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Literature review

Nerve conduits for treating peripheral nerve injuries: A systematic literature review

Traitement des lésions nerveuses périphériques par chambre de régénération: revue systématique de la littérature

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Abstract

Peripheral nerve injuries are a major public health problem. Nerve conduits have been developed in the recent years, although it is still not clear if they should replace nerve grafting and neurorrhaphy. This systematic review aims to gather evidence regarding the use of nerve conduits for peripheral nerve repair.

The following electronic databases were searched: MEDLINE, Cochrane Library (CENTRAL) and Embase. Study selection and data extraction followed the PRISMA guidelines.

The systematic review of the literature retrieved 6767 articles. Only 27 studies were retained accounting for 1022 patients: 10 randomized controlled trials, 15 case series and 2 cohort studies. Ten different types of tubes were described and a variety of evaluation methods were used to assess outcomes in terms of efficacy (motor and sensory recovery) and complications. The Semmes–Weinstein monofilament test and the static and moving 2-point discrimination test were the most commonly applied tests to evaluate nerve recovery. In general, outcomes showed no significant difference between groups. Synthetic conduits had more complications.

Despite major methodological limitations in the studies, we can conclude that use of nerve conduits is preferable over suture repair and nerve grafting, as the functional recovery rates are above 80%. The choice of conduit is based on the surgeon's expertise, but use of synthetic conduits is discouraged due to their higher complication rates.

Keywords: Nerve repair; Nerve tubulization; Nerve conduit; Peripheral nerve injuries

Résumé

Les lésions nerveuses périphériques sont un réel problème de santé publique. Des chambres de régénération ont été développées ces dernières années, mais nous ne savons pas encore clairement si elles pourront remplacer la greffe ou la suture nerveuse.

Cette révision systématique avait pour objectif de mettre à jour les preuves en faveur de l'utilisation de ces chambres de régénération dans la réparation du nerf périphérique.

Nous avons utilisé les bases de données suivantes: MEDLINE, Librairie Cochrane (CENTRAL) et Embase. Les études ont été sélectionnées et les données extraites selon les paramètres de PRISMA.

Nous avons effectué notre révision systématique à travers 6767 articles. Nous n'avons retenu que 27 études avec 1022 patients: 10 études randomisées et contrôlées, 15 séries de cas et 2 études de cohortes. Dix types de substituts différents de régénération ont été utilisés, ainsi qu'une grande variété de méthodes d'évaluation en termes d'efficacité (récupération motrice et sensitive) et nous avons colligé les complications survenues avec cette méthode de réparation. Le test monofilamentaire de Semmes-Weinstein et le test de discrimination des 2 points (statique et

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dynamique) ont été utilisés pour évaluer la récupération nerveuse. Il n'a pas été observé de différence significative entre les groupes. Les tubes synthétiques ont engendré davantage de complications.

Malgré les limites méthodologiques de cette étude, nous avons pu conclure que l'utilisation de chambres de régénération est un procédé et une option sûrs pour traiter les lésions des nerfs périphériques avec plus de 80% de bons résultats fonctionnels. Le choix de la chambre de régénération va dépendre de l'expérience du chirurgien, mais d'ores et déjà, l'usage des tubes synthétiques est fortement déconseillé devant les forts taux de complications.

Mots-clés : Réparation nerveuse ; Tubulisation nerveuse ; Conduit nerveux ; Lésions des nerfs périphériques

1. Introduction

Peripheral nerve injuries are a major public health problem with a yearly estimated incidence of 13–23 cases per 100,000 persons [1,2]. The most common causes of nerve lesions are trauma and iatrogenic procedures. These conditions usually result in painful neuropathies or decreased motor function and sensory perception, which drastically affect patient's quality of life and ability to work. Surgical repair is required in most cases to restore nerve function [1–3].

The first-line treatment for nerve transection is neurorrhaphy (82% of cases); cases in which there is a defect are most commonly treated with nerve autografts or nerve conduits (18% of cases) [4–6]. With neurorrhaphy, the nerve stumps must be properly realigned and assembled to achieve satisfactory regeneration. Surgeons must carefully minimize the tissue damage and the number of sutures because even minor technical errors and poor fiber arrangement can result in non-effective repairs or complications such as neuromas [2].

When there is a defect, nerve autografts and nerve conduits are the preferred first-line options [6]. Nerve autografts are still considered the gold standard for treating this kind of injury [4,5,7,8]. However, autografting has important limitations: (1) the need for an additional incision to harvest the donor sensory nerve, resulting in donor site sequelae; (2) limited availability of donor tissue; (3) neuroma formation at the donor site; (4) numbness and motor recovery of function far below expectations at the host site [5,7–10].

Despite advancements in traditional surgical methods, complete recovery of neural function to its original state is rarely achieved [11]. Considering this limitation, new methods have been developed in recent years to optimize outcomes in nerve injuries with loss of substance. Among these new methods, the process of tubulization stands out as an important achievement in this area [10,12]. The tubular structures act as a connection between nerve stumps to guide axonal growth from the proximal stump to the distal stump while protecting the injured nerve so it can heal without interference from surrounding tissues [7].

Nerve conduits can be synthetic or made of natural materials using absorbable (biodegradable) or non-absorbable (non-biodegradable) compounds [4,7,13].

Synthetic non-biodegradable materials can cause chronic inflammation, which can prevent the passage of nutrients and cause the tube to collapse, thereby compressing the nerve [6,9]. The use of tubules made of blood vessels, muscles or other biological tissue can lead to fibrosis, cell infiltration and loss of mechanical precision [13].

An ideal nerve conduit should be biocompatible, biodegradable, flexible, highly porous, compliant, neuroinductive and neuroconductive (with appropriate surface and mechanical properties) [2]. Recent advances in use of nerve tubulization seek to mimic the peripheral nerve structures in order to increase compatibility and reduce toxicity [14]. Absorbable synthetic materials might be the best choices, as they are biocompatible and reduce the chance of an immune response. Another beneficial characteristic of these materials is that the degradation rate and mechanical properties can be controlled, creating an opportunity to individualize the patient's treatment [2,13].

Despite of the exciting potential of nerve conduits, it is still unclear whether they should replace nerve grafting and neurorrhaphy [6]. This review aims to gather evidence regarding the use of nerve conduits for peripheral nerve repair including all original reports that describe clinically meaningful outcomes related to this technique alone or in comparison with the other treatment options for traumatic and iatrogenic nerve injuries.

2. Methods

This systematic review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria [15].

2.1. Eligibility criteria

This review included studies with microsurgical procedures to repair peripheral nerves using tubules derived from tissues (venous, arterial or muscular) or synthetic conduits made of absorbable or non-absorbable compounds. Studies that used animal models or an accompanying reparative substance in the nerve tubules were excluded. Case reports or case series with less than 10 patients or articles describing only neurorrhaphy or nerve grafting were excluded.

2.2. Search strategy

We searched the following electronic databases on April 29, 2016: MEDLINE (accessed by PubMed), Cochrane Library (CENTRAL) and Embase.

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