Functional Outcome Following Nerve Repair in the Upper Extremity Using Processed Nerve Allograft

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Purpose Reconstruction of peripheral nerve discontinuities with processed nerve allograft has become increasingly relevant. The RANGER Study registry was initiated in 2007 to study the use of processed nerve allografts in contemporary clinical practice. We undertook this study to analyze outcomes for upper extremity nerve repairs contained in the registry database.

Methods We identified an upper extremity–specific population within the RANGER Study registry database consisting of 71 nerves repaired with processed nerve allograft. This group was composed of 56 subjects with a mean age of 40 ± 17 years (range, 18–86 y). We analyzed data to determine the safety and efficacy of processed nerve allograft. Quantitative data were available on 51 subjects with 35 sensory, 13 mixed, and 3 motor nerves. The mean gap length was 23 ± 12 mm (range, 5–50 mm). We performed an analysis to evaluate response-to-treatment and to examine sensory and motor recovery according to the international standards for motor and sensory nerve recovery.

Results There were no reported implant complications, tissue rejections, or adverse experiences related to the use of the processed nerve allografts. Overall recovery, S3 or M4 and above, was achieved in 86% of the procedures. Subgroup analysis demonstrated meaningful levels of recovery in sensory, mixed, and motor nerve repairs with graft lengths between 5 and 50 mm. The study also found meaningful levels of recovery in 89% of digital nerve repairs, 75% of median nerve repairs, and 67% of ulnar nerve repairs.

Conclusions Our data suggest that processed nerve allografts offer a safe and effective method of reconstructing peripheral nerve gaps from 5 to 50 mm in length. These outcomes compare favorably with those reported in the literature for nerve autograft, and exceed those reported for tube conduits. *(J Hand Surg 2012;37A:2340–2349. Copyright © 2012 by the American Society for Surgery of the Hand. All rights reserved.)*

Type of study/level of evidence Therapeutic III.

Key words Nerve graft, nerve injury, nerve regeneration, peripheral nerve, processed nerve allograft.

Peripheral nerve injuries are a common consequence of trauma to the upper extremity. If transected, the nerve requires surgical intervention for functional recovery to occur. If transection injuries are not surgically repaired, the patient can be subjected to lifelong disability, pain, and impaired quality of life.[1–3]

The surgical goal of nerve reconstruction is to achieve a tension-free repair. If direct approximation of

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the nerve ends result in increased tension at the repair site, as a result of the extent of trauma or nerve retraction, interpositioning of a nerve graft is recommended to restore continuity. Autologous nerve graft has long been the preferred material to reestablish nerve continuity. This technique results in the creation of a new nerve injury, increased operative time, and the generation of donor site morbidity, and is hampered by limited sources for donor nerves. These constraints have necessitated the development of alternative methods for restoring nerve continuity. Current alternatives in the surgeon's arsenal include hollow tube conduits or grafting with processed nerve allograft.

Hollow tube conduits and autologous vein provide a protective environment that serves as a physical barrier to isolate the nerve from the surrounding tissue and to contain the fluid that seeps from the cut nerve ends. This fluid creates a provisional fibrin matrix that serves as a substrate or rudimentary bridge for the cells and regenerating axons. This mechanism of action results in a relatively disorganized regeneration and has limited the application of conduits to short-gap, noncritical sensory nerve defects or as a coaptation aide for alignment of the nerve.[4,5]

Processed nerve allografts (Avance Nerve Graft; AxoGen, Inc., Alachua, FL) provide decellularized and predegenerated human nerve tissue for the restoration of nerve continuity. These grafts maintain the microarchitecture inherent to nerve tissue, including the physical structure of the epineurium, fascicles, endoneurial tubes, and microvasculature. They are rapidly revascularized and repopulated with host cells and provide a microenvironment conducive to axonal regeneration. Until recently, limited clinical data have been available to establish the role these grafts play in peripheral nerve reconstruction.[6–9]

We initiated the RANGER Study registry in 2007 as a means to collect data on utilization and outcomes from the use of processed nerve allografts for the reconstruction of peripheral nerve defects. This model was designed to provide a source of data and analysis of adult nerve injuries and repairs to establish additional understanding of applications and expected outcomes. The registry includes 12 studies centers. This comprehensive database includes a robust spectrum of nerve types, mechanisms of injury, and injury locations, including head and neck and upper and lower extremities.[10] We undertook this study to analyze the RANGER Study registry database for outcomes from nerve repairs performed in the upper extremity between 2007 and 2010. Here, we report on the experiences from processed nerve allografts repairs of 71 peripheral nerve injuries in the upper extremity.

MATERIALS AND METHODS

Study design

We performed this investigation and the RANGER Study registry in accordance with our institutional review boards and Good Clinical Practices.[11] All consenting adult subjects implanted with the processed allograft were eligible for the study. We used standardized data capture forms to normalize information from the charts of subjects. Chart reviews were completed in a retrospective fashion to collect subject, injury, and repair demographics as well as outcome measures from surgeon, nursing, and therapy records. We collected data for functional outcomes in an observational manner, because each center followed its own standard practices with regard to postoperative care. In addition, we collected information on adverse experience or complications related to the nerve graft (ie, extrusion, infection, tissue rejection, communicable diseases) occurring intraoperatively or postoperatively. All data were entered into a centralized database and assessed by an independent statistician.

We queried the RANGER Study registry database for all nerve repairs in the upper extremity in subjects reporting sufficient outcomes data to assess a response to the treatment. To qualify for this outcomes population, subjects had to have reported follow-up assessments at a time commensurate with the approximated distance for reinnervation, based on estimated 2-mm/day regeneration.

We analyzed this de-identified dataset as a whole and stratified based on predefined criteria for specific nerves and factors that affect recovery outcomes. We used descriptive statistics to describe the demographics, baseline characteristics, and trends of postimplantation. Continuous parameters (eg, functional scores), total number, mean, median, and standard deviations (SDs) of the mean were recorded. We also recorded categorical parameters (eg, complication rates, adverse events), frequencies, and percentages. We performed chi-square analysis to determine whether there were statistical differences between this group and the study population as a whole.

Study population

We identified a population of 56 subjects in the database presenting with 71 nerves repaired with processed nerve allograft in the upper extremities. This group was composed of 39 men (70%) and 17 women with a mean ± SD age of 40 ± 17 years (range, 18–86 y) and