Focused Ultrasonic Spinal Commissurotomy: Experimental Evaluation*

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In 1927, Armour reported the first spinal commissurotomy, performed with the encouragement of Dr. Godwin Greenfield. Putnam, apparently independently, reported three instances of a similar “new” operation in 1934. There was then a brief burst of interest in this unique method of pain relief but it soon fell into disfavor because of the paralysis which frequently resulted from surgical disruption of the anterior spinal artery.

Earlier spinal cord experiments with focused ultrasound suggested the possibility of using ultrasound to perform discrete spinal commissurotomies. Early in 1963 a patient, reported by Ballantine, underwent this procedure with excellent relief of pain. This result prompted a physiological investigation of spinal commissurotomy.

Methods

Thirty-five adult mongrel cats weighing between 2.5 and 3.0 kg. were used. In acute physiological experiments the animals were anesthetized with cyclopropane, tracheotomized and placed on a Bird respirator. Following a laminectomy of T-10 through S-1, and in most animals also of C-1, the left 5th, 6th, or 7th dorsal root, the left posterior tibial and/or sural nerve and occasionally the left superficial radial nerve were exposed for stimulation. The animal was placed in a recording frame and maintained on Flaxedil and oxygen. Rectal temperature was kept between 35.5 and 37.5°C.

The nerves were stimulated with an American Electronics stimulator. Single stimuli delivered through platinum wire electrodes above ‘C’ threshold (25–35 volts, 0.5 msec.) and trains of 300 to 500 msec., 50 per second, with 40 volt intensity, were used. Nerve responses were recorded with platinum electrodes placed 8–10 cm. proximally

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Fig. 1. Lower thoracic spinal cord recording site and were displayed on a Tektronix 555 or 565 oscilloscope. Bipolar stainless steel recording electrodes having a tip diameter of 10–15 microns, exposed tip of 30 microns, and a tip separation of 1 mm., were introduced into the contralateral spinal cord, medulla or ventral tegmentum. Suitable responses were elicited at the recording sites shown in Figs. 1 and 2. Responses were photographed with a Grass Kymograph camera. After initial recordings a spinal commissurotomy was done with a focused ultrasonic beam. The ultrasonic generator has a frequency of 2.7 megacycles. A plate voltage of 1.15 K V., pulse duration 0.3 sec. gave the desired lesions. Twenty to 40 lesions were made, 0.6 mm. apart in a caudal-rostral plane. Each lesion was vertically elliptical and measured about 1×0.5×1 mm. in size.

* Manufactured by Radionics, Inc., Burlington, Massachusetts.

Fig. 2. Medullary recording site.
FIG. 3a. Evoked potential in medulla (top line) and in lower thoracic spinal cord (bottom line) after single stimulus (†) of 0.5 msec. duration, 7 volts. Vertical marker represents 50 microvolts; horizontal marker represents 50 msec. Control response before commissurotomy.

FIG. 3b. Evoked potential in medulla (top line) and in lower thoracic spinal cord (bottom line) after single stimulus (†) as in 3a. but recorded after a 2-segment lumbar commissurotomy begun caudally and proceeding rostrally.