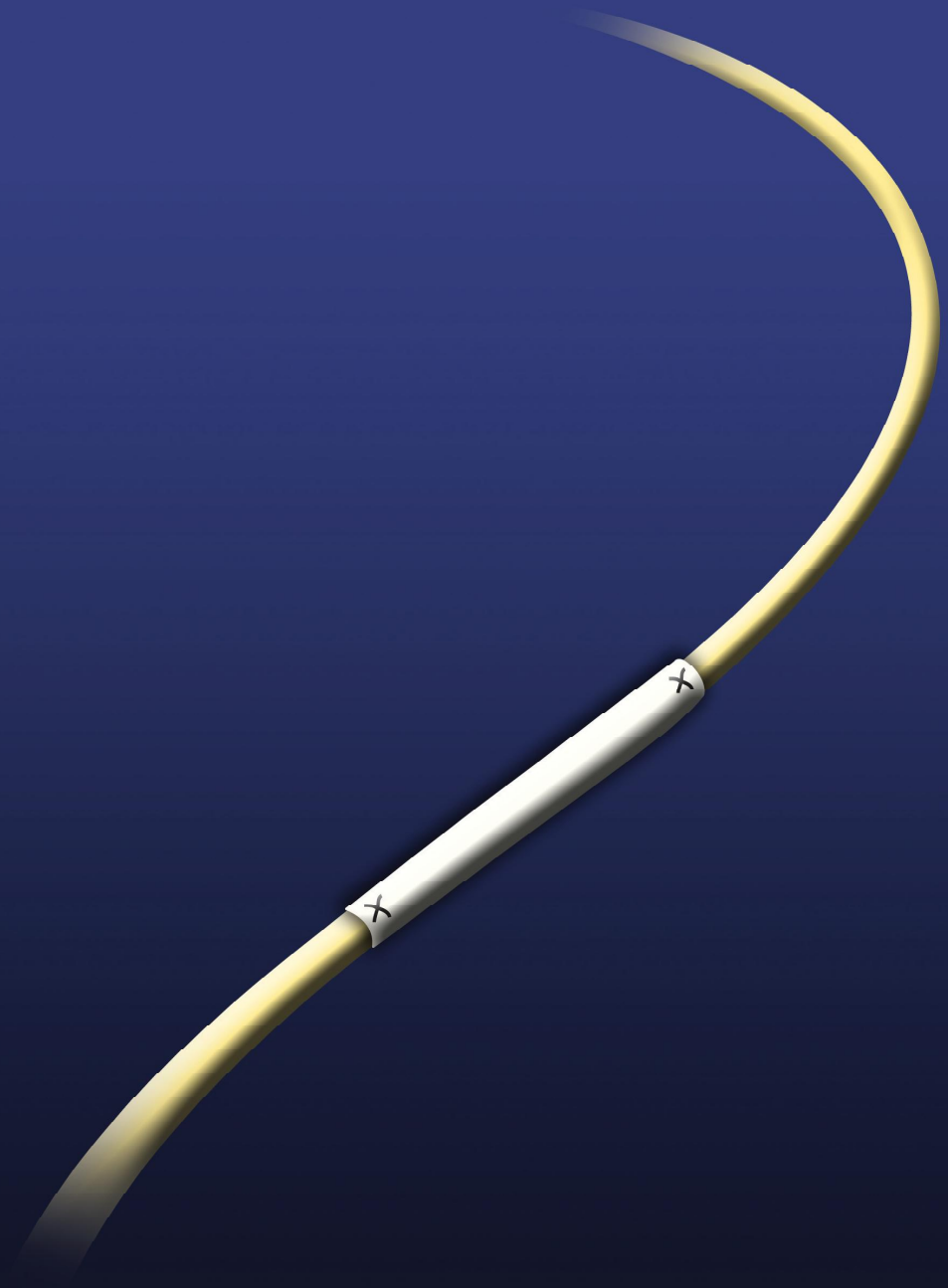
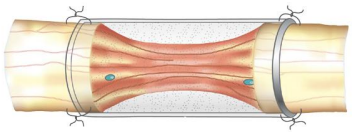
Understanding Nerve Conduits



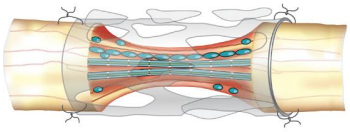
HOW NERVE CONDUITS WORK.

Peripheral nerves have the ability to effectively regenerate if given the proper environment. Autografts and allografts provide a multitubular internal structure and scaffolding that supports and physically guides axonal regeneration.[1] However, nerve conduits are hollow and provide only gross guidance.[1,2,3,4] Regeneration through a conduit relies on the formation of a fibrin cable. This rudimentary structure, not the conduit itself, is what provides the physical support that makes regeneration possible. The process is shown below:

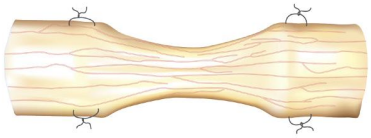
HOURS
Fluid seeps from the nerve ends into the void of the conduit.



DAYS
An hourglass-shaped fibrin cable forms. The regeneration potential is dependent upon the presence, integrity, and cross-sectional area of this fibrin cable.



MONTHS
Cell migration and axonal regeneration occurs within the cable and is restricted by the thinnest portion.



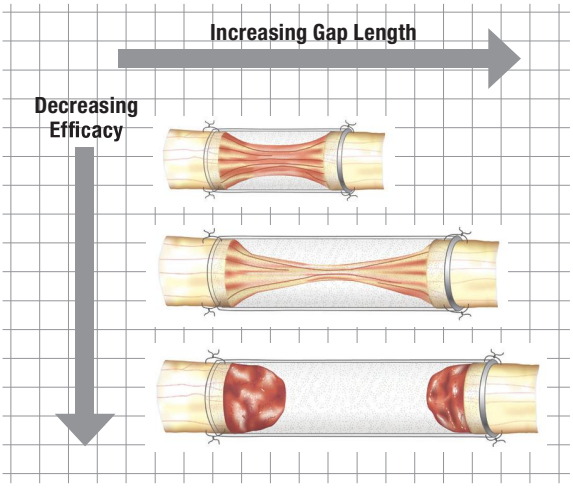
YEARS
Often the resulting tissue is visibly thinner, containing a limited number of regenerated axons.

CLINICAL EXAMPLE
A thinning nerve cable seen in a 10mm gap previously repaired with a conduit.

Image courtesy of Jonathan Isaacs, MD
Virginia Commonwealth University Health System

THE LENGTH LIMITATION OF CONDUITS.

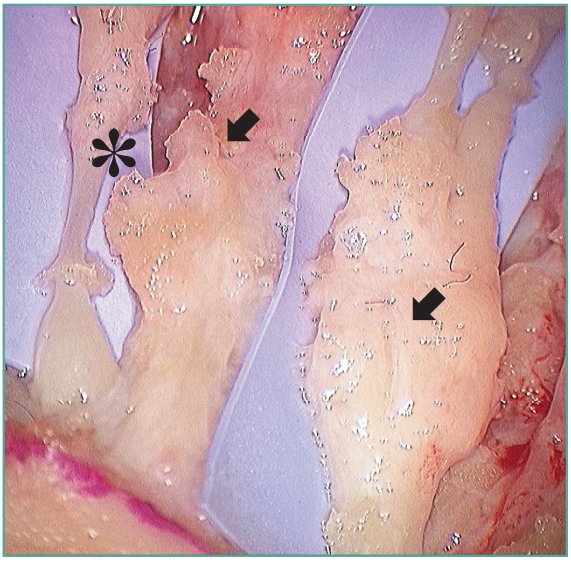
Regeneration within a conduit occurs predominantly through the fibrin cable. The integrity of the fibrin cable is a function of the conduit dimensions.[5,6] The illustrations below demonstrate what happens as the length of the gap increases.



At short gap lengths, the fibrin cable is robust enough to allow regeneration.

As the gap length increases, the integrity of the fibrin cable diminishes and thinning restricts the regenerative space.

If the cable does not form, axons are not able to cross the gap. This results in no regeneration or possibly a neuroma.



CLINICAL EXAMPLE

Referred patient where multiple conduits failed in 18mm gaps.

✻ Denotes thinned atrophic nerve tissue.
⬋ Denotes loss of integrity and neuroma formation.

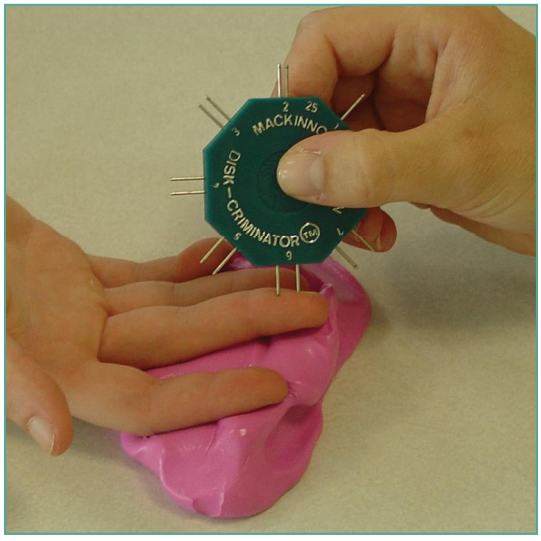
Image courtesy of Bauback Safa, MD
The Buncke Clinic

CLINICAL OUTCOMES WITH CONDUITS.

Landmark clinical studies have examined the efficacy of commercially available conduits. As summarized below, results in gaps ranging from 0-5mm demonstrate that conduits can be a successful nerve repair option. Results using conduits in gaps greater than 5mm are highly variable and less reliable.

Type of Nerve	Gap Length	% Failure*	Other Findings	Clinical Publication
Digital Nerves (Sensory)	0-4 mm	0%	34% failure rate in gaps 5mm or greater	Weber et al., 2000[7]
	5-7 mm	39%		
	8-25 mm	29%		
Digital Nerves (Sensory)	6-18 mm	25%	100% of gaps > 16mm failed	Lohmeyer et al., 2009[8]
Digital Nerves (Sensory)	5-30 mm	14%	27% reported poor resolution of pain	Mackinnon and Dellon, 1990[9]
Sensory, Mixed and Motor Nerves**	2.5-20 mm	57%	31% required revision***	Wangensteen and Kalliainen, 2009[10]

*No or poor sensory recovery as defined by the MRCC scale
**Mostly sensory nerves in the upper extremity, but also includes mixed and motor nerves elsewhere in the body
***When quantitative measurements were made



CLINICAL EXAMPLE
Sensory nerve assessment of 2 point discrimination.

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SUMMARY

A clear understanding of nerve regeneration through conduits and the inherent limitations is essential in considering treatment options. Conduits offer advantages, including off-the-shelf availability, alleviation of tension[11], and reduced potential for fascicular mismatch.[12,13,14] They can be effective at short gaps (typically 5mm or less).[7] However, there is a higher risk of conduit failure as gap length increases due to reliance upon the fibrin cable.[7,8,9,10,15]

Clinical studies have shown that **gaps greater than 5mm** have:

- High failure rates
- Limited pain resolution
- High revision rates

The strengths and limitations of conduits should be considered when evaluating treatment options for peripheral nerve injuries.

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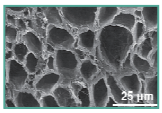

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