Clinical Observations on Respiratory and Vasomotor Disturbance as Related to Cervical Cordotomies

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Forerster, in 1913, first suggested the upper cervical cord as a site for cordotomy when control of pain in an upper extremity or neck was necessary. It was not, however, until 1931 that he cautioned against a general use of bilateral high cervical cordotomy because of the impaired respiratory function that might result. He reported in 1932 that cordotomies in the high dorsal area were not associated with respiratory motor disturbances and concluded that the efferent tracts from the medulla oblongata to the spinal nuclei are not positioned in the anterior tracts.

Since these reports, there have been numerous authors who have published their experiences with high cervical cordotomies and some divergence of views, particularly in reference to respiratory difficulties, has continued.

Peet et al., in 1933, advised that bilateral high cervical cordotomy should not be performed because of the danger of respiratory paralysis. "The phrenic nerves", they said, "arise chiefly from cells in the fourth cervical segment. The exact location of the tracts descending to these cell bodies is unknown. Theoretically, at least, edema following section of the anterolateral tracts might involve these descending fibers or the phrenic cells in the anterior horns as well as the motor tracts of the intercostal muscles, resulting in respiratory failure."

In 1950, White and associates, after reviewing their series of patients subjected to high cervical cordotomies, concluded that mortality was greater in the postoperative period when this region was used. Two of 9 deaths they reported were a result of immediate respiratory and circulatory failure.

More information was offered by French and his co-workers. Five of 12 patients undergoing bilateral simultaneous high cervical cordotomy died in the immediate postoperative period. It was concluded that such procedures were fatal if the level of analgesia obtained was high enough to relieve bilateral upper thoracic and lower cervical pain. It also was recognized that transitory paralysis of the ipsilateral intercostal muscles and diaphragm occurred in almost all cases. This usually disappeared within 24 hours and was not associated with pulmonary complications. French commented that patients who exhibited this transitory respiratory muscular paralysis were more likely to maintain a permanent high level of analgesia. Grant and Wood, Jackson, and Belmusto and Owens indicated undesirable mortality figures following high cervical cordotomies.

Brihaye and Retif reported that high cervical cordotomies gave better results in their series, but a higher incidence of mortality was encountered. They concluded that bilateral high cervical cordotomy (if done properly) should never be performed at one sitting. Matson and Shillito concurred with this view.

Stookey, Roulhac and Horrax and Price reported their experiences with high cervical cordotomies, some of which were bilateral, and these authors were impressed with the absence of postoperative complications.

Forerster, in 1936, reported his observations on vasomotor alterations following bilateral cordotomies. He concluded that vasoconstrictor pathways to both sides of the body were represented in each anterolateral quadrant of the cord. Others de-
scribed "orthostatic or postural" hypotension resulting from bilateral cordotomies. White et al. and French inferred that this change might occur in high cervical cordotomies.

The consensus, it would seem, is that a bilateral simultaneous high cervical cordotomy is dangerous. Despite this general view, it was obvious that more detailed information relating to respiratory and vasomotor change resulting from cervical cordotomies at different segments, both unilateral and bilateral, was required. This study was, therefore, undertaken. Specifically we wished to establish:

(1) The incidence and degree of respiratory and vasomotor alterations following high cervical cordotomies (C1, C2, C3) and low cervical cordotomies (C5, C6, C7, C8) whether unilateral or bilateral.

(2) A more precise anatomical location of the pathways of the fibers serving these systems. This interest was sparked initially by 2 fatal complications which were related to high cervical cordotomies for which good explanations were lacking. These cases are reported below.

Case 1. A 62-year-old white male underwent a bilateral high cervical cordotomy because of pain in the lumbodorsal midline and lower extremity. Four years previously, carcinoma of the rectum had been excised through a combined abdominoperineal approach.

Physically, there was no evidence of cachexia or advanced carcinomatosis. The right leg was markedly edematous and little movement of the legs could be elicited because of pain.

At operation, bilateral incisions, 5 mm. deep, were made; one at C2 and the other at C3.

After operation, respiratory difficulties were encountered, but with positive-pressure assistance he recovered nicely within 24 hours. Sensory levels at around C5 bilaterally were recorded. His progress was excellent over the next 3 days.

He was assisted into a chair on the 4th postoperative day and collapsed immediately. Vital signs were unobtainable. External cardiac massage was instituted and resuscitation was possible. Respirations were very depressed and required positive-pressure assistance. Despite all efforts, he expired 3 days following his collapse and 7 days following operation.

Autopsy revealed atheroma of the coronary artery and a small metastatic nodule in the right auricle. Tumor was encountered extensively elsewhere. There was no untoward surgical damage to the spinal cord.

Case 2. A 39-year-old white female underwent a bilateral high cervical cordotomy because of intractable pain on the basis of widespread abdominal and pelvic adenocarcinoma of the cervix.

Incisions of 4 mm. were made at right C1 and left C3 levels in the anterolateral spinothalamic tracts.

Immediately after, marked respiratory difficulties were encountered and were characterized by thoracic and diaphragmatic asynchrony. This persisted for about 1 hour. Within 24 hours, no apparent significant residual disturbance existed. She was discharged 9 days later, but returned in 1 week markedly cyanotic with a respiratory rate of about 2/minute. Immediate resuscitative measures were instituted and positive-pressure respirations were begun. It was learned that barbiturates had been used the previous evening for sleep and that she had been found in this respiratory state shortly before readmission. She recovered from the acute disturbance, but during periods of natural sleep, respiratory efforts became ineffective and required assistance. She eventually expired as a result of widespread carcinomatosis.

Postmortem examination indicated adequate surgical incisions of the cervical cord. There were no unanticipated findings.

Clinical Observations

**Methods.** The majority of the 20 patients included in these studies were operated on in the sitting position under general anesthesia administered via an endotracheal tube. Fluothane was the general anesthetic agent of choice, and in 2 instances local anesthesia was employed. In every instance the lower extremities were wrapped with elastic bandages and then elevated so as to prevent vascular pooling. A standard cervical laminectomy was carried out. The incisions aimed at the anterolateral spinothalamic tracts were never less than 4 mm. and never more than 5½ mm. in depth. The anterior cut was carried out perpendicular to the lateral incision so that the entire quadrant was incised. This usually would include all tissue up to and just medial to the emergence of the anterior nerve root. Constant arterial pressures were monitored in most instances via a brachial or femoral artery using a Rochester needle connected to a strain gauge leading