoagulation might be expected, the advisability of using an epidural catheter should be carefully weighed.

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