Endoscopic-guided percutaneous radiofrequency cordotomy

Technical note

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The authors present the first clinical implementation of an endoscopic-assisted percutaneous anterolateral radiofrequency cordotomy. The aim of this article is to demonstrate the intradural endoscopic visualization of the cervical spinal cord via a percutaneous approach to refine the spinal target for anterolateral cordotomy, avoiding undesired trauma to the spinal tissue or injury to blood vessels. Initially, a lateral puncture of the spinal canal in the C1–2 interspace is performed, guided by fluoroscopy. As soon as CSF is reached by the guide cannula (17-gauge needle), the endoscope can be inserted for visualization of the spinal cord and its surrounding structures. The endoscopic visualization provided clear identification of the pial surface of the spinal cord, arachnoid membrane, dentate ligament, dorsal and ventral root entry zone, and blood vessels. The target for electrode insertion into the spinal cord was determined to be the midpoint from the dentate ligament and the ventral root entry zone. The endoscopic guidance shortened the fluoroscopy usage time and no intrathecal contrast administration was needed. Cordotomy was performed by a standard radiofrequency method after refining of the neurophysiological target. Satisfactory analgesia was provided by the procedure with no additional complications or CSF leak. The initial use of this technique suggests that a percutaneous endoscopic procedure may be useful for particular manipulation of the spinal cord, possibly adding a degree of safety to the procedure and improving its effectiveness. (DOI: 10.3171/2010.4.JNS091779)

KEY WORDS • pain • cancer • percutaneous cordotomy • spinal endoscopy • radiofrequency • spinal cord

Illustrative Case

Patient Presentation

This 64-year-old man presented with progressive right-sided chest pain, which had been recurring for 9 months and was related to advanced lung cancer. With the progression of the disease, the pain became worse, constant, pulsatile with high intensity (visual analog scale score 95/100 mm), and resistant to medications. The pain was localized in the right thorax from the T-3 to T-7 dermatomes, and related to neoplastic invasion of the parietal pleura and the chest wall. The oncology clinic referred the patient for additional palliative treatment of pain because of the inability to control the pain using opioid and adjuvant analgesics. In our institution, the indication of ablative procedures for pain control follows

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a strict protocol. Only patients with advanced oncological disease, no possible curable treatment, and referring pain beyond control with medication including opioid infusion pumps, are referred to ablative procedures. Informed consent was obtained from the patient for this particular procedure in addition to institutional approval.

Operative Technique

Under light sedation, the patient was accommodated in the supine position with the head firmly fixed by the Rosomoff head holder. Initially, fluoroscopy guided placement for local anesthesia in the skin and deep muscle tissue in the upper lateral cervical region (approximately 1 cm distal and dorsal to the mastoid process). Also under fluoroscopic visualization, a 17-gauge cannula was inserted perpendicularly to the skin toward the spinal canal in the C1–2 interspace (Fig. 1). Once the CSF space was reached, fluoroscopy was no longer used.

When the dura is transposed by the cannula, the cannula becomes rather fixed by the skin, cervical muscles, and the dura itself, allowing narrow mobility of a few millimeters. Through the same cannula a 0.9-mm-thick endoscope (Myelotec, Inc.) was inserted for direct view of the spinal canal. This device renders a 70° FOV with a magnification of 40 at a 0° angle of view, which provides a clear image through CSF. The endoscopic visualization offered clear identification of the pial surface of the spinal cord and its blood vessels, the arachnoid membrane, the dentate ligament, the dorsal and ventral root entry zone, and respective radicular blood vessels (Fig. 2). The target point for the electrode insertion in the spinal cord was defined as the midpoint between the dentate ligament and the ventral root entry zone (Fig. 2A). Once the target point was determined, the cannula was kept in place by the surgeon’s hand and the endoscope could be withdrawn safely. This procedure required skilled handling to keep the spinal cord somewhat fixed to the cannula; while visual control was provided by the endoscope, the cannula was gently advanced toward the surface of the spinal cord touching the pia right over the intended target. Through the same cannula the radiofrequency electrode was inserted, touching the pial surface of the spinal cord at the determined spot. Conventional recording of tissue impedance guided the insertion of the electrode into the spinal cord (approximate impedance: 200 Ω for CSF, 800 Ω for the spinal cord). Further controlled electrical stimulation (50 Hz and 1-msec pulse width) provided confirmation of the target by eliciting a tingling sensation over the contralateral thoracic region, including the painful area. This control was possible because the patient was awake and fully participating in the procedure at this time.

The lesioning was then performed by the application of radiofrequency for 60 seconds, reaching a temperature of 75°C. In this particular case, 2 consecutive lesionings were enough for satisfactory thermoanalgesia on the contralateral side of the body, reaching the spinal level up to the clavicular region. Right after the lesioning was performed, the endoscope was again inserted into the CSF space to view the point of the electrode insertion in the pial surface of the spinal cord.

Postoperative Course

There was no bleeding or any complications during the procedure. No CSF leak was detected in the early or late postoperative period. Other than immediate pain relief, an ipsilateral Horner sign, and mild upper limb ataxia, no other additional postoperative neurological signs were observed. These signs are routinely observed after percutaneous radiofrequency cordotomies and are often transient. The limb ataxia lasted for 9 days, and after 14 days the patient had completely recovered. During the 6-month follow-up the patient’s pain relief was maintained (visual analog scale score 0/100 mm).

Discussion

In 1931, Burman introduced the concept of myeloscopy for direct spinal cord observation. In 1938, Pool developed a narrow fiberoptic needle endoscope that was thin enough to pass through a 17-gauge spinal needle. Those authors used this device to examine the craniocervical transition in procedures around the medulla. Although no practical progress in the surgical field was made, they proposed that such a device could be used for operations in the spinal canal, permitting direct vision through limited exposures.

Cordotomy was classically described and continues to be performed using either open laminectomy in the thoracic levels or percutaneously in the upper cervical spine under indirect visualization, based on fluoroscopic oily contrast medium myelography as described by Mullan and Rosomoff et al. This percutaneous radiofrequency...
The method is the preferred technique and has been performed at our institution since the 1970s with good results. However, this procedure requires an experienced surgeon for the interpretation of myelographic images that sometimes are not very clear. In addition, the oily contrast medium has no clearance in the CSF and the long-term permanence of the medium is associated with arachnoiditis.4,7 Recently, a similar procedure has been described5 using CT-based myelographic guidance but still requiring intrathecal contrast injection. This technique also requires a CT scan, which in most institutions is not located in the operating room.

The outcome and complication rate associated with cordotomy is related primarily to proper placement of the radiofrequency electrode, and the lesion made by this method is rather circumscribed (Fig. 3). The direct visualization of anatomical landmarks makes target determination more obvious for the surgeon and therefore safer. The endoscopic technique described in this paper apparently makes the procedure faster, the usage of fluoroscopy shorter, and does not require contrast medium administration.

**Fig. 2.** Endoscopic view of the spinal cord during the procedure (patient is face up). The tip of the guide cannula is the crescent-shaped outline at the edge of each panel. The dentate ligament (dotted line) is visualized as a bright white elongated structure transversally positioned, determining the anterior and posterior faces of the spinal cord. The asterisks indicate ventral rootlets. **A:** Lateral aspects of the spinal cord. The dark circle is the target point in the ventrolateral aspect of the spinal cord. **B:** Dorsolateral aspects of the spinal cord. **C:** Spinal cord and the dentate ligament (center). **D:** Dorsolateral aspects of the spinal cord.

**Fig. 3.** Axial (left) and sagittal (right) T2-weighted MR images of the patient obtained on the first postoperative day. Both images show the edematous tissue reaction to the radiofrequency lesion (arrow) in the anterolateral quadrant of the spinal cord between the C-1 and C-2 levels.
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Spinal endoscopy is a technique that may be used for intradural procedures, providing safer manipulation of the nervous tissue. This technical report shows the possibility of using endoscopy not only in cordotomies, but also in other spinal interventions, with development of new apparatuses to keep the endoscope in place while additional instruments can be inserted to handle the neural tissue or other lesions.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Fonoff, Teixeira. Acquisition of data: Fonoff, Almeida, Alho, Lara, Teixeira. Analysis and interpretation of data: Fonoff, Lara, Teixeira. Drafting the article: Fonoff, Almeida, Alho, Lopez, Lara. Critically revising the article: Fonoff, Teixeira. Reviewed final version of the manuscript and approved it for submission: Fonoff, Almeida, Alho, Lara, Teixeira. Administrative/technical/material support: Fonoff, Lara, Teixeira. Other: Lopez (figure conception and drawing).

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Manuscript submitted December 4, 2009. Accepted April 1, 2010. Please include this information when citing this paper: published online April 30, 2010; DOI: 10.3171/2010.4.JNS091779. Address correspondence to: Erich Talamoni Fonoff, M.D., Ph.D., Rua Dr. Ovídio Pires de Campos, 785, São Paulo, Brazil 01060-970. email: fonoffet@usp.br.