THE SURGICAL RELIEF OF SPASTICITY IN PARAPLEGIC PATIENTS

II. PERIPHERAL NERVE SECTION, POSTERIOR RHIZOTOMY, AND OTHER PROCEDURES*

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In order for the paraplegic patient to insure health and an extended life span, ambulation with orthopedic aids must be pursued. Ambulation is necessary from several standpoints, one of the most important of which is the excretion of calcium. In the recumbent position calcium is mobilized from the bones of the limbs and is excreted in great quantities in the urine. This leads to the formation of urinary calculi which recur with great frequency unless the primary cause—recumbency—is removed. Only when the limbs are forced to bear weight is the process stopped. Of lesser importance, but still significant, are other improvements that are noted when ambulation is pursued, such as better vasomotor tone and superior bladder and bowel reflexes. In many patients, persistence and perfection of ambulation techniques are rewarded by a useful mode of locomotion. Furthermore, although a limited amount of aided walking is possible in patients with high cord lesions, it is often too difficult to prove of real value as a useful means of travel. It is useless to advocate ambulation as a means of locomotion for all patients, for some patients do not have enough persistence to reach that goal. On the other hand, one should never be satisfied with a wheel chair existence for these patients. To do so demonstrates a failure to recognize the underlying metabolic disorders associated with spinal cord injuries.

In attempting to launch patients into a schedule of training for ambulation, one of the difficulties frequently encountered is uncontrolled reflex spasms of various muscle groups in the limbs and abdomen. Thus, the feet may bounce out of the shoes, the legs may suddenly fly forward, or the legs may draw sharply against each other. Any one of these unpredictable reflex actions serves to throw the patient off balance, creating a fear in the mind of the patient and acting as a damper to his further efforts.

In a previous publication it was pointed out that the procedure of choice for the relief of severe flexor spasms in patients with complete traumatic

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transverse lesions of the spinal cord was section of appropriate anterior spinal nerve roots. Patients so treated show remarkable improvement, particularly after ambulation is undertaken. However, a somewhat larger group of patients presents problems of spasticity in which irrevocable procedures do not seem necessary or justified. This group is comprised of those patients whose spinal cord injuries are clinically incomplete or have been proven to be anatomically incomplete by operation. Included in this category are those whose injuries are of less than one year’s duration and have not been demonstrated to be complete, and those who have exhibited considerable return of function but are disabled by severe spasms of the legs. The procedures which will be described have been undertaken after a trial of vigorous physical therapy and other medical measures; regardless of the therapy instituted, physical therapy was continued. The disappointing results obtained from curare in water, curare in oil, prostigmine, and other such agents forced the use of surgical measures in most cases. Watchful, expectant waiting for spasticity to “burn out” rarely was profitable, for spasticity that interferes with ambulation usually demands immediate correction. Too frequently, physiotherapeutic measures merely serve to augment the spasticity. It is the aim of the authors to list those procedures utilized in an effort to control spasticity and to evaluate the benefits derived from each.

PERIPHERAL NERVE SECTION

1. Obturator Nerve. Bilateral section of the obturator nerves at their entrance into the obturator canals will relieve the severe adductor spasm seen in almost all patients with spastic paraplegia. This approach is far preferable to the regular orthopedic approach and can be performed entirely extraperitoneally. In 12 patients, there were no failures to relieve the adductor spasm by this procedure, whereas 5 of 8 patients observed who had been done by the lower approach had inadequate relief, probably because of failure to sever sufficient branches. The identification of all of the branches of the obturator nerve in the thigh wherein muscles must be transected and extensively dissected is an exceedingly difficult task, even for the highly skilled orthopedic operator. In all of the patients with complete obturator nerve section ambulation could be conducted without a hampering bar on long leg braces, previously necessary because of severe scissoring action of the legs. All but one of these operations were carried out on patients with clinically incomplete lesions. Strangely enough, each of these patients had a marked reduction in general spasticity and much unsuspected voluntary motor function was uncovered by the procedure. In 8 patients, markedly spastic bladders with capacities of less than 2 ounces gained in capacity to as much as 15 ounces with fair automatic control. In the others, definite improvement in bladder capacity and control was noted. This procedure should probably be used in many permanent quadriplegic patients with adductor spasms. A lipless glass urinal would then stay between the legs, allowing removal of the catheter.
The technique utilized is as follows: a Pfannenstiel incision is made and each obturator canal is approached by muscle splitting and blunt extraperitoneal dissection. When the canal and the entering nerve are palpated, retractors are placed and the area is visualized. The nerve is freed from the vessels and a segment is removed between 2 silver clips. Layer by layer closure of the incision is then carried out.

2. Sciatic Nerve Section. In general, outright section of the sciatic nerve would not be considered in patients in whom it is felt that there is a chance for return of function. However, bilateral section and immediate careful re-suture have been carried out in 5 patients who had advancing contractures of the Achilles tendons. Two of these showed function prior to surgery and both regained total function, with the period before re-innervation being used to good avail in stretching contractures and mobilizing joints. The remaining 3 probably had complete lesions; they resisted destructive procedures and merely desired to keep their feet from bouncing out of the shoes of the braces.

The technique utilized in these 5 cases has been as follows: the peroneal and tibial nerves were exposed just above the popliteal space and after placement of aligning sutures, were completely sectioned. Suture was then carried out with tantalum wire.

No case has been done above the hamstring innervation since most patients encountered have relatively little difficulty ambulating with long leg braces if the feet can be placed at right angles. Generally, when either the hamstring or Achilles tendons are shortened by contracture, the ankles can be placed at right angles only if the knees are flexed; when the knees are extended, the feet passively plantar flex. Tenotomy is not required and correction of one will provide an adequate solution of the difficulty.

3. Other Peripheral Nerve Sections. It would be reasonable to expect that almost any peripheral nerve might have to be sectioned in an attempt to relieve spastic contractions. However, in paraplegias and in quadriplegias, only one other nerve has been sectioned, the femoral. It is uncommon to find cases in which the major hindrance to ambulation with braces is not traceable to plantar flexion or to adduction or flexion of the thighs. Occasional patients are seen who have such severe flexion of the thighs that balance can not be maintained and lying in bed is actually hazardous. In these patients, section of the femoral nerve, or injection with ethyl alcohol, will accomplish gratifying results.

The femoral nerve can be approached by a combined technique in which both the obturator and femoral nerves can be visualized and sectioned, or the femoral nerve can be sectioned alone. A 2 cm. incision is made one finger breadth below Poupart’s ligament, centered over the lateral side of the femoral canal. The fascia is incised on the lateral side of the canal and the nerve can be picked up easily before any branching occurs. Section alone, or section and re-suture can be accomplished readily.

**POSTERIOR SPINAL NERVE ROOT SECTION**

Since the advocacy of posterior root section for athetosis by Spiller and for cerebral spastic paraplegia by Foerster many operations of this kind
have been carried out with conflicting results being reported. In general, the procedure appears to be warranted in cerebral spastic palsy. Only 2 patients have been subjected to this procedure in the group of patients observed by the authors. In 1, the lesion of the spinal cord had been present for 8 months without any return and in the other, motor function was apparently completely present. In both, it did not appear to be proper or timely to section the anterior spinal nerve roots, although spastic contractions were so vigorous and continuous that they seemed likely to jeopardize the general well-being of the patients. The results were disappointing. Both obtained relief from adductor spasm, but the flexor spasms were unaffected. Each had a high dorsal cord lesion and the roots resected included all from the 10th thoracic through the 1st sacral. It seems likely that any attempt to eliminate afferent impulses short of abolishing all of them below the point of lesion would be doomed to failure. To accomplish this, very extensive laminectomy would be necessary. Since the bladder reflexes would suffer from deafferentation, such a solution would not be wise.

OTHER PROCEDURES

The procedures discussed below have limited application, but their use has been helpful on occasion.

1. Alcoholic Injection of the Spinal Cord. Ninety-five per cent alcohol can be injected directly into the spinal cord with relief of massive spasms. Lumbar puncture needles are advanced carefully into the spinal cord at several levels above the conus medullaris, and from 0.5 to 1.0 cc. of 95 per cent ethyl alcohol are injected at each point. Flaccidity appears immediately and is maintained for approximately 6 weeks. The primary usefulness of this procedure is found in the occasional patient who has massive decubiti in the sacral region, precluding the possibility of immediate anterior rhizotomy. In 1 patient subjected to this procedure, a distressing development occurred. For 10 days, a right Horner’s syndrome and right ulnar palsy were present. It would require very little further upward extension to bring about death.

2. Subarachnoid Injection of Alcohol. Dogliotti demonstrated the relative safety of subarachnoid injections of alcohol. The patient is placed on his side with moderate rotation to bring the anterior roots uppermost and ethyl alcohol is injected slowly. Usually, 1 cc. of 95 per cent alcohol is sufficient and the other side can be done in 10 days. Since the specific gravity of alcohol is less than that of the spinal fluid, the uppermost side is generally affected. However, even with slow injection, the greatest effect may occur on the lowermost side. The effects are usually very transient, sometimes lasting only several days. Out of more than a dozen patients so treated, none had effects lasting longer than 6 weeks. The procedure is usually done as a temporary measure. The result is similar to that obtained by anterior rhizotomy but is of much shorter duration. With massive decubiti or with urinary tract calculi as complications, sufficient time is often obtained for corrective measures to be instituted.
3. **Continuous Spinal and Continuous Caudal Anesthesia.** Although these measures have been carried out for as long as 3 consecutive days, no permanent effect on spasticity has been seen. It is possible to obtain as much information about the presence of contractures from a single spinal anesthesia. Continuous spinal anesthesia can be very dangerous.

4. **Sympathetic Ganglionectomy.** Since Hunter and Royle first pointed out the therapeutic application of knowledge of the influence of the sympathetic nervous system on spasticity, many surgeons have attempted to relieve spasm by removal of sympathetic ganglia. Successful results were infrequent enough to cause abandonment of its use as a means of treating spasticity. In a small number of spastic patients the lumbar ganglia were removed for other reasons without apparent effect on spasticity, save possibly in 1 case. Some question might be raised as to the reliability of this patient’s powers of observation, but those in attendance to the patient agreed with him that lumbar sympathetic ganglionectomy had reduced an already minimal amount of spasticity without abolishing it. The procedure was unilateral, leaving one leg for control, and impartial observers stated that the sympathectomized limb appeared to be less spastic than the other. However in patients where spasticity is of minor degree, no real problem exists, and sympathectomy is not advocated.

5. **Orthopedic Procedures.** Only in neglected cases are destructive procedures to the joints or their surrounding structures justified. Usually, section and resuture of the sciatic nerve will allow physiotherapeutic measures to eliminate contractures of the Achilles tendons. The hamstring tendons rarely require surgical section.

6. **Miscellaneous Considerations.** An attractive hypothesis as to the causation of spasm of the limbs has been explored by Scarff and Pool. They noted that stimulation of the distal stump scar of the severed spinal cord gave greater spasm than did stimulation of any part of the distal cord. Resection of this scar gave temporary relief only. In 2 cases, they noted that the dorsal columns appeared to be “trigger zones” for eliciting the spasms, and section of the columns gave transitory relief. In 1 patient with extensor spasms, Meyer and Freeman sectioned the extrapyramidal tracts without affecting the severity of the spasticity. A number of patients with extensor spasticity and obviously incomplete lesions have benefited markedly by exploration of the site of the injury and freeing of extensive arachnoid adhesions. The demonstration of Poppen and Hurxthal that a subarachnoid obstruction to the free flow of spinal fluid will be attained only when the space has been limited to a caliber smaller than that of the puncture needle has been verified at operation on numerous occasions. Exploration of the site of old injury usually shows extensive adhesive arachnoiditis mostly confined to the posterior portion of the canal, with rare cases showing similar involvement in the anterior quadrants. Perhaps these cases are examples of the “irritative” thesis of Scarff and Pool.

The factors contributing to spasms in patients with spinal cord injuries
are undoubtedly manifold. Not the least of these is the ischemia induced by damage to the blood supply to the spinal cord. As demonstrated by Alexander and his associates, the midthoracic portion of the spinal cord is supplied by blood derived from lumbar and high thoracic arterial branches. As such, this area is particularly vulnerable to damage, leaving the distal segment of the spinal cord well supplied with blood and thus capable of its maximal reflex activity. Minimal local damage can induce maximal vascular injury where the blood supply is as vulnerable as it is in the midthoracic region. The resulting ischemia and subsequent glial proliferation can effectively interfere with the conduction of corticospinal impulses. Likewise, the contraction of the glial tissue can be shown to be productive of distortion of the architectonics of the cord in the region of the pyramidal tracts, lending some credence to the hypothesis of Scarff and Pool.

SUMMARY

1. Procedures utilized in the treatment of spasticity following trauma to the spinal cord are outlined and evaluated.
2. Selected peripheral nerve sections are beneficial.
3. Posterior rhizotomy does not appear to offer sufficient relief to justify its use.
4. Alcoholic injections of motor nerves or of the spinal cord give temporary relief and have limited application.

REFERENCES

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