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POSTTRAUMATIC NEUROMA OF THE RADIAL NERVE TREATED WITH AN AUTOGENOUS EPINEURAL CONDUIT TECHNIQUE. A CASE REPORT

AQ1 **I.A. IGNATIADIS, M.D.,* C.K. YIANNAKOPOULOS, A.M. AVRAM, and N.E. GEROSTATHOPOULOS**

We present the outcome of the first clinical application of a new technique using an epineural flap to bridge a short nerve defect. A 28-year-old male had suffered a radial nerve laceration at the lower third of the arm, proximal to the brachioradialis branch, 3 weeks before surgery. During surgery, a neuroma-in-continuity was excised preserving the epineural sleeve. Two longitudinal epineural flaps were created, one from the proximal and one from the distal nerve stump and used to bridge a 1-cm-long nerve defect. Each epineurium flap was sutured to the intact epineurium of the other side and additionally to each other. An electromagnetic nerve stimulator was used to enhance the nerve regeneration process. Nerve regeneration was followed up for 17 months with excellent functional results. © 2008 Wiley-Liss, Inc. Microsurgery 00:000–000, 2008.

Primary nerve repair after trauma is desirable in all cases but occasionally it is not possible.[1,2] The reconstruction of a peripheral nerve defect after trauma or excision of a neuroma in adults and adolescents remains an insufficiently solved problem.[1,2] In such cases, nerve grafting or bridging of the defect is indicated. The ensuing defect can be bridged using a variety of autologous, heterologous, or synthetic materials.[3,4] The purpose of all bridging materials is to assist and guide axon regeneration, and most materials employed are usually tubular in shape although filamentous materials such as collagen have also been used.[5–7] Although autologous nerve grafting usually using the sural nerve graft is the most satisfactory technique, its use is limited by the quantity of the nerve graft material and the accompanying secondary morbidity from the harvesting technique and the eventual nerve loss.

The epineurium is a biologically active membrane surrounding the nerve and contributes significantly to its function. It has been used in animals[8–13] to bridge nerve defects.

We describe the first clinical application of an epineural flap technique, experimentally validated in rabbits,[8,9] in a patient with short radial nerve defect after excision of a neuroma-in-continuity.

CASE REPORT

A 28-year-old male patient suffered a radial nerve laceration at the middle third of his left arm, proximal to the brachioradialis branch of the radial nerve, by a knife 3 weeks before presentation. Because of complete loss of the radial nerve function, the patient was admitted for surgical exploration of the wound. During the operation, the initial wound was extended proximally and distally, and the radial nerve was carefully explored under magnification and dissected proximally and distally. A neuroma-in-continuity, 2.5 cm in length, was exposed and carefully dissected free from normal to abnormal tissue (see Fig. 1). The neuroma and scar tissue were resected F1 to healthy tissue to prevent new scar tissue formation in the proximal and distal nerve stumps. Care was taken to avoid extensive iatrogenic injury to the epineurium. The two nerve stumps were approximated and held with 10-0 nylon sutures leaving a 1-cm-long nerve defect.

The epineurium was then incised longitudinally in the proximal and distal stumps creating two 1.5-cm-long epineural flaps, one from the proximal and another one from the distal nerve stump (see Fig. 2). The epineurium was F2 plicated serving as an additional mechanical aid to bridge the nerve gap, reducing the nerve tension. The flaps were stitched to the epineurium of the other side and finally each to other with side-to-side stitches. The gap between the nerve stumps was filled with a blood clot from the patient's blood. A drawing of the surgical procedure is provided in Figure 3. F3

Postoperatively, immobilization with a posterior splint was used for 4 weeks. Wound healing proceeded uneventfully. A series of static and dynamic splinting was used accompanying regular physiotherapy sessions. Supplementary, an electromagnetic nerve stimulator (Compex, Chantonnay, France) was used to enhance nerve regeneration. The device was applied in 7-minute sessions every second day for 4 months.

The efficacy of the repair was assessed by the recovery of wrist, thumb, and finger mobility and by the progression of Tinel's sign. The Tinel's sign was progressing for the first 5 months and was followed by gradual recovery of

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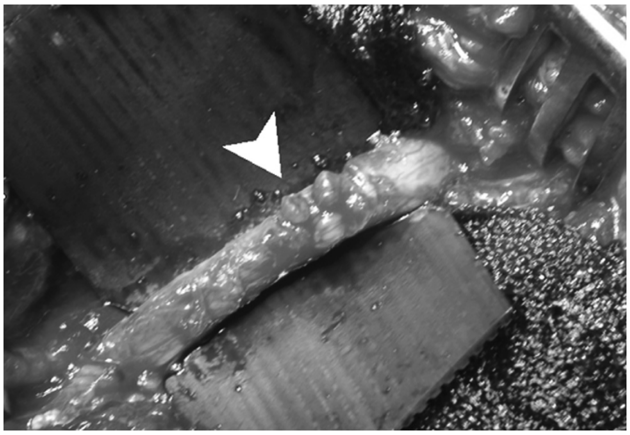

Figure 1. Intraoperative photograph of the neuroma-in-continuity of the radial nerve (arrowhead).

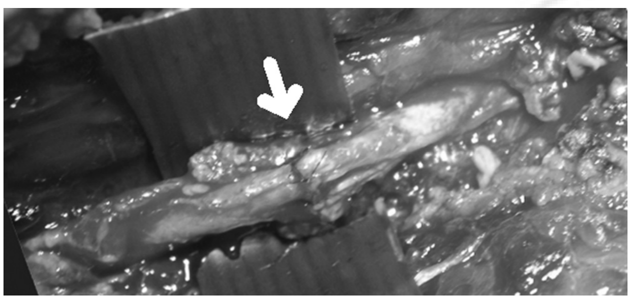

Figure 2. Intraoperative photograph of the sutured nerve stumps covered with the epineural flaps. The arrow shows the location of the nerve repair.

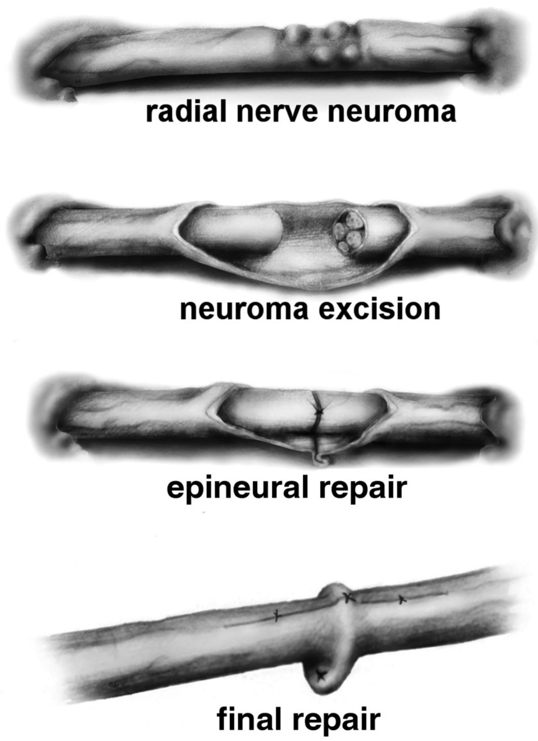

Figure 3. Drawing of the surgical procedure. The neuroma was dissected free and excised, preserving the epineurium. The nerve stumps were approximated and sutured without tension leaving a 1-cm-long defect. Two epineural flaps fashioned from the proximal and the distal stumps were plicated and sutured to each other to reduce repair tension and to isolate the nerve defect area.

the extensor muscle strength. Evaluation of the results was performed using the Medical Research Council Method, measuring both motor and sensory recovery. Motor recovery of the radial nerve was measured by the activity of the wrist, finger, and thenar extensor muscles, which demonstrated M4 (excellent) 17 months postoperatively (see Fig. 4). F4 Sensory recovery at the area of the superficial radial nerve at the second metacarpal area was S3.

DISCUSSION

Although autologous nerve grafting is currently the recommended technique for reconstructing nerve gaps, normal function is not always restored and results are not excellent.[1,2] After a peripheral nerve laceration, a large defect may arise between the proximal and distal nerve segments. In certain cases, harvesting or sacrifice of autologous nerves is not feasible or wanted, and in such cases, a nerve conduit has to be used.[3–5] Various types of nerve conduits have been tested for the purpose of restoring a nerve defect including iso-, allo-, or xenografts, absorbable or nonabsorbable materials, collagen, tendons, etc.

The idea of using the epineurium to bridge a nerve defect is not new. Several experimental studies in animals supported the idea of using the epineurium in nerve reconstructive surgery.[8–13]

The epineurium tube protects the regeneration site from undesirable external humoral influences providing a positive regeneration environment. The interposed epineurium is not just a passive conduit but it may assume a more active role in the nerve regeneration process by providing neurotrophic factors. Additionally, the axoplasmic fluid is retained at the repair site and this facilitates the regeneration process.

The use of epineurium has several advantages: a neural origin conduit is used; no separate surgical exposure for harvesting is necessary; there is no donor-recipient size mismatch; the biocompatibility is perfect; there is no antigenicity or inflammatory reaction; and the cost of harvesting is negligible. Disadvantages are that the intraoperative surgical management of the epineurium is technically difficult, the harvesting procedure is time-consuming and demanding, and the amount of the graft material is limited. A concern is that stripping of the epineurium might influence nerve electrophysiologic properties.

*Figure 4. One year after the operation, the patient was able to fully extend his wrist (**a**), the fingers (**b**), and the thumb (**c**).*

Denuding of the sciatic nerve from the epineurium in the rat did not induce significant alterations in the nerve function.[10]

We have evaluated the effectiveness of nerve regeneration through various epineural conduits for bridging short nerve defect in a rabbit model.[8,9] A 10-mm-long sciatic nerve defect was bridged either with three variations of an epineural flap or with a nerve autograft, which served as control group. Animals were examined 21, 42, and 91 days postoperatively to evaluate nerve regeneration using light microscopy and immunocytochemistry. Additionally, the gastrocnemius muscle contractility was examined 91 days postsurgery. Our studies showed the presence of nerve regeneration in all epineural flap groups similar to the control group, especially in the group where an advancement epineural flap was used.

In our animal studies,[8,9] unlike all other similar studies, the epineural tube was not left empty but it was filled with a blood clot to prevent lumen collapse. Failure to fill the tube may partly account for some of the unsuccessful results in previous experiments. Furthermore, filling the conduit chamber with growth factors or exogenous matrix precursors may promote regeneration although filling of a short epineural sleeve with fibrin glue did not make any functional difference.[13]

CONCLUSIONS

In special circumstances, the use of an epineural flap may be useful for bridging short nerve defects in humans. The procedure may be accompanied by the use of neurotrophic factors to promote nerve regeneration. The epineurium serves as a mechanical means to reduce the gap size, to increase the repair strength, and to effectively assist nerve regeneration.

Finally, we do not suggest the widespread use of the technique until is fully validated in clinical studies although the initial experimental and clinical data are encouraging.

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