Percutaneous, Intramedullary Cordotomy Utilizing the Unipolar Anodal Electrolytic Lesion*

S. Mullan, M.D., J. Hekmatpanah, M.D., G. Dobben, M.D., and F. Beckman, B.A.

Division of Neurological Surgery, University of Chicago School of Medicine, Chicago, Illinois

Percutaneous interruption of the pain tract of the spinal cord by means of an intradural strontium needle has provided very satisfactory relief from pain in approximately 80 per cent of the 75 patients for whom it has been used. It does not provide satisfactory early relief for patients with pain in the chest or arm. This is because necrosis at the periphery of the lesion (at a depth of 5 mm.) develops slowly over a period of about 3 months. If a higher dose of radiation is delivered, early necrosis of the “arm” area could be produced, but the periphery of such a lesion would spread into the cortical spinal tract in about 2 months’ time. Early destruction of the “arm” area by a percutaneous technic, therefore, demands a needle that penetrates the cord. A thulium needle was devised but at this time studies relating to induced thrombosis of arteries led us to re-examine the unipolar anodal electrolytic lesion. Although some parameters of this lesion have been found unsuitable by previous authors, we found that by lowering the current and increasing the time, we could provide an ideal lesion for our purpose—a lesion less than 5 mm. in diameter, which develops slowly over a period of 10 to 30 min. It was not certain from laboratory studies alone whether the physiological loss of function coincided with passage of the current, or whether it followed after a short interval (inside 24 hrs.) when the histological limits were more easily determined. It was felt that it probably coincided with passage of the current and that this would allow the operator to observe the physiological lesion as it developed and to modify it in position and extent as he deemed necessary.†

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Technic

The patient lies supine with his head resting comfortably on a roentgen-ray table, so arranged that biplane radiography of his upper cervical region may be made without moving either patient or roentgenographic tubes (rapidly developing Polaroid film†). The head and neck should be in neutral position. After preparing the skin and anesthetizing it with local anesthetic, a #22 spinal puncture needle, 9.5 cm. in length, is inserted into the skin at a point about 1 cm. below and behind the tip of the mastoid process. The point will vary according to the development of the mastoid process. The needle is inserted horizontally to a depth which varies with the thickness of the neck, but which is often about 6 cm., until it reaches the dura mater. The muscles are anesthetized liberally as the needle passes, but once the needle touches the dura mater, there is a definite flick of pain in most instances. The extradural space is anesthetized liberally and the needle is inserted through the dura mater. The latter gives the observer a feeling of resistance, which is greater than that experienced on doing a midline lumbar puncture and not so great as that experienced when going through the atlanto-occipital membrane in the course of a posterior cisternal puncture. In spite of anesthetizing the dural space, the patient is almost always aware of further pain as the needle traverses it, and this leaves the operator in little doubt as to the position of the needle. On withdrawing the stillette, cerebrospinal fluid flows out freely though slowly. There is no need to aspirate. If fluid does not flow (which is rare) it may be that the needle has penetrated the cord and radiographs must be taken to determine the position of the needle before assuming that it should be inserted to any greater depth. If the needle has, in fact, pierced the cord, there is rarely any doubt about this because penetration of the cord with a #22 needle gives considerably greater pain than that experienced by penetrating the dura mater only. Although the pain described on penetrating the dura mater is definite, it is not severe, and if the patient is prepared, he will not wince or move, but he may very well wince if the cord is penetrated abruptly.

When free flow of cerebrospinal fluid occurs, 5
cc. of air are injected and a lateral radiograph taken immediately will outline the anterior surface of the cord. If the head is too high, air will enter the skull and cause slight headache (Fig. 1). If the needle is seen to lie in a position that is thought to be anterior to the dentate ligament, then 1 cc. of Pantopaque is injected and a lateral radiograph will show some of it to lie in a pocket or in several pockets, anterior to the dentate ligament (Fig. 2). After several minutes it may fall posterior to the cord or into the cisterna magna. If the needle lies posterior to the dentate ligament, it is withdrawn and reinserted into the position 2 mm. behind the anterior surface of the cord and 1 cc. of Pantopaque is injected. Occasionally the Pantopaque does not hold up on the dentate ligament, but falls through posteriorly and in these instances the posterior surface of the cord may be outlined by injecting 2 cc. of Conray diluted with 2 cc. of saline to make a 4 cc. injection. This water-soluble contrast material is somewhat heavier than water but not so heavy as Pantopaque and pools posteriorly in such a manner as to show the posterior surface of the cord. If the head is dependent, the Conray may flow out easily into the aqueduct and the 3rd ventricle. Its disadvantage is that nausea occurs in almost all cases, and in a few cases there is vomiting. These discomforts come on about 10 or 13 min. after injection at a time when the material is no longer easily visible radiographically. The desired point of entry into the cord is 2 mm. anterior to the dentate ligament as best determined by the level of Pantopaque or, if not, at a point 2 mm. anterior to the midpoint between the levels of air and Conray. Occasionally, the pockets of the dentate ligament present a convex rather than a straight border posteriorly and it is not certain that these truly represent the anterior levels of the corticospinal motor tract. In such cases we prefer to take our measurements from the anterior surface of the cord. There is one other useful measurement—the distance between the dentate ligament and the posterior border of C2 which very rarely exceeds 10 mm. If the apparent position does exceed 10 mm. then we prefer to take this average figure for our first insertion, and then reposition more posteriorly only if the first position proves to be unsatisfactory (Fig. 3).

Several insertions and reinsertions may be necessary before the needle is finally lined up on the desired point. If in the course of these insertions blood is obtained extradurally, this almost always means that the needle is too far anteriorly. When the optimum point has been reached, the anode, 10 mils in diameter, made of iridium, iridium-platinum alloy or platinum-clad tungsten wire, insulated* except for its terminal mm., is now inserted through the #22 needle until it touches the cord. A definite resistance is encountered. Insertion of the sharp point of these very fine but firm wires into the cord causes little or even no pain, unlike the rather severe pain that occurs when a #22 needle is accidentally inserted, but as the insulated coat catches upon the pia mater there may be a more definite but not a severe pain. By the operator's sensation of touch and by the patient's response to pain, the operator knows at what point the cord is penetrated after the point has left the #22 needle. If it pierces the cord after about 2 mm., he knows that he is entering the cord near its widest point, but if 5 mm. or 6 mm. elapse, then he is touching it anteriorly (Fig. 4). At the point of contact with the cord an anteroposterior radiograph will now show how far the tip of the needle is from the midline. If it is 5 mm. or 6 mm. from the midline, the position is probably good. If it is 2 mm. to 3 mm. from the midline, he is almost passing anteriorly. Once the needle has been inserted into the cord to the desired depth, which will vary according to

* Three coats of baked Epoxylite.