Target Physiologic Corroboration in Stereotaxic Cervical Cordotomy*

J. A. TAREN, M.D., ROSS DAVIS, M.D., AND E. C. CROSBY, PH.D.
Section of Neurosurgery, University of Michigan Medical Center, Ann Arbor, Michigan

The recent conversion of cervical cordotomy from an open procedure to a closed stereotaxic procedure has extended the benefits of cordotomy to many more patients. The four accepted steps of stereotaxic surgery must be followed: 1) definition of the radiologic coordinates of the target; 2) the use of a precision apparatus to approach the target; 3) physiological confirmation of the target; and 4) precise destruction of the target. Elimination of any one of these steps will increase the hazard to the patient.

The Target and its Environs

 Destruction of the lateral spinothalamic tract at the second cervical cord segment usually results in a contralateral loss of superficial pain, temperature, deep pain and visceral pain below a level of C-3 or C-4 although overlap of the pain fibers from upper cervical levels with the ventral secondary ascending tract of cranial nerve V may preclude these high levels.\(^6^,8,15,16,19,20,22,23,39,40,46\) The hazards of cordotomy at this level are due chiefly to the proximity of other important pathways as well as to considerable anatomic variation. Moreover, the second cervical cord segment is at the lower margin of the cervicomедullary junction where the anteroposterior diameter of the cord increases rapidly, and the position of tracts varies with the size and position of the motor decussation (Figs. 1–4).

A descending respiratory pathway (ventrolateral reticulospinal tract) is probably intermingled with and deep to the fibers of the anterior part of the lateral spinothalamic tract as concluded by Nathan.\(^3^,4,6,28\) Recently, Hitchcock and Leece\(^13\) have presented evidence to show that automatic respiration in man is mediated through this reticulospinal pathway in the anterolateral quadrant of the cord (voluntary control of respiration is presumably through the corticospinal tract). Unilateral destruction of this pathway results in little functional respiratory loss unless the contralateral respiratory function is poor. In our experience as well as that of others, however, bilateral lesions involving the anterior portion of the lateral spinothalamic tract have been extremely dangerous in that the patients may be unable to respire while asleep. That this is not a new concern can be adduced from Foerster's letter of 1932 in which he stated "I personally would be afraid of a bilateral chordotomy at a high cervical level."\(^21\)

It may be possible to avoid these pathways where only bilateral sacral analgesia is required since the portion of the lateral spinothalamic tract from sacral levels is most posterior. However, should bilateral pain relief be required, one lesion is made at C-2 and the other lesion, 7 to 10 days later, by the anterior approach of Lin, \(et\ al.,\) at C-5 or C-6, thus preserving diaphragmatic respiratory pathways on one side.\(^25\)

The motor decussation usually extends from the obex to the C-1 level but the crossed corticospinal tracts may not assume their typical posterolateral position until they are at the lower portion of C-2 (Figs. 5–7). This decussation occurs over usually 8 to 10 mm; the arm fibers cross more superiority than do the leg fibers. Contralateral leg weakness can occur either if the lesion is too high (toward C-1) or if there is variation and the decussation is as low as upper C-2. Not only may the location of the pyramidal tract and the number of fibers it contains vary, but also the relative number of decussating fibers. Barone\(^9\) stated that 80% of the
fibers of the pyramidal tract cross to one side while 20% do not; according to Nyberg-Hansen and Rinvik, the proportion of crossed fibers varies in man from 0 to 100%. Häggqvist found crossed and uncrossed fibers in both the lateral and ventral corticospinal tracts.

Aberrant corticospinal tracts have been described as well as in a case in which the corticospinal tract did not decussate at all but remained in the anterolateral quadrant of the cord. There is also much variation in the size and the importance of the ventral corticospinal tract that usually carries motor fibers to the trunk and neck musculature. Encroachment on the lateral corticospinal tract, which is more medial and more anterior than we had suspected at this level, is to be avoided although destruction may produce surprisingly little permanent functional loss in terms of paresis of the extremity or bladder if the lesion is unilateral. As has been shown elsewhere with stereotaxic lesions in the thalamus, a unilateral error may be compensated but a bilateral symmetrical error is always dangerous.

The lateral spinothalamic tract is overlaid at this level by the ventral spinocerebellar tract which contains sacral, lumbar, thoracic, and cervical fibers in that order from posterior to anterior. This pattern is duplicated in the dorsal spinocerebellar tract which, however, carries fewer cervical fibers. A lesion eliminating all of the ventral spinocerebellar tract as well as the most anterior portion of the dorsal spinocerebellar tract produces ipsilateral ataxia of the arm.

The additional hazard of an undesirable neurological deficit produced by a lesion obliterating the anterior spinal artery must be considered. This is particularly important since Perese and Fracasso have pointed out that there were two such arteries in 13 of 28 human cervical spinal cords and that these arteries did not ordinarily follow the anterior median fissure.