NERVE GRAFTS: THE IMPORTANCE OF AN ADEQUATE BLOOD SUPPLY*

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(Received for publication September 30, 1944)

The use of nerve grafts to bridge gaps is unavoidable in those instances in which the various manipulative measures for closing defects, such as the mobilization, rerouting or postural shortening of nerves with subsequent stretching, are insufficient or inadvisable. The use of autologous grafts, such as those employed by Bunnell for the repair of nerves of the hand and by Ballance and Duel for bridging gaps in the facial nerve within the Fallopian canal, has been successful in a high percentage of cases. However, clinical success has been relatively uncommon following the insertion of grafts into gaps of other large major nerves. This occasionally led to the performance of end-to-end suture of nerves under great tension, in which cases the use of grafts might have proven wiser. This point was forcefully illustrated in a recent experience in which occasions arose for suturing the digital nerve of the index finger in two patients. In one, a male aged 65 years, loss of sensation over the radial border of the index finger followed a laceration at the base of the digit. Because of the presence of intense pain at the site of the scar, operation was undertaken. The nerve ends were found to be separated by a gap of 0.5 cm. and, after the terminal neuromas were resected, a graft 1 cm. long taken from the lateral femoral cutaneous nerve was introduced into the defect of the digital nerve and sutured with 10 drops of autologous unmodified plasma. Excellent coaptation of nerves was obtained. The operation was done 6 months after the original injury was sustained. Four weeks after the operation, sensation for pin prick had returned over the formerly analgesic area of the index finger. The day after this operation was performed, the occasion arose for treating a laceration of the index finger in a physician 31 years of age. The injury severed the branch of the median nerve at the base of the proximal phalanx on its radial side, exactly the same site as in the previous case. The patient, a pianist, was greatly concerned over the analgesia of the radial side of his finger. At operation 6 hours after the accident, direct end-to-end suture of the nerve was done by the combined tantalum wire-plasma clot technique using 6 drops of autologous unmodified plasma. The union appeared quite satisfactory except that it was under considerable strain. Examinations 4 weeks and again 7 weeks after operation revealed no return of sensation to the finger. The use

* This work was done under a contract recommended by the Committee on Medical Research between the Office of Scientific Research and Development and the Jewish Hospital of Brooklyn. The work was also aided by grants from the Committee on Medical Research of the American Medical Association and from the Dazian Foundation.
of a nerve graft rather than direct suture under tension would probably have been the operation of choice in this as in the former case.

A similar conclusion follows from our experience in dogs in which after the excision of 3-cm. segments of the sciatic nerve bilaterally, a 3-cm. fresh autologous sciatic nerve graft was used on one side and on the other side the nerve ends were sutured directly under considerable tension. Roentgenographic studies in two such cases following the intravascular injection of a mixture of red lead and glue showed good vascularization of the nerve on the side of the graft but practically none distal to the suture site on the other side (Fig. 1 A, B). Histological examination of the nerve specimens revealed considerably more fibrosis at the junction on the side of the simple end-to-end suture under tension. In another animal in which this procedure was carried out, there was regeneration of nerve fibers which had become myelinated down to the paw. However, fewer nerve fibers were present on the side sutured under tension. In two other dogs in which the same procedure was carried out, there occurred separation of the nerve ends on the side of the strained suture. Under such conditions it seems fair to conclude that nerve grafts would have a definite usefulness if the conditions governing their success could be determined, and this has been the purpose of our study.

**FIXED AND FRESH GRAFTS**

Some success has been reported with the use of formalinized homologous nerve grafts in humans although evaluation of these results is difficult because of insufficient data. We have found, however, that satisfactory restoration of function may follow the use of formalinized nerve grafts in dogs but, on the whole, animal experimentation has shown that the results obtained with such grafts and also with heterologous grafts are not as good as those which follow the insertion of fresh homologous nerve grafts. Autologous nerve grafts have been attended by better results, but in the case of the principal limb nerves the use of a single autologous nerve graft would be out of the question since there would be no justification in man for sacrificing one major functioning nerve for another. The only type of autologous nerve graft that could be used to bridge a gap in a large nerve is the cable graft prepared by placing segments of small nerves that can be sacrificed without serious deficit to the patient side by side until their combined cross-sectional diameter is equal to that of the nerve to be repaired. In our earlier experiments in dogs and monkeys the use of cable grafts prepared from intercostal nerves to repair defects in the sciatic nerve did not seem promising, since microscopically a large part of the central stump proved to be in contact with the considerable amount of connective tissue derived from the epineurium of the individual strands forming the graft. It seemed to us that such a condition would hinder the downgrowth of a significant proportion of nerve fibers from the proximal stump and our experiments at this point were focussed on the use of single grafts. The most favorable type of single graft that would be available for the repair of defects of the large nerves in