CURRENT CONCEPTS

Barriers to Epineural Scarring: Role in Treatment of Traumatic Nerve Injury and Chronic Compressive Neuropathy

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The physiological limitations of neural regeneration make peripheral nerve surgery challenging to both the surgeon and the patient. Presence of nerve gaps and local wound factors may all influence outcome, suggesting that barriers to reduce perineural scarring, minimize fibrosis, and avoid ischemia would be beneficial. To examine the evidence supporting their use, we reviewed the autologous and commercially-available options for barriers against scarring around a nerve. Numerous clinical case series demonstrated the effectiveness and safety of local/rotational flaps and autologous vein wrapping when used in the presence of recurrent compressive neuropathy. Translational research in animal models supports the biocompatibility of commercially available nerve wraps following nerve repair. To date, there are no reports of clinical use of commercially available nerve wraps in acute nerve repair, but a growing number of case series demonstrate their effectiveness and safety in chronic compressive neuropathy. Limited clinical evidence exists to support the efficacy of vein or flap coverage in acute nerve repairs. *(J Hand Surg Am. 2018;■(■):■−■. Copyright © 2018 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Nerve wrap, nerve repair, cicatrix, recurrent carpal tunnel, recurrent cubital tunnel.

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RATIONALE FOR USE OF BARRIERS TO EPINEURAL SCARRING

When performing nerve repair, a favorable soft tissue envelope would intuitively seem to minimize the chances of ischemia and scar formation that can impede neural regeneration. In the case of revision surgery for chronic compressive neuropathy, surgery in an already scarred tissue bed can create additional adhesions that lead to eventual symptom recurrence and traction-related pain. Ideally, a barrier could be used to promote nerve gliding and reduce scarring around the nerve, without proliferation of extraneural fibrosis and scarring. Scientists and surgeons have provided innovative solutions, ranging from synthetic and xenograft materials to autologous vein wrapping and pedicled/free tissue coverage. There is no clear guidance on which barriers provide the best results in either the acute or the chronic situation or the indications for their use.

We conducted a review of the published literature regarding perineural scarring and barriers. A search was conducted in Ovid Medline (1946−present), Embase (1946−present), Clinical Trials database, Cochrane Databases, Scopus (1823−present), Science Citation Index (1900−present). A total of 8,841 unique citations were filtered to 47 articles based on article titles and abstracts, with 20 articles

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included here to support our discussion and promote ongoing dialog on this topic.

THE IDEAL BARRIER

The ideal barrier to perineural scarring should have the following characteristics: (1) minimal or no chance of rejection or inflammatory reaction; (2) sufficient porosity to facilitate diffusion of nutrients without allowing axonal escape; (3) avoidance of scar-induced ischemia; (4) promotion of nerve gliding; (5) minimal or no donor site morbidity; and (6) minimal cost or supply restraints (Table 1).[1]

TYPES OF BARRIERS AVAILABLE

Adipofascial or muscle flap (pedicle or free tissue)

The concept of using local tissues to provide a barrier around a nerve has been promoted extensively in the treatment of recurrent carpal tunnel syndrome (CTS) and cubital tunnel syndrome (CuTS). Whereas incomplete release of the transverse carpal ligament during carpal tunnel release (CTR) or newly created points of compression of the transposed ulnar nerve are common reasons for revision surgery, another frequent finding during revision surgeries for both CTS and CuTS is adherence of the nerve to the surrounding tissues. Soltani et al[2] performed a systematic review for surgical treatment of recurrent CTS. Of the 14 articles describing rotational or free flap coverage options, 7 discussed hypothenar fat pad or ulnar artery-based perforator flaps.[2] Additional options include other rotational flaps (synovium, pronator quadratus, palmaris brevis, abductor digiti minimi, and radial artery perforator) and free flaps (omentum and anterolateral thigh flaps). Of all options for flap coverage in revision carpal tunnel release, we prefer the hypothenar fat pad flap because of minimal morbidity and reliable blood supply (Fig. 1). In the meta-analysis of 14 studies (n = 294) using flap coverage during revision CTR, there was an 86% success rate. This was substantially higher than the 74% success rate seen in patients treated with decompression alone (7 studies; n = 364). More recently, Pace et al[3] performed an unmatched, retrospective cohort study of patients who underwent flap interposition or decompression only during revision CTR. The authors did not detect a difference in outcomes, but they did not report a power analysis.[3] With regard to recurrent CuTS, there is little evidence-based guidance in the literature about the type of procedure to use during revision cases. We have found that perineural fibrosis may form after any of the procedures used for primary treatment.

TABLE 1. Comparison of Nerve Barrier Options Based on Ideal Characteristics for a Barrier to Epineural Scarring

Ideal Characteristics	Adipofascial or Muscle Flap	Vein Wrapping	HA-CMC Membrane (Seprafilm)	Bovine Collagen (Neurawrap, Neuramend)	Porcine Small Intestine Submucosa (Axoguard)
Biocompatible	Yes	Yes	No reports of rejection	No reports of rejection	No reports of rejection
	Nonabsorbable	Nonabsorbable	Absorbs by 7 d	Absorbs by 4–8 mo	Absorbs by 3 mo
Semipermeable	Yes	Yes	Yes	Yes	Yes
Nonconstricting	No reported cases of cicatrix formation after use	No reported cases of cicatrix formation after use	No reported cases of cicatrix formation after use	No reported cases of cicatrix formation after use	No reported cases of cicatrix formation after use
Promote nerve gliding	Yes	Yes—demonstrated in animal model	Unknown	Unknown	Unknown
Minimal/no donor site morbidity	Depends on flap harvested (minimal for local fat pad flap)	Yes (typically edema)	No donor site morbidity	No donor site morbidity	No donor site morbidity
Minimal cost or supply restraints	Increased surgery time	Increased surgery time	Subject to implant cost and availability	Subject to implant cost and availability	Subject to implant cost and availability