

Remplir™ Sales Training - USA

Module 2



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*This training includes general information on nerve repair that may not apply to Remplir.
Please refer to Remplir's IFU.*

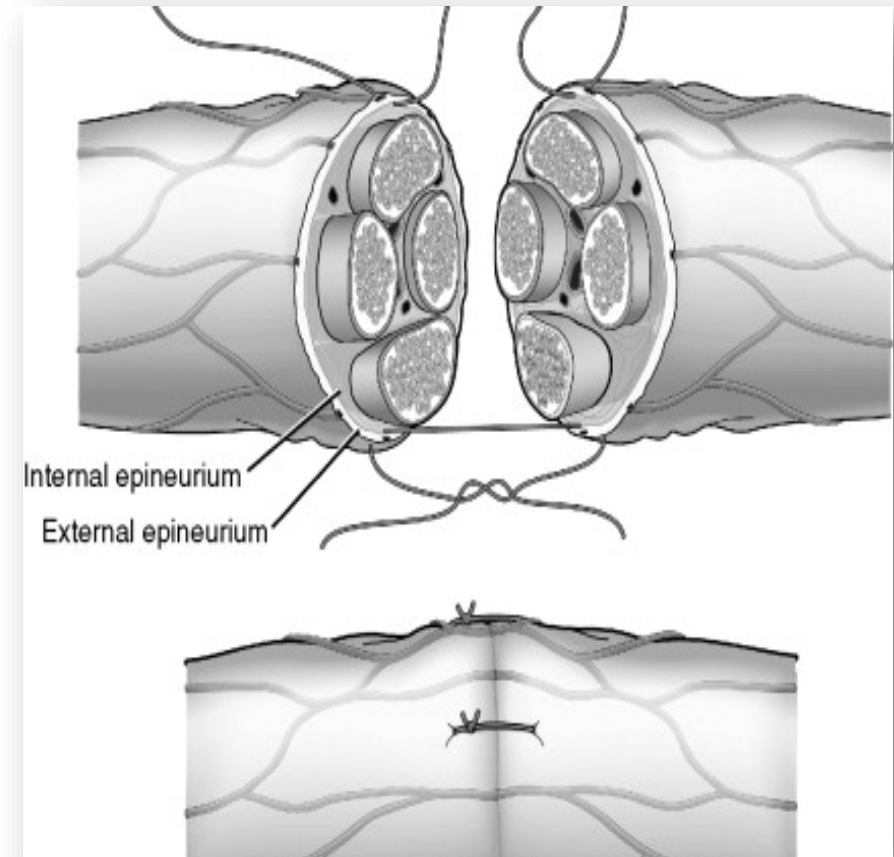
Learning Objectives

- Learn the key surgical techniques for nerve repair: direct nerve **neurorrhaphy** (end-to-end reconnection), use of grafts or conduits to bridge gaps, nerve **protection** (wraps) and **capping** techniques.
- Understand critical factors for successful nerve healing, such as achieving an atraumatic repair, proper alignment of nerve ends, and minimizing scar tissue.
- Recognize common challenges and clinical considerations in nerve repair (e.g. managing gaps between nerve ends, common compressive neuropathies, preventing neuroma formation, etc).

Direct Nerve Repair (neurorrhaphy)

Goal: Surgeons resect damaged nerve ends; align and suture nerve ends carefully to avoid tension

- Emphasis on gentle handling and good alignment to optimize functional outcome.
- Gold standard for surgical repair
- Neurorrhaphy has been used for over 50 years with no substantial changes or improvements

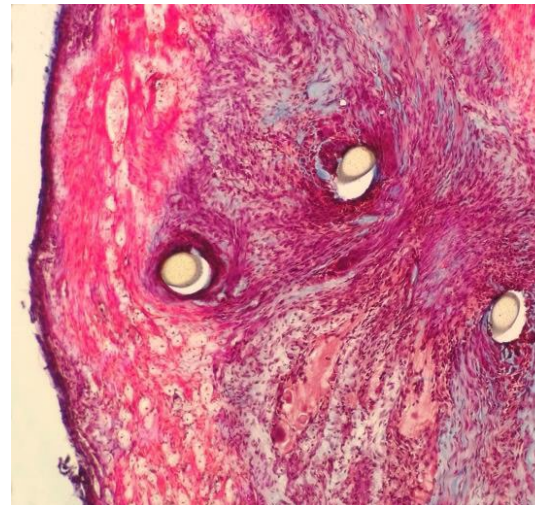
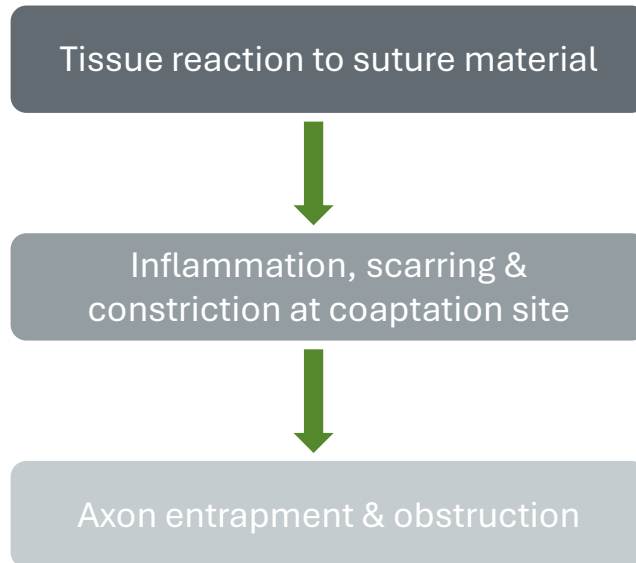


Problem with Neurorrhaphy

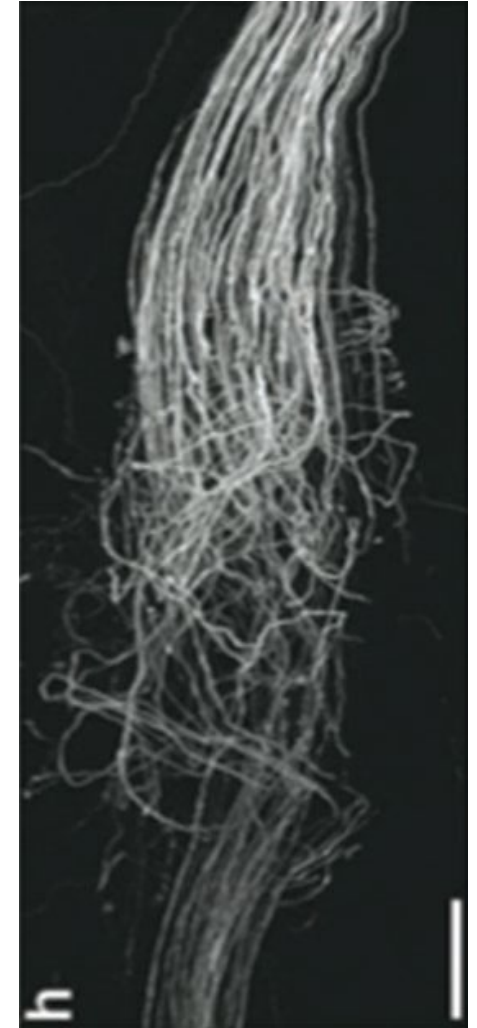
Studies show

- 60% of repairs by experienced surgeon are "excellent"^{1,2}
- **Approx. 50% of axons fail to regenerate** at the repair site³

Add references

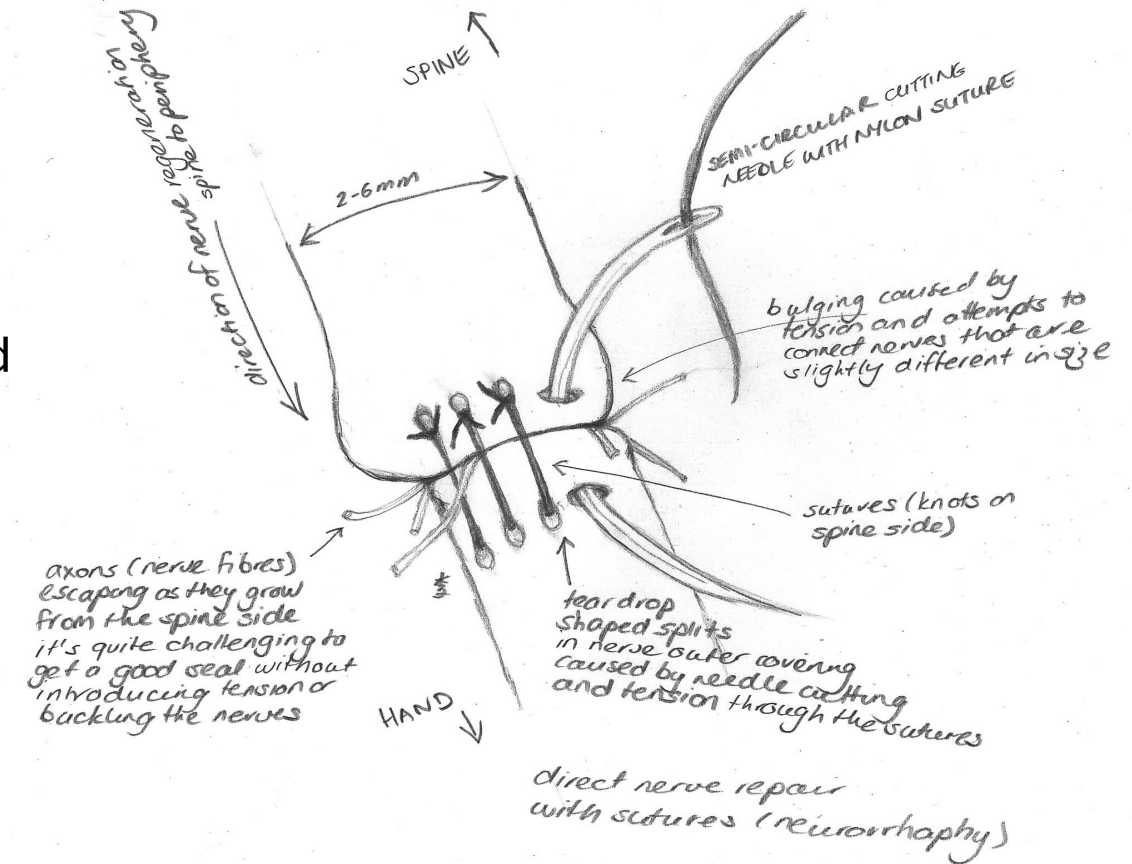


8 weeks post-op - Courtesy of Z Pletikosa



Potential issues arising from neurorrhaphy

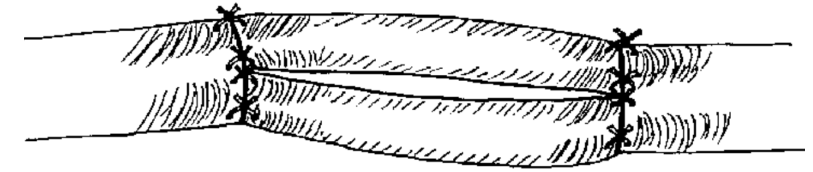
1. Bulging caused by tension & mis-matched size of nerve ends
2. Axon escape due to poor fit between nerve ends
3. Splits in epineurium caused by suture damage and tension on sutures



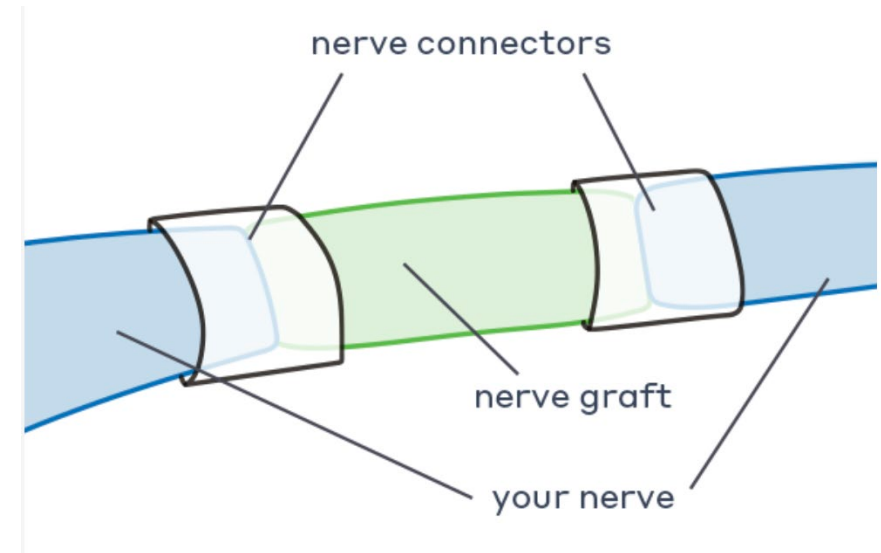
Bridging Nerve Gaps

- When a nerve segment is missing, surgeons may use an **autograft** (patient's own nerve) or a **processed nerve allograft** (donor nerve) or a **collagen conduit**.
- Graft can be used in **single** or **cabled** configuration.
- Studies show modern processed allografts can yield comparable recovery to autografts for certain gap lengths—without needing a second surgical site.
- Conduits can be used to bridge small gaps (<20mm) or to assist with graft coaptation.

Autograft/Cabled Nerve Grafting

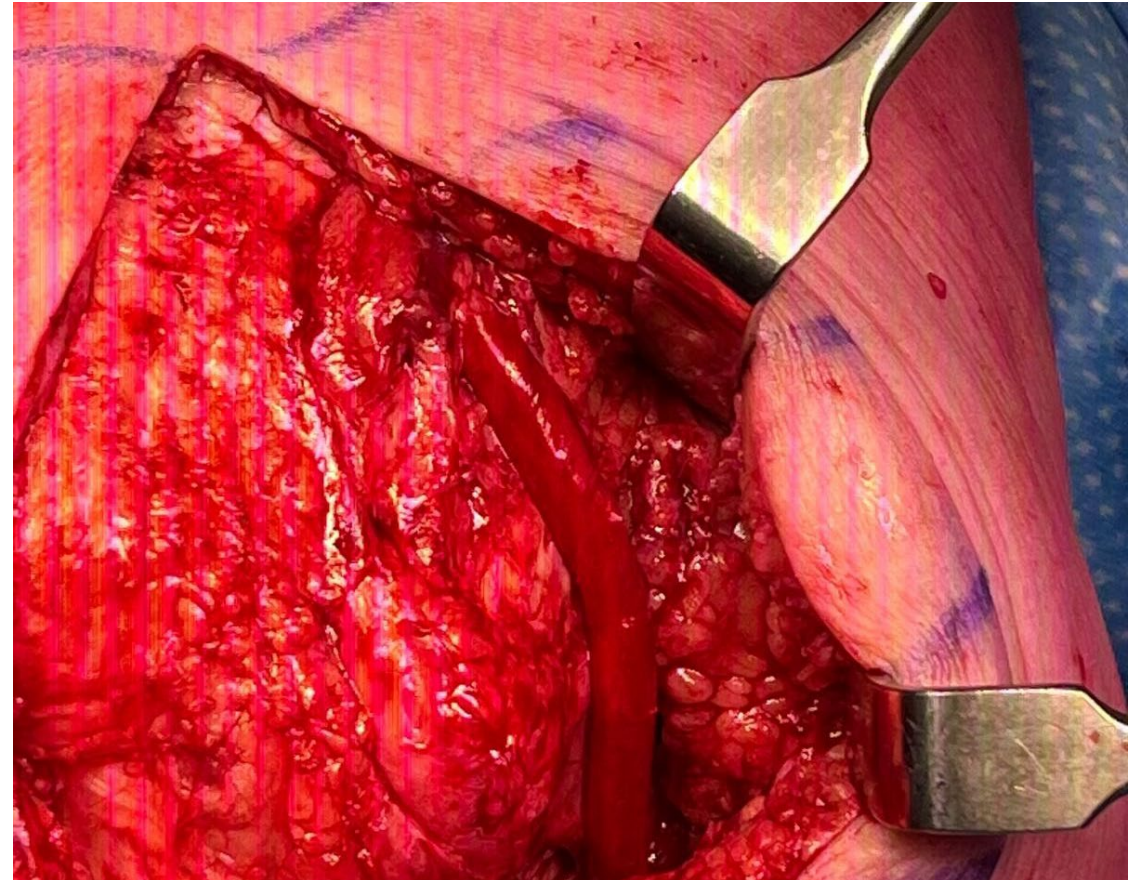


Processed Nerve Allograft



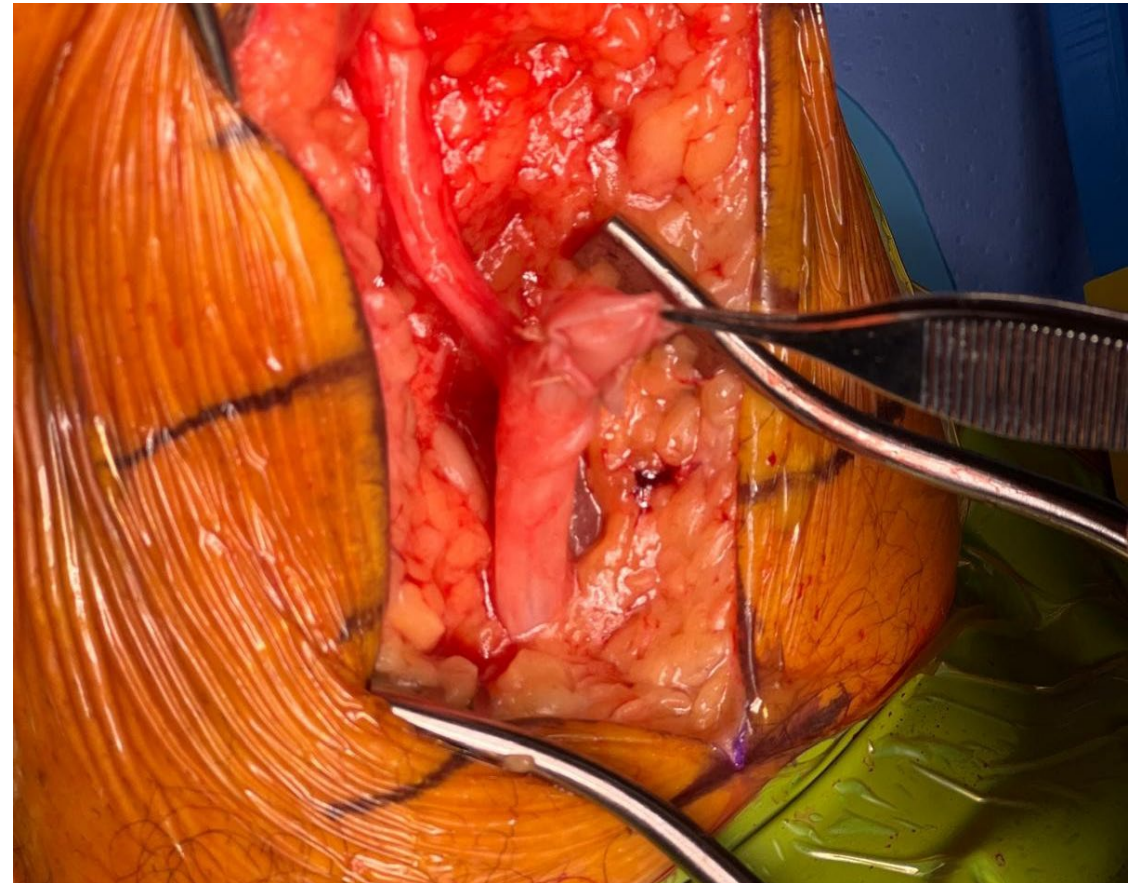
Nerve protection with wraps

- A protective wrap can reduce the risk of scarring, create a microenvironment for axon regrowth, and facilitate nerve gliding
- This is particularly important for traumatic wound beds or compressive neuropathies



Neuroma protection – nerve capping

- A **neuroma** is a disorganized growth of axons at the site of a nerve injury
- **Nerve capping** is a preventative treatment used to reduce the risk of neuroma formation at a free nerve end
- Recent innovations include **nerve wraps or caps**, which help isolate regenerating axons and prevent them from interacting with surrounding soft tissue and protect the severed nerve stump from mechanical stress, reducing the risk of neuroma formation.



Factors to consider

The 5T's for creating the ideal microenvironment for nerve regeneration

Timing of repair

- Early intervention maximizes regeneration potential; delays can lead to permanent loss of function.

Topography

- Proper fascicular alignment (nerve topography) is critical for restoring function; microsurgical techniques help achieve accuracy.

aTraumatic repair

- A non-hostile environment at the repair site (minimize sutures and tension) that prevents inflammatory responses and reduces scarring, which can block blood flow and impair nerve regeneration

Trimming of nerve ends

- Trimming is essential to remove damaged or necrotic tissue, promote precise coaptation, reduce fibrosis, and minimize inflammation, supporting optimal nerve healing and functional recovery.

Type of repair material

- Biocompatible and resorbable materials (like collagen wraps) that support the smooth movement of regenerating nerves without long-term complications.

Post-operative care

- Controlled immobilization and monitored recovery ensure a stable environment for nerve healing and reduce complications.

Classification of nerve injury

Defining an ideal **wrap** (Type of material) for nerve regeneration:

- **Minimal or No Inflammatory Reaction**
 - A non-hostile environment that prevents inflammatory responses which can inhibit nerve healing and regeneration.
- **Sufficient Porosity**
 - Ensures the diffusion of nutrients while preventing axonal escape.
 - Supports nutrient flow to promote cell survival and tissue repair.
- **Avoidance of Scar-Induced Ischemia**
 - Prevents the formation of scar tissue, which can block blood flow and lead to ischemia (lack of oxygen) that impairs nerve regeneration.
- **Promotion of Nerve Gliding**
 - Supports the smooth movement of regenerating nerves, reducing friction and compression that could disrupt healing.
- **Minimal or No Donor Site Morbidity**
 - Limits the damage or complications at the donor site when biological materials are harvested for repair.
- **Minimal Cost or Supply Restraints**
 - Ensures that the materials and techniques used are affordable and accessible, without being limited by cost or supply issues

Dy, C. J., B. Aunins and D. M. Brogan (2018). "Barriers to Epineural Scarring: Role in Treatment of Traumatic Nerve Injury and Chronic Compressive Neuropathy." J Hand Surg Am 43(4): 360-367.

Principles of nerve repair

Papers to Read

1. Barriers to Epineural Scarring: Role in Treatment of Traumatic Nerve Injury and Chronic Compressive Neuropathy
 - <https://www.sciencedirect.com/science/article/abs/pii/S0363502317321123>
 - **PLEASE NOTE:** this paper states there is not enough evidence to support use of commercially available devices, such as nerve wraps. This is a gap in the market that is addressed by Remplir.
2. Nerve conduits for treating peripheral nerve injuries: A systematic literature review
 - <https://pubmed.ncbi.nlm.nih.gov/28325431>



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