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Original article

Transfer of the rhomboid nerve to the suprascapular nerve: An anatomical feasibility study

Transfert du nerf du rhomboïde sur le nerf suprascapulaire : étude anatomique de faisabilité

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Abstract

Paralysis of the suprascapular nerve, in partial injuries of the brachial plexus, most often warrants a nerve transfer. Transfer of the spinal accessory nerve to the suprascapular nerve is performed most often. We propose to directly transfer the nerve of the rhomboid muscles (branch of the dorsal scapular nerve) to the suprascapular nerve in the supraspinatus fossa. This anatomical study included 10 shoulders. Dissection of the suprascapular nerve and the branch of dorsal scapular nerve to rhomboid muscles (rhomboid nerve) was performed through a posterior approach. Once the nerves were freed, the possibility of suturing the two nerves together was evaluated. Tensionless suture of the rhomboid nerve to the suprascapular nerve was possible in all shoulders in this study. In addition, the diameter of the two nerves was macroscopically compatible: the average diameter of the rhomboid and suprascapular nerve was 2.9 and 3 mm, respectively. The diameter of the rhomboid nerve is more suitable than that of the spinal accessory nerve for a transfer to the suprascapular nerve. Moreover, the spinal accessory nerve is preserved in this technique, thereby preserving the function of the trapezius muscle, which could be used for muscle transfer if the nerve surgery fails. In addition, use of the rhomboid nerve allows the suture to be performed downstream to the suprascapular notch and avoids poor results linked to multilevel injuries of this nerve. Finally, if the posterior approach is extended laterally, associated transfer of the nerve to the long head of the triceps brachii to the axillary nerve is also possible. Rhomboid nerve transfer to the suprascapular nerve is anatomically possible. A clinical study will now be necessary to confirm this hypothesis and set out preliminary results.

Keywords: Rhomboid nerve; Dorsal scapular nerve; Suprascapular nerve; Spinal accessory nerve; Nerve transfer; Brachial plexus

Résumé

Les paralysies du nerf suprascapulaire, dans les atteintes partielles du plexus brachial, justifient le plus souvent un transfert nerveux. Le transfert du nerf spinal accessoire sur le nerf suprascapulaire est le transfert le plus réalisé. Nous proposons, dans le cadre d'une étude anatomique, un transfert direct du nerf destiné aux muscles rhomboïdes, branche du nerf dorsal de la scapula, sur le nerf suprascapulaire dans la fosse supra-épineuse. Cette étude a été menée sur 10 épaules. Une dissection du nerf suprascapulaire et du nerf des rhomboïdes par voie postérieure a été réalisée. Une fois les nerfs libérés, la possibilité d'une suture entre les deux nerfs a été évaluée. La suture, sans tension, du nerf des rhomboïdes sur le nerf suprascapulaire a toujours été possible dans notre étude. De plus, il n'y avait pas macroscopiquement d'incohérence de diamètre entre les deux nerfs : le diamètre moyen du nerf des rhomboïdes était de 2,9 mm et celui du nerf suprascapulaire était de 3 mm. Le diamètre du nerf des rhomboïdes correspond parfaitement à celui du nerf suprascapulaire. De plus, il permet d'éviter le sacrifice du nerf spinal accessoire, conservant ainsi la fonction du muscle trapèze, alors transférable en cas d'échec de la chirurgie nerveuse. Il permettrait de plus de réaliser la suture en aval de l'incisure scapulaire (supérieure) et d'éviter les mauvais résultats liés aux lésions étagées de ce nerf. Enfin la voie d'abord postérieure permet, lorsqu'elle est prolongée latéralement, de réaliser un transfert associé du nerf du chef long du triceps brachial sur le nerf axillaire. Ce transfert du

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nerf des rhomboïdes sur le nerf suprascapulaire est anatomiquement possible. Cependant, une étude clinique sera nécessaire afin de confirmer cette hypothèse et de donner des résultats préliminaires.

Mots clés : Nerf du rhomboïde ; Nerf dorsal de la scapula ; Nerf suprascapulaire ; Nerf spinal accessoire ; Transfert nerveux ; Plexus brachial

1. Introduction

Partial paralysis of the brachial plexus represents approximately 25% of plexus injuries [1]. In paralysis of the C5 and C6 roots, restoring elbow flexion and shoulder elevation is the main objective. If the roots are ruptured, one of the most used and most reliable nerve transfers remains that of the external branch of the spinal accessory nerve to the suprascapular nerve; this restores abduction and/or external rotation of the shoulder [2].

However, the difference in diameter between the spinal accessory and suprascapular nerves can reduce the quality of supraspinatus and infraspinatus muscle reinnervation [3,4]. Moreover, this transfer partially sacrifices trapezius function, a muscle fundamental to shoulder function [5]. In addition, the suprascapular nerve can be injured at several levels, from its origin to the suprascapular notch [6]. In this case, anterior transfer of the spinal accessory nerve to the suprascapular nerve is not always effective or justifies undertaking multiple surgical approaches.

Thus, we undertook an anatomical study to evaluate the possibility of performing a direct transfer of the rhomboid nerve to the suprascapular nerve in the supraspinatus fossa.

2. Materials and methods

This study was performed on 5 fresh cadavers (10 shoulders). A posterior incision was made along the spine of the scapula. The trapezius was detached close to its scapular insertion to access the supraspinatus fossa. Next, the deep aspect of the supraspinatus muscle was detached to access the suprascapular notch. The suprascapular nerve was located and then freed by sectioning the transverse scapular ligament to obtain the maximal length necessary for the subsequent suture.

The levator scapulae muscle was detached from the medial border of the scapula, and then retracted to expose the deep aspect of the dorsal scapular nerve. Once exposed, the branches to the levator scapulae muscle and the rhomboid muscle were isolated. The branch for the rhomboid muscle was freed as far as possible in the muscle and in the dorsal scapular nerve to obtain the maximum length. The branch was then sectioned close to the muscle and was brought into contact with the suprascapular nerve (Fig. 1).

The excess length when two nerves overlap was measured with a digital caliper (Cogex, France) to determine the possibility of performing a tensionless suture. In addition, the diameter of the two nerves was measured.

3. Results

In all cases, the distance between the two nerve ends (suprascapular and rhomboid nerves) was small enough that they could be brought together without placing tension on them (Fig. 2). The two nerves always had excess length available. The average excess length was 3.1 mm (range 2 to 4 mm).

The average diameter of the rhomboid nerve was 2.9 mm (range: from 2 to 4 mm) and the suprascapular nerve 3 mm (range: from 2 to 4 mm).

4. Discussion

The dorsal scapular nerve arises from the C5 and C4 roots and occasionally from the C3 and C6 roots [7,8]. In most publications, the dorsal scapular nerve is one single nerve. It penetrates the middle scalene muscle, runs on the ventral side of the levator scapulae muscle and continues to the ventral side of rhomboid muscles near the medial border of the scapula [7,8].

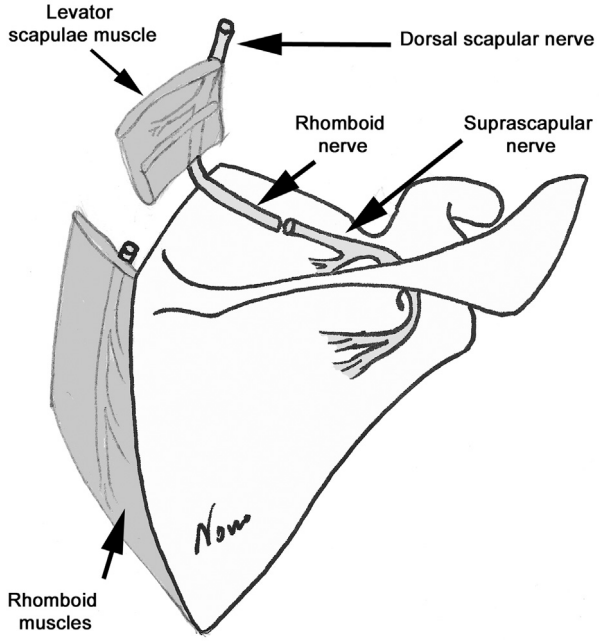

Fig. 1. Drawing that shows the principle behind transferring the nerve to the rhomboid muscles (terminal branch of the dorsal scapular nerve) to the suprascapular nerve downstream of the suprascapular notch. The levator scapulae muscle is detached from the medial border of the scapula to expose the rhomboid nerve. The rhomboid nerve is divided close to the rhomboid muscle to obtain the maximal possible length and diameter. The suprascapular nerve has been divided at the suprascapular notch and rerouted to rhomboid nerve.

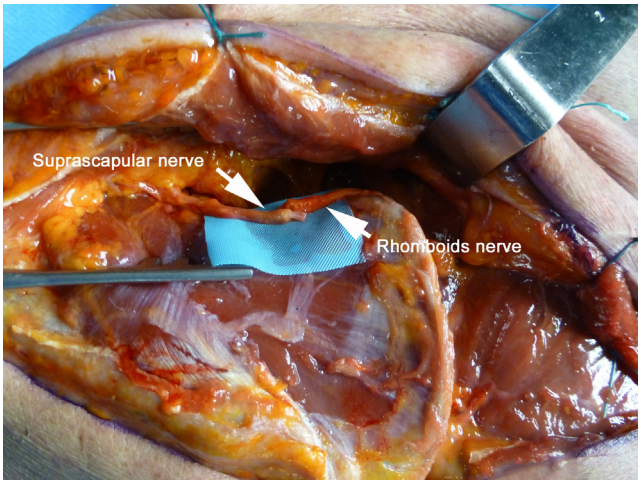

Fig. 2. Cadaver dissection showing the possibility of transferring the nerve of the rhomboid muscles to the suprascapular nerve (left side). Joining the two nerve ends was always possible in our study without placing tension on the nerves.

The rhomboid nerve, which is a terminal branch of dorsal scapular nerve, splits into small branches along the anterior border of rhomboid muscles [8]. In the technique proposed here, the rhomboid nerve must be divided just before it passes under the top edge of the rhomboid minor muscle in order to obtain the maximum possible diameter and length.

In partial paralysis of the brachial plexus without avulsion of the superior C5 and C6 roots, the dorsal scapular nerve, which originates high on the C5 root, is generally preserved. Rupture at the nerve roots most often occurs at the convergence of the C5 and C6 roots, which form the upper trunk. Moreover, even in cases of C5 and C6 root avulsion, the rhomboid nerve may be preserved because of a branch from C4 [7].

This can be clinically determined by the absence of rhomboid atrophy, and also by the absence of detachment from the vertebral border of the scapula during resisted forward movement of the shoulder joint [7]. An electromyogram can also verify the integrity of this branch of the plexus. Finally, during surgical exploration, direct stimulation of the rhomboid nerve provides definitive verification of its functionality before suturing the suprascapular nerve (after the myelin degeneration period). In cases where it cannot be stimulated, it is still possible to use the posterior part of the spinal accessory nerve [9]. To our knowledge, only the levator scapulae nerve, a branch of the dorsal scapular nerve, has been used to restore elbow extension with a graft being interposed between the nerve to the long head of the triceps brachii by an anterior approach [6]. Encouraging results (M3–M4) were reported in 12 patients.

The advantages of transferring the rhomboid nerve to the suprascapular nerve in order to restore supraspinatus and infraspinatus muscles function are multifold.

First, the diameter of rhomboid nerve is perfectly suited to that of the suprascapular nerve whereas the diameter of the lateral branch of spinal accessory nerve is smaller [3]. For pure motor nerves, nerve diameter is correlated to the number of fascicles [4]. In addition, if the nerve surgery were to fail, direct transfer of the trapezius muscle is still possible, particularly to restore external rotation [10].

Secondly, we have shown that it can be harvested by a posterior approach and sutured directly on the distal stump of the suprascapular nerve without tension, downstream of the suprascapular notch. This distal suture, when performed close to the supraspinatus muscle, results in faster motor recovery and avoids multilevel injuries of the suprascapular nerve. These associated injuries in the supraclavicular region and at the level of the suprascapular notch are not a rare occurrence. They are the source of poor results, which have compelled some authors to perform several anterior approaches [6]. Moreover, if only external rotation has to be recovered, the rhomboid nerve may be transferred directly to fascicles of the infraspinatus muscle. In this case, fascicles of the infraspinatus muscle have to be located and dissected in the suprascapular nerve until its division. However, the rhomboid nerve may not directly reach the motor branch of infraspinatus at the inferior scapular notch (spinoglenoid notch).

Extending the posterior incision over the spine of the scapula towards the posterior aspect of the arm can allow simultaneous transfer of the nerve to the long head of the triceps brachii to the axillary nerve [11]. The dorsal approach is proposed by certain teams to allow transfer of the spinal accessory nerve to the suprascapular nerve and of the radial nerve to the axillary nerve [11].

This entirely anatomical study obviously requires a subsequent clinical study in order to judge the effectiveness of this nerve transfer. All factors necessary for clinical efficacy are present: the diameter of the two nerves matches perfectly, a pure motor nerve is transferred to another pure motor nerve, and the nerve is sutured close to the muscle, allowing faster motor recovery [4]. The number of nerve fibers comprised by the rhomboid nerve was not calculated; this data could have given some additional indication of the effectiveness of the reinnervation.

Obviously a clinical study will be necessary to assess the risk of sequelae linked to the removal of the rhomboid nerve. Complete laceration of the dorsal scapular nerve may induce scapula winging [12–14]. However, in our technique the levator scapulae's nerve is preserved, thereby stabilizing the scapula. Moreover, the majority of other scapula-stabilizing muscles are preserved, notably the trapezius and serratus anterior. As a consequence, the risk of scapula winging is probably low [6,15]. Moreover, the rhomboid muscles are commonly used and released to stabilize the scapula in trapezius or anterior serratus palsy during the Eden–Lange procedure [5].

5. Conclusion

Transfer of the rhomboid nerve to suprascapular nerve is anatomically feasible. All factors are present for clinically efficiency. However, a clinical study is needed to assess muscle reinnervation and overall shoulder function.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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