PERIPHERAL NERVE LENGTHENING

I. EXPERIMENTAL*

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During the past 12 years, considerable advance has been made in the
diagnosis and treatment of peripheral nerve lesions. However, the
satisfactory repair of large gaps continues to be a problem. Grafts
of all types have received extensive trials in humans and in experimental
animals. Reports prior to 1940 have little value because of inadequate cri-
teria for motor and sensory recovery. Furthermore, it has been difficult to
apply to humans results obtained in animals because of different characteris-
tics of regeneration. Heterogenous grafts have been universal failures. The
encouraging results of homologous grafts in animals have not been equalled
in humans. Autografts have been more successful.

In a well documented report, employing the Oxford scale for recovery,
Seddon7 reported that of 52 cases followed, 52 per cent showed results as
good as suture, 67 per cent success or partial recovery, and 33 per cent were
failures. There were 20 cases of digital, or other small nerve lesions with
small gaps. Of main trunk grafts, the median was the most successful (7
success, 3 partial success, and 3 failures) while among various other main
trunk grafts, 1 was a success, 1 partially successful, and 6 were failures. A
serious disadvantage was that for defects in main nerve trunks, another in-
jured nerve in the same patient had to be sacrificed for graft material, thus
sacrificing one of the two nerves. In several instances in Seddon’s series both
nerves might have been salvaged by nerve lengthening.

Grafts present other disadvantages. As the length of a thick graft in-
creases, there is increased danger of ischemic necrosis at the center of the
graft, especially when the graft must be laid in a relatively avascular zone
of scar secondary to the widespread area of tissue destruction so often asso-
ciated with large nerve gaps. Finally, the growing axon, if it succeeds in
traversing the graft, must then pass an additional suture line, which may
be fibroosed by the time the axon reaches it.

Similarly, the procedures of extensive mobilization and transplantation

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present certain disadvantages. Contiguous blood supply is interrupted, and postoperative scarring is engendered. When motion is restored and previously flexed joints are extended, traction may result in extensive damage over long segments proximal and distal to the suture line.\textsuperscript{2,3} Extreme flexion of joints and immobilization are also highly undesirable in a denervated limb because of fibrosis, atrophy and contractures that occur.

On general grounds, therefore, the ideal method for overcoming large gaps is to transport by some means the central stump to the distal stump so that suture can be accomplished without tension and so that only the one suture line and distal stump need be traversed.

In a recent report, Hoen\textsuperscript{4} noted the deleterious effects of traction on the distal segment of a severed nerve. It was also noted that when end-bulb suture was performed, the central end appeared to tolerate stretch better than the distal end. These observations led to the trial of several stretch procedures in patients presenting otherwise unbridgeable gaps; the results are the subject of a separate communication.\textsuperscript{5} The present report deals with the initial phase of a program designed to evaluate these procedures in the experimental animal.

The early literature on nerve stretch has been summarized by Sanders\textsuperscript{6} and Denny-Brown.\textsuperscript{1} It is evident from a review of the literature that previous studies have been concerned with the effects of rapid or acute stretch. There has been no attempt to assay the effect of prolonged traction on nerves. The report of Denny-Brown cited above is of interest in that it points out that while a unifascicular nerve may elongate 100 per cent without serious damage, a multifascicular nerve will tolerate far less stretch without fatal damage, because of lesions of the integument, which is minimal in the unifascicular nerve. This suggests that the integument and not the axon is the limiting factor in nerve lengthening.

**MATERIALS AND METHODS**

Adult mongrel dogs weighing 15–20 lbs. were used. All were observed for a period of 1 month with serial weighing and limb measurement to rule out the possibility of growth before operation was undertaken.

The left sciatic nerve was used in all cases, the right serving as a control (except #5). The sciatic nerve, being a multifascicular nerve, was chosen because it was desired to test the effect of stretch on the integument as well as the axon. The anesthetic used was intravenous Nembutal and the nerve was approached posteriorly by separating the hamstring muscles. This allowed a clear approach to the nerve from the trochanter of the femur to the entry of the peroneal and tibial branches into the leg musculature. In the neuroma experiments, the nerve was sectioned, bleeding was controlled, and 6 weeks were allowed to elapse for the formation of a firm neuroma. Suture materials for attaching the neuroma included .007 and .003 tantalum wire and stainless steel wire #30 and #32. The steel wire proved best because it was less brittle than tantalum wire. The leg was immobilized by taping, plaster cast, or brace. The latter two were poorly tolerated by the animal and were discarded after a number of trials. The tape was removed in 2 weeks, and the animal was allowed to extend the leg spontaneously. This was usually carried out slowly over a period of