Percutaneous Radiofrequency Cervical Cordotomy: Technique*

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Credit for the conception of percutaneous cordotomy belongs to Mullan and his associates of Chicago. However, their technique utilizes a radioactive-tipped needle, and, since isotopic needles are not generally available, the method cannot be used by all neurosurgeons. It is important that a method be available which could be applicable in any neurosurgical unit, since the percutaneous approach is the most acceptable procedure yet to be developed. It is simple to perform, it is well tolerated by the patient, and it may be offered to those in all states of health, including patients who otherwise could not or should not be subjected to a major operative procedure. This report describes a modification of the Mullan technique which utilizes standard equipment, available commercially or easily built, and portable instrumentation. It appears to approach the practical ideal for generalized use.

Technique

The patient is premedicated with a combination of an analgesic, hypnotic, and belladonna alkaloid. Control is supplemented at the time of cordotomy intravenously as necessary. Medication may be heavy or light as suits both the patient and surgeon, so long as a state is maintained wherein subsequent testing for levels of analgesia may be accomplished. The cordotomy tray consists of the equipment shown in Fig. 1.

The patient is placed on the standard table in the radiology department, and open-mouth anteroposterior and lateral projections of the cervical spine are made for accuracy of roentgenographic technique. The head is fixed in a regular cup head-holder or a more intricate holder may be constructed, Fig. 2. In this unit, 2 standard cup rests have been aligned anteriorly and posteriorly. A microscope stage has been mounted on either side of the base with a clip attached to the end for manipulation of the cordotomy needle. A wheel is raised with 1 per cent procaine directly beneath the tip of the mastoid process. An 18 gauge, thin-wall, 3 \( \frac{1}{2} \) in. spinal needle is advanced through the wheel parallel to the table and perpendicular to the axis of the spine. Procaine is injected for analgesia along the route of introduction. When the needle meets resistance, anteroposterior and lateral roentgenograms are taken and developed by rapid hand or Polaroid methods.† The needle is usually against a lamina, or at the edge of the spinal canal Fig. 3. The angulation of the needle is corrected to place the tip midway between the laminae of C1 and C2 and toward the ventral half of the spinal canal. More procaine is injected, making a total of 10 to 15 ml. by the time the epidural space is reached.

The subarachnoid space is then punctured. The patient should be warned beforehand since this is sometimes painful, due to contact or traction on the C2 root by the needle. The stylet is removed allowing a free flow of cerebrospinal fluid, a 2-way stopcock is attached, and 10 ml. of air are injected. Another set of anteroposterior and lateral projections is made. Almost invariably, the needle will be found to have penetrated a greater distance than was anticipated, Fig. 4. For this reason, it is best to have overcorrected anteriorly so as to not have punctured the spinal cord at this point in the procedure.

The needle is attached to the microscope stage manipulator and is withdrawn to midway between the projected lateral edge of the odontoid process and the wall of the spinal canal. The hub of the needle is lifted anteriorly, thus directing the tip of the needle posteriorly. Under these circumstances, the needle cannot become displaced too far dorsally, since it impinges against the denticate ligament which maintains it in an anterior position. The placement is checked by another set of roentgenograms. The movement of the needle may be accomplished entirely by hand and maintained by adhesive tape, if a manipulator is not available.

The electrode is then thrust through the needle into the anterior quadrant of the spinal cord. Again, nerve root traction produces suboccipital pain so the patient, once more, must be forewarned. The electrode consists of 0.020 in. stainless steel, bored 2 mm. at the tip, and insulated with p. e. #50 polyethylene. It is usual to extend the electrode 4 mm. beyond the tip of the spinal needle; 2 mm. bared, 2 mm. insulated. The electrode is attached to the coaxial cable of the radio-frequency generator, Fig. 2. The radiofrequency unit being used was constructed from the design of Arnow. Similar instruments are sold commercially, but all have to be standardized in animal tissue for lesion size. The maximum sized lesion for this unit is a 5 mm. ellipsoid after 30 seconds exposure. When the current is applied for 10 seconds or more, it produces diffuse, suboccipital pain. Therefore at this stage too the patient must be forewarned. For safety, the size of the lesions is increased gradually by 5, 10, 15, and 30 second increments of the

† Polaroid Type 57, 3000 speed, 4 × 5 in. film is used with a 4 × 5 in. experimental x-ray cassette and model 500 film holder, supplied through H. J. Frede of the Polaroid Corporation, Cambridge, Massachusetts.
radiofrequency current, Fig. 5. With proper electrode placement, after 5 seconds exposure, analgesia rises contralaterally to between the ankle and knee. After 10 seconds, it is mid-thigh; after 15 seconds D4 to D12; after 30 seconds C3 to D4. The variation in the upper level depends on the depth of penetration of the electrode. If upper extremity analgesia is desired, the tip of the electrode must reach a position about 2 mm. from the midline where it is possible to produce selective arm and upper thoracic analgesia, Fig. 6. Perineal, lower extremity, and abdominal deficits can be obtained by a more lateral placement of the electrode.

The analgesic level is immediate and can be checked on the x-ray table. Radiofrequency lesions have this important advantage over the delayed effect induced by isotope necrosis. It is possible to perform bilateral one-stage cordotomy by directing the electrode across the mid-line. However, in all but 2 instances, it has been our practice to stage bilateral cordotomies 1 week apart, hoping thereby to avoid respiratory and autonomic complications or other untoward results from the potential additive effects of 2 acute spinal cord lesions. Cordotomy may be accomplished in an average time of 50 minutes; our range has been 9 to 95 minutes. Recently, an omnidirectional cinefluorographic unit has been employed together with closed-circuit television. Average cordotomy time has been reduced to 24 minutes, range 20 to 35 minutes using this equipment.

Results

The first cordotomy with this technique was done on November 5, 1964. Since the subsequent follow-up period is so short, it is not possible to discuss definitive results. Therefore, the results to date are presented as provisional, and are better classified as immediate effects.

Forty-four cordotomies have been attempted in 35 patients. Fourteen cordotomies have been unilateral. Sixteen cordotomies have been performed in the 8 patients who have had bilateral procedures. The patients ranged in age from 32 to 82 years; males predominated 5 to 1. Twenty-nine of the 35 patients have had intractable pain due to carcinomatous infiltration. Carcinoma of the lung was the most common diagnosis, followed by carcinoma of the rectum and breast. Six patients had painful peripheral neuropathies; one had