Delineation of the obex by contrast radiography during percutaneous trigeminal tractotomy

Technical note

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Accuracy of percutaneous implantation of an electrode into the descending trigeminal tract can be improved substantially by contrast radiography. A translateral x-ray film taken after 1 cc of Pantopaque emulsified with 1 cc of cerebrospinal fluid has been injected by midline puncture of the cisterna magna will outline the floor of the fourth ventricle, the obex, and the dorsum of the medulla oblongata. Injection is made under mild pressure and with the patient prone. This technique has been used successfully on 12 patients.

Key Words · percutaneous trigeminal tractotomy · contrast radiography · technique · obex · fourth ventricle

While percutaneous cordotomy and neuromodulator techniques find their place in the relief of chronic pain of the trunk and limbs, application of these methods for relief of intractable facial pain with preservation of touch sensations remains a difficult problem. In 1967 Crue, et al., reported the first percutaneous trigeminal tractotomy (PTT). A few other reports followed. Crue, et al., directed their electrode to a target 6.5 mm from the midline, and 4 mm deep to the posterior part of the brain stem. Hitchcock used a target 6 mm from the midline, and 3 mm anterior to the posterior aspect of the spinal cord at the upper C-1 level. In some cases they outlined the cervicomedullary region with air or a water-soluble contrast medium.

The following new technique was used in 12 patients in whom appropriate coordinates were outlined by contrast radiography using emulsified Pantopaque.

Method

The patient is positioned prone on the x-ray table as shown in Fig. 1. A stretcher mattress underlies the patient up to his shoulders. The dorsum of the brain stem must be horizontal to retain the emulsified Pantopaque.

X-ray tubes are set up for posteroanterior (PA) and translateral radiographs with tube-to-target distances of 30 in. and tube-to-film distances of 40 in. This results in real measurements being 75% of the length of measurements made on the x-ray film. The coordinate-to-target measurement on the x-ray film must be one-third greater than the real measurement. Scout films should show
the odontoid through the open mouth. Polaroid or fast-developing film is used.

Under sterile conditions, a standard 18-gauge spinal needle is passed in the midline into the cisterna magna, and 1 cc of cerebrospinal fluid (CSF) withdrawn. The CSF sample is mixed thoroughly with 1 cc of Pantopaque by shaking in a 10 cc syringe, and the mixture is injected under mild pressure to scatter the contrast droplets over the brain stem surface. A translateral x-ray film should delineate the floor of the fourth ventricle, the obex, and the dorsum of the medulla.

About 4 cm lateral to the midline (ipsilateral to the facial pain) an 18-gauge, thin-wall, 3½ in.-long guide needle is passed percutaneously above the C-1 lamina toward the cisterna magna, and directed to the target point. Although considerable leeway is allowed because the guide-needle can be corrected by tilting even after its tip is in the cisterna magna, guidance films should confirm its approach before the dura is punctured. The guide-needle should terminate in the cisterna magna at the following uncorrected film coordinates as seen in Fig. 2: 12 mm (e) from the midline on the PA film and 8 mm (a) caudal to the obex at the level of the dorsum of the brain stem on the transla-

ter film. The guide-needle may need to be more cephalad (distance a) if it is essential to get the sensory 7th, 9th, 10th, and mandibular division of the 5th cranial nerves. This increases the risk of ipsilateral ataxia.

The electrode consists of the stylet of a 22-gauge (0.4 mm diameter) 4½ in.-long spinal needle which is insulated with vinyl tubing except for its terminal 3 mm. While connected to the lead of the (inactive) radiofrequency current generator, the electrode is inserted toward its coordinate point and into the brain stem. Based upon the initial position of the guide-needle, the surgeon may have to tilt the guide-needle slightly and hold it in position while he passes the electrode into the brain stem. He can then release the guide-needle and the electrode will remain in position. One may use the increase in electrical resistance or impedance as an indicator of electrode passage from CSF into the brain stem. The electrode tip will terminate in the descending trigeminal tract (with the vinyl insulation against the pia) at the following uncorrected film coordinates (Figs. 2 and 3): 0 to 10 mm (d) from the odontoid midline on the PA film and at, or just caudal to, the level of the obex (b) and 4 mm (c) anterior to the plane of the floor of the fourth ventricle on the translateral film. The radiographic distance (d) from the odontoid midline varies (averages 5 mm) due to the mobility and displacement of the brain stem as the electrode is inserted. The undisturbed surface of the 15-mm-wide brain stem normally should lie 10 mm (uncorrected) from the midline of the PA x-ray film under the present conditions of magnification.

The patient's verbal response to stimulation is most important. A 50 cps square-wave current of less than 0.5 V should cause pain in the ipsilateral side of the face. If pain or sensation is felt in the ipsilateral body (dorsal column stimulation), the operator should hold the guide-needle, withdraw the electrode, tilt the hub of the guide-needle medially, reinsert the electrode, and then release the guide-needle. If pain is felt in the contralateral body (spinothalamic tract stimulation), the operator should do the same thing but correct by tilting the hub of the guide-needle laterally. With appropriate placement of the electrode, radiofrequency

Fig. 1. Photograph of the patient in position for PTT.
Contrast radiography with trigeminal tractotomy

Fig. 2. Diagram of the electrode in the brain stem during PTT. 3 = third ventricle; 4 = fourth ventricle; AC = anterior commissure; CNS 5 = chief sensory nucleus, trigeminal; DTT = descending trigeminal tract; STT = spinothalamic tract; x, y, z = electrode, insulation, and guide needle, respectively; a = distance from the obex to guide-needle tip; b = distance from the obex to electrode tip; c-c' = distance from the electrode tip to the plane of the floor of the fourth ventricle (c); d = distance from the odontoid midline to the electrode tip; e = distance from the odontoid midline to the guide-needle tip.

coagulation with about 50 mA of current will create an adequate lesion. The current strength should be increased in increments with testing for analgesia. The current duration may be 10 to 60 sec.

Results

The procedure has been carried out on 12 patients: eight with neoplasm of the head and neck and four with benign causes of intractable pain (two with post-herpetic pain, one with tic dououreux, and one with orbital pain after loss of an eye). Satisfactory delineation of the floor of the fourth ventricle, obex, and dorsum of the brain stem occurred in every case. Complete analgesia of the sensory 5th, 7th, 9th, and 10th cranial distribution occurred in seven patients. In the remainder, ophthalmic-maxillary analgesia was effected. Transient ipsilateral ataxia was common. No dysarthria occurred. Three patients had contralateral body analgesia also.

Figure 4 illustrates the lesion in the first tractotomy patient. He died from cancer 10 months after tractotomy. This well-defined glial scar 2 mm below the obex is in a case with total facial analgesia. Examination of the area postrema showed persistent plasma cells and lymphocytes, most likely a chronic reaction to the emulsified Pantopaque. Nearly all of these patients had a 2- or 3-day temperature elevation of 101°F to 102°F. There was minimal neck stiffness, and CSF white cell counts ranged from 10 to 1000/mm³. Cultures were always negative. It is presumed these responses represent a transient aseptic meningitis secondary to the emulsified Pantopaque.

Discussion

Trigeminal tractotomy was initiated by
division fibers lie most ventrolateral near the spinothalamic tract and the mandibular division fibers most dorsomedial near the lateral cuneate nucleus and the tractus cuneatus. Apparently the pain and temperature fibers of the 7th, 9th, and 10th cranial nerves run just dorsomedial to the mandibular division and cross with this division or a little higher. Using percutaneous techniques, Hitchcock instead seemed to find that all the facial pain fibers reached the C-1 level (excepting the peri-oral or central facial pain fibers in some cases, these fibers being possibly located deeper). Kunc indicated that all facial pain pathways terminate 6 to 10 mm below the obex, based on his surgical experience with patients under local anesthesia. However White and Sweet are critical of this.

Our own experience tends to confirm the generally accepted fiber distribution. With lesions below the obex, analgesia is readily effected in the ophthalmic and maxillary region; but analgesia in the mandibular zone is less often achieved, and analgesia in the area innervated by the 7th, 9th, and 10th and intra-oral portion of the 5th cranial nerves is least often obtained. For this reason we agree with other authors that this procedure Sjöqvist over three decades ago. His original incision was made 8 to 12 mm above the obex, corresponding approximately to the level of the lowest vagal rootlets or to the junction of the middle third with the lower third of the inferior olive. Experience with persistent ipsilateral ataxia (injury to the restiform body) and dysarthria (injury to the nucleus ambiguous) convinced surgeons to cut at or within 10 mm inferior to the obex, generally incising about 3 to 5 mm deep from a dorsomedial point in line with the posterior rootlets of C-2 to a ventrolateral point at the emergence of the spinal accessory rootlets.

Most surgeons confirm experimental evidence that these pain and temperature fibers in the three divisions of the trigeminal nerve cross over to form the contralateral secondary ascending trigeminal tract, with the third division crossing highest (near the level of the obex) and the first division crossing lowest just below the cervicomедullary junction. In this pathway the ophthalmic
Contrast radiography with trigeminal tractotomy should not be generally used for treatment of mandibular tic douloureux. On the other hand, there is definite value to defining the obex on the x-ray film when total analgesia with minimal ataxia is required.

We have had no deaths resulting from PTT, and we are unaware of any deaths from this procedure carried out by other authors. Since the open surgical trigeminal tractotomy has a mortality rate exceeding 30% in cancer patients (less than 2% in patients with trigeminal neuralgia), we feel PTT represents a step forward in pain therapy. Although it appears that emulsified Pantopaque injected as described produces a transient meningeal reaction following PTT, no serious problem resulted. It may be worthwhile to inject methylprednisolone acetate with the mixture.

This contrast radiographic technique has allowed us to insert an electrode with accuracy into the descending trigeminal tract with minimal injury to nearby neural pathways (Fig. 5). Destruction of the dorsal spinocerebellar tract almost certainly occurs, but the resulting ipsilateral ataxia appears transient. Sophisticated stereotaxic instrumentation in conjunction with this method of defining the coordinates may be worthwhile. The excellent results of our recent experience have not indicated the need for carrying out PTT with the patient’s head in a stereotaxic frame in the operating room.

References

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