STUDIES ON THE SACRAL REFLEX ARC
IN PARAPLEGIA*

I. RESPONSE OF THE BLADDER TO SURGICAL ELIMINATION OF
SACRAL NERVE IMPULSES BY RHIZOTOMY

ARNOLD M. MEIROWSKY, M.D.,' C. DAVID SCHEIBERT, M.D., AND
THOMAS R. HINCHEY, M.D.†

Section of Neurological Surgery, Veterans Administration Medical
Teaching Group, Kennedy Hospital, Memphis, Tennessee

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It is the purpose of these studies to broaden the clinical and experimental
evidence of true bladder automaticity, and to apply this evidence to
surgical measures in the treatment of patients with transverse myelop-
athy.

Goltz and Ewald in 1896, and Müller in 1902, apparently first observed
automatic micturition subsequent to complete destruction of the sacral cord
in animals and men. Upon sectioning of both pelvic nerves, Elliott found
temporary paralysis of micturition which was replaced 4 to 5 weeks later
by some “lame” degree of bladder automaticity. Denny-Brown described
the occurrence of periodic micturition without residual and without inconti-
nence in cases of complete destruction of the cauda equina. While Müller’s
and Denny-Brown’s observations indicated the existence of automatic prop-
erties of the bladder, surgical denervation of the bladder in man to establish
automaticity has never been reported. In 1945, Hoen described 1 case in
which he had sectioned the motor components of both 3rd sacral roots within
the dural sac with the idea of lessening the tone of the external sphincter.
Following this operation, the patient was able to evacuate his bladder com-
pletely. Hoen assumed that the 3rd root is the main contributor to the pudic
nerve, but that contributions from the 2nd and 4th sacral roots were suf-
ficient to maintain sphincter control. In a discussion of the surgical relief
of spasticity in paraplegia, Freeman and Heimburger suggested that section
of selected anterior sacral roots may be indicated in some cases of neurogenic
bladder that are resistant to routine methods of care. Recently, Heimburger,
Freeman, and Wilde succeeded in demonstrating accurate determinations
of the sacral innervation of hypertonic bladders by novocain injections of
the nerve roots in conjunction with cystometric studies. On the basis of
their clinical investigation, they concluded that the anterior root of the 3rd
sacral nerve rendered dominant innervation to the human bladder. They
have furthermore shown that selected cases of neurogenic bladder, charac-

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† Present Address: Department of Neurological Surgery, Washington University School of Medic-
cine, St. Louis, Missouri.
characterized chiefly by urinary retention, can be treated successfully by bilateral block of the 3rd sacral roots with novocain solution or with alcohol. Shelden and Bors reported that a voluntary type of micturition was established in 19 out of 24 patients subsequent to intrathecal injection of alcohol.

This paper deals entirely with observations on the bladder status in transverse myelopathy subsequent to surgical elimination of sacral nerve impulses by rhizotomy.

During the period from September 1947 until October 1948 12 rhizotomies have been performed for surgical relief of spasticity in the lower extremities, and 1 rhizotomy for relief of root pain and establishment of bladder automaticity. Two of these patients had traumatic transverse myelopathy of the cervical cord, while the remaining 11 patients had a thoracic level. The classical anterior rhizotomy with section of the anterior roots from T12 to S1 was performed on 5 of the 13 patients. This group of 5 patients is irrelevant to the present study of surgical elimination of sacral roots. It is, however, of interest to note that there was no change in the bladder status in these 5 patients subsequent to anterior rhizotomy.

Of the remaining 8 patients, all anterior roots from T12 to S5 were sectioned in 3 patients; anterior and posterior roots from T12 to S5 were divided in the other 5 patients.

REPRESENTATIVE CASES

Case 1. H.R., a 25-year-old white male veteran, sustained a gunshot wound of the left chest and thoracic spine July 1, 1945 on Okinawa. The injury resulted in immediate complete paraplegia with a dermatome level at T7. Progressive flexor and adductor spasm of the lower extremities was first noticed 2 weeks after injury. The patient was admitted to Kennedy Veterans Administration Hospital on June 6, 1946. Laminctomy of the 5th, 6th and 7th thoracic vertebrae (AMM) on June 13, 1947 verified a complete anatomical transection of the spinal cord at T5. Multiple decubital ulcers and progressive nutritional deficiency complicated the paraplegia-in-flexion. On April 15, 1948, anterior rhizotomy from T12 to S5 (AMM) resulted in complete flaccidity of the lower extremities.

Bladder status before and after rhizotomy (Table 1): Straight catheter drainage was used for 26 days subsequent to injury. A suprapubic cystostomy was performed on July 27, 1945 and was closed on April 26, 1946. After 1 month of straight catheter drainage, the patient was without a catheter for 8 months. During this time the patient had an overflow incontinence during spasm. In January 1947, a urethral catheter was reinserted with intermittent tidal and straight drainage. Seven days after anterior rhizotomy on April 15, 1948, the catheter was permanently removed. Since that time the patient has urinated at will without incontinence and without residual urine.

Comment. Following anterior rhizotomy the patient has an automatic bladder with voluntary micturition without residual and without incontinence.

Case 2. J.B., a 25-year-old white male veteran, was pinned under an auto when a jack broke on Feb. 26, 1947, with fracture of the 11th thoracic vertebra. He suffered