Percutaneous lateral cervical cordotomy: target localization with water-soluble contrast medium

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Water-soluble intrathecal contrast material was used for radiographic identification of the cord target in 13 patients undergoing percutaneous lateral cervical cordotomy. Adequate visualization of the dentate ligament, considered essential for successful placement of the electrode, was achieved in seven cases. In the remaining six patients, four with suboptimal definition and two with nonvisualization of the ligament, an additional injection of contrast medium using a modified coaxial needle system outlined the entire thickness of the cervical cord. This technique improved needle-tip positioning in relation to the cord and resulted in successful surgery in all six patients.

KEY WORDS • cordotomy • operative technique • instrumentation

Percutaneous lateral cervical cordotomy is an effective surgical treatment for intractable pain and a good alternative to chemical analgesia. The goal of the procedure is to interrupt the selected sensory fibers (lateral spinothalamic tract) responsible for the patient's pain. A successful procedure depends largely on precise placement of the ablative electrode. The dentate ligament serves as an important landmark for proper placement of the electrode, which enters the surface of the cord just anterior to the attachment of the dentate ligament to the pia. The ligament can be demonstrated radiographically on supine cervical myelography. Visualization of the ligament with water-soluble myelographic contrast material, although inconsistent, can be improved by a technical modification that allows for visualization of the entire cervical cord. Better geographical orientation facilitates placement of the electrode in cases where visualization of the dentate ligament is inadequate.

Operative Procedure

Patient Positioning and Selection of Entry Point

Percutaneous cervical cordotomy is routinely performed under fluoroscopy. The patient is placed supine in the Radionics headholder* or a similar device. The position of the head and shoulders is adjusted so a perfect superimposition of the lateral elements of the C-1 and C-2 vertebrae is achieved and the corresponding interlaminar space is open. The point of entry, corresponding to the superior border of the C-2 lamina, is marked on the skin between the middle and the junction of the anterior one-third and posterior two-thirds of the anteroposterior diameter of the spinal canal. A sagittal T1-weighted magnetic resonance image of the upper cervical region, if available, may be helpful in evaluating the precise position of the upper cervical cord in relation to the anterior and posterior boundaries of the spinal canal. The point-of-entry mark on the skin may be adjusted according to the position of the cord with reference to the cord midline (Fig. 1).

Choice of Spinal Needle

Cervical cordotomy may be performed using either a No. 18 or No. 20 conventional spinal needle (either will accommodate the electrode). There is a substantial difference in the manipulation of these needles during the approach and search for the target. A No. 20 needle is thinner and more flexible, and its course during advancement can be modified using the bevel-deflection technique, which allows for more precise initial placement. However, because of its flexibility, it is difficult to maneuver the tip during the target search. For this reason, a larger-caliber spinal needle is preferred.

Injection of Contrast Material

A coaxial needle system for injection of contrast material into the cervical subarachnoid space combines a conventional No. 18 spinal needle and a No. 22 needle.

* Headholder, Type RCK-2A, manufactured by Radionics, Inc., Burlington, Massachusetts.
Percutaneous lateral cervical cordotomy

**FIG. 1.** *Left:* Magnetic resonance image, midline sagittal view, as a basis for the estimated skin entry point (arrow). *Right:* Diagram showing how the entry point was arrived at. The anteroposterior midpoint of the cervical cord (0) is related to AB, a line between the posterior cortex of the C-2 vertebral body and the superior aspect of the junction of the laminae at the same level. The dentate ligament attachment is in the cord midline.

The skin point of entry (C) on the lateral fluoroscopic image should be slightly anterior to 0 (in this case about midpoint on line AB).

**FIG. 2.** Diagram of the coaxial needle system. The smaller inner needle has a blunt tip and a side port. The flow direction can be adjusted by rotation of the inner needle.

**FIG. 3.** Intraoperative magnetic resonance image showing adequate visualization of the target on the initial injection of contrast medium. The dentate ligament (arrows) is clearly visible.

**FIG. 4.** Intraoperative lateral radiograph obtained after injection of contrast material through a directional flow needle showing opacification of the entire spinal canal. The dentate ligament cannot be identified but the anterior and posterior borders of the cord are clearly outlined (arrows).

designed with a blind-end side port fitting within its lumen (Fig. 2). The side port can be directed by rotating the hub of the inner needle.

After penetration of the subarachnoid space, 5 to 7 cc of fluid is withdrawn and collected in a sterile container. Approximately 3 to 4 cc of 240 mg% contrast medium (Iohexol 240) is injected into the subarachnoid space through the No. 18 needle. If the dentate ligament is adequately visualized (Fig. 3), placement of the electrode is carried out in the usual manner. If the ligament cannot be identified, an additional 4- to 5-cc injection of contrast material through the directional flow needle, with the side port pointed upward, will opacify the complete subarachnoid space and outline the entire thickness of the cord. A 2:1 mixture of contrast material in cerebrospinal fluid (CSF) increases the injection volume and enhances uniform opacification of the canal. Although a faster injection rate will assure better distribution and mixing with CSF, it is unlikely that this technique will provide visualization of the dentate ligament. However, the anterior and posterior borders of the cord will be clearly defined, facilitating the approach (Fig. 4).

**Clinical Results**

From June, 1990, to February, 1992, 13 cervical cordotomies were performed at the Memorial Sloan-Kettering Cancer Center via a lateral C1–2 approach in
adult patients with advanced cancer complicated by intractable pain in the pelvis and/or lower extremities. The two-stage technique described above was used in an initial attempt to outline the dentate ligament. The ligament was adequately visualized on injection of one portion of contrast material and the procedure was successfully completed in seven of the 13 patients. The dentate ligament could not be positively identified in one case because of poor definition, and in three cases because of unusual horizontal lines overlying the area of its attachment; in two other patients the ligament was not visualized at all. A directional flow needle was used to inject additional contrast medium and, although the ligament was not visualized by this maneuver, the entire thickness of the cervical cord was clearly depicted, facilitating the approach (Fig. 4). Successful placement of the electrode was achieved in all six patients.

Discussion

The dentate ligament is an important landmark in localizing the ascending sensory fibers during a lateral cervical cordotomy. In the past, an oil-based contrast material (Pantopaque) and air, or a combination of both, were used for localization.2,3,5,6 Emulsified Pantopaque was deposited in the subarachnoid space just above the ligament and, on its way to the dependent portion of the canal, some material became trapped along the superior surface of the ligament, outlining its course. Air was used to outline the anterior border of the spinal cord. Pantopaque is no longer available and the introduction of air into the subarachnoid space is not recommended because of associated morbidity.

The flow dynamics and pattern of opacification of the subarachnoid space by water-soluble intrathecal contrast medium differ, predominantly because of low viscosity and rather quick mixing with CSF. When introduced, contrast medium flows to the dependent portion of the canal, but the trapping mechanism of the dentate ligament is inefficient. This may be caused by too rapid dilution of the contrast material or anatomical inconsistencies of the dentate ligament such as incomplete development, fenestrations, or variability of pial attachment of the cord. The posterior border of the spinal cord may sometimes be outlined, improving the surgeon’s orientation. However, the anterior border is rarely visualized when the conventional method is used, since the reverse curvature of the spine in a supine patient does not allow for pooling; instead, the contrast medium flows either cranially to the cisterna magna and posterior fossa or caudally into the thoracic region. In the 13 lateral cervical cordotomies with injection of water-soluble contrast material via the conventional method, the ligament was outlined adequately in seven patients.

Injection through the directional flow needle accomplishes more efficient mixing of contrast material within the subarachnoid space, resulting in visualization of the entire thickness of the cervical cord. This complementary method is helpful in localizing the ablation target when the ligament cannot be identified or when more than one structure resembling the dentate ligament is visualized on the initial injection.

References

4. Onofrio BM: Cervical spinal cord and dentate delineation in percutaneous radiofrequency cordotomy at the level of the first to second cervical vertebrae. Surg Gynecol Obstet 133:30-34, 1971

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