PERIPHERAL NERVE SURGERY
THE TWO-STAGE OPERATION*
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(Received for publication August 15, 1955)

From time to time, defects in major peripheral nerves are encountered that cannot be overcome by any combination of procedures usually employed for primary suture. This is especially true during time of war when large numbers of nerve injuries are concentrated in neurological centers. When primary repair is impossible, the problem becomes one in which either a two-stage lengthening operation (bulb suture or “stretching” procedure) or a nerve graft must be employed. With the exception of those of Professor Seddon§ and his associates, nerve grafts have not been successful in a significant number of reported cases. If the defect cannot be made up by either a two-stage operation or a nerve graft, the only remaining possibility for improvement in function of the disabled extremity is an orthopedic operation, a tendon transfer or arthrodesis, either of which is inferior to even mediocre neurologic recovery following nerve repair.

In a series of 1713 peripheral nerve operations performed at one neurosurgical center during World War II, we had no successful experience with nerve grafts. We encountered 92 (5.3 per cent) patients in whom repair was attempted and 77 (4.5 per cent) patients in whom the defect was overcome by the use of a two-stage operation. There were 30 patients requiring a two-stage operation upon whom we obtained follow-up data from 6 to 26 months. There were 52 (3 per cent) patients in whom the nerve injury proved to be irreparable, either before or after an attempted two-stage operation, 15 of them following an attempted two-stage repair.

In a previous publication,² we catalogued our experience in overcoming large defects by primary suture and described the method that we employ in accomplishing a primary nerve repair. The essentials of the procedure to overcome such defects consist of wide mobilization of the proximal and distal segments and the use of prolonged fixation of the joints in a position to lessen the nerve defect. The surgeon must be ever cognizant of the fact that every effort should be made at the original operation to do a primary suture without resorting to the two-stage procedure, because the results are never as good in comparable cases when the two-stage procedure is used in contrast

* Presented at the third annual meeting of the Houston Neurological Society, Houston, Texas, March 18–19, 1955.
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to a one-stage repair. The tension that is employed in the so-called "stretching operation" unquestionably produces further intraneural damage through scarring and thereby lessens the final recovery of both sensory and motor function. Nevertheless, by whatever means a nerve suture is accomplished, if there is functional recovery, the final result is considered superior to an orthopedic procedure to overcome the loss of function from the paralyzed nerve.

The two-stage operation (bulb suture or "stretching operation") has been employed often in the repair of large defects and the gain in length resulting from it has been attributed to an actual stretching of the nerve. We doubt that it is possible to stretch a major nerve to any significant degree—certainly not over 1 cm. or at the most 2 cm. Our feeling is that the apparent gain in length following traction is ascribable to gradual shortening of the normal course of the nerve. Properly performed traction may provide an additional 5 or 6 cm. in length, but at the same time causes additional injury throughout the entire length of nerve subjected to it. Thirty to 40 per cent of function is lost as a direct result of this traction in contrast to what one might expect had the nerve ends been united without tension and by the use of other procedures to shorten its course. It is for this reason that we consider the two-stage operation a last resort for nerve repair, and preferable only to a nerve graft.

In the literature on peripheral nerve surgery, little attention has been directed toward the method of performing the two-stage operation. It is our belief that damage to the nerve can be reduced to a minimum by observation of certain technicalities which we have employed. Usually, the suture is performed with little regard for the additional amount of injury that results from uniting the proximal and distal lesions to each other with cat-gut, heavy silk, or wire sutures. Others have sutured the neuromas to fascia, muscle, or periosteum, markedly flexed the joints, and later employed rapid extension within 10 to 14 days during which time the nerve presumably is being "stretched." Actually the nerve is being forcibly pulled from its normally somewhat tortuous course in the extremity. We are certain that this method produces such extensive injury within the nerve, both in the proximal and distal segments, that the already large defect may be actually increased rather than decreased, making eventual repair impossible. When this rapid method of traction and extension is employed, one will find as thin slices of the segments are made in search of an anatomical design somewhat like normal nerve, that progress may extend many centimeters into the proximal or distal ends before anything resembling normal architecture is encountered. The homogeneous mass of fibrosed and degenerated nerve that has destroyed the normal architecture represents damage from the rapid traction applied to the nerve under tension.

After observing several patients with extensive defects from their original wound in whom bulb suture had been done previously, we abandoned the usual technique in favor of one using the same care as that used in a patient undergoing primary repair. Even with this superior method, some