A NOTE ON IDENTIFICATION OF THE MOTOR SUPPLY TO THE DETRUSOR DURING ANTERIOR DORSOLUMBAR RHIZOTOMY

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During recent years surgical treatment of muscle spasm below the region of severe spinal cord injury has received considerable impetus. In 1933 Munro attempted bilateral intradural division of the lower thoracic, lumbar, and 1st sacral anterior nerve roots in markedly spastic patients with anatomic transection of the spinal cord, with the intention of converting their paralysis into a flaccid one, and enabling otherwise impossible rehabilitation to be carried out. In 1945 the same author described a revised surgical technique for anterior dorsolumbar rhizotomy, and reported a total of 10 civilian patients treated in this manner.

Among the numerous casualties with spinal cord injuries in World War II were many men in whom there developed extreme involuntary activity in the skeletal musculature below the level of their cord lesion. Medical therapy of this reflex activity proved discouraging. Botterell et al. reported a series of 5 anterior rhizotomies for “mass reflex” in 1946, and shortly thereafter Freeman and Heimburger described operative technique and results of rhizotomy in 15 paraplegic men, with observations on an additional 13 subjects operated upon by other surgeons. Invariably, reports on this operative procedure stressed the difficulties inherent, during surgery, in identifying the exact segmental level of a given anterior root. In his first cases Munro counted upward from the 5th sacral anterior root, but soon discarded this method as unsatisfactory, and utilized instead the last firm dentate ligament as an indication of the level of the 1st lumbar root. MacDonald et al. pointed out, however, that the last dentate ligament is relatively variable in level, and does not have a constant relation to the 1st lumbar root. Other investigators stated that, though the last firm dentate ligament is a fairly constant finding at the level of the 12th dorsal vertebra, anterior roots below this level may appear to be fused, and that resultant miscount during rhizotomy would result in section of motor roots to the bladder. The same authors suggested that an anterior root too large to be enclosed in a single silver clip should be designated as two roots.

It appears evident that, even with extreme care in the visualization and identification of anterior roots by all available methods, anterior rhizotomy performed in this manner is attended by considerable hazard to the motor

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supply of the detrusor. Accordingly, a method of more positive identification of the sacral roots constituting the efferent innervation of the bladder was utilized.

Anterior dorsolumbar rhizotomies were performed by the author during the years 1946–1947 on 22 patients exhibiting severe mass extension or mass flexion reflex activity below the level of cord injury. Indications for operation were similar to those described by other authors.\textsuperscript{2,8} Exploratory laminectomy to verify the completeness of cord interruption was performed in the majority of the subjects. Intravenous sodium pentothal was utilized in approximately $\frac{1}{2}$ of the cases as the anesthetic of choice. Other men were operated upon with no anesthetic, or with local infiltration of 1 per cent procaine hydrochloride containing epinephrine. The difficulties in identification of sacral motor roots innervating the bladder were largely obviated by reliance on the effects produced on the musculature of the bladder through electrical stimulation of isolated ventral roots.

**METHOD**

The day prior to surgery, a Foley urethral catheter was inserted in the bladder of the patient, and a preoperative cystometrogram performed. The rate of introduction of fluid into the bladder was not allowed to exceed 90 drops per minute, and a curve of all (except respiratory) fluctuations in bladder pressure was plotted. The volume at which the first maximal detrusor contractions occurred was thus determined. Under standard conditions in a given subject, this critical volume did not vary more than 1–2 oz., hence one preoperative cystometric determination usually sufficed.

In the operating room, the patient was placed prone on the table with the latter broken at the hips to flatten the normal lumbar lordosis. The thighs were thus placed in a position of partial flexion, effectively minimizing flexor movements of the lower limbs even in those patients showing intense reflex activity below the level of cord transection. It was not necessary to adopt the lumbar puncture position, despite moderate contractures at the hips in a few men. Heavy towel rolls were now placed beneath each inguinal crease to elevate the hips of the patient and, in addition, to insure that no portion of the ventral abdominal wall was in contact with the table. The urethral catheter was led down between the thighs and attached to a modified Munro tidal-drainage unit,\textsuperscript{9} allowing an ample length of rubber tubing at the perineum. The patient was then draped in the usual manner, and the entire apparatus shielded from the operative field.

Standard midline incision for exposure of the lower end of the cord was carried out, and the medial ends of the last dentate ligaments used for retraction of the conus and cauda equina. Immediately prior to root stimulations, an assistant drained the contents of the bladder, and introduced slowly a volume of saline slightly less than that previously estimated to be necessary for reflex detrusor contraction.

Root stimulation was now carried out, beginning with the root exiting at the D11–D12 intravertebral foramen and proceeding caudally, each root being lifted with a nerve hook, blocked from the field, and stimulated at 1–2 volts for 5 seconds. A Bovie stimulator was used in a few instances, but a later model Garceau peripheral nerve stimulator was employed in the majority of operations. All anterior roots