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Transfer of the rhomboid nerve for restoration of shoulder external rotation in partial brachial plexus palsy

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ABSTRACT

Restoration of shoulder external rotation in partial brachial plexus palsies is a real challenge. The transfer of the spinal accessory nerve to the suprascapular nerve remains the gold standard. This transfer, however, cannot be always performed. Therefore, in these cases, we previously proposed the transfer of the rhomboid nerve to the suprascapular nerve through a posterior approach. The goal of the present study is to assess this technique through a short series.

Eight male patients had a partial plexus palsy. Five patients had C5, C6 root injuries, two patients had C5, C6, C7 root injuries, and one patient had C5 to C8 root injuries. No patients had C5 or C6 root avulsions. In one patient, the spinal accessory nerve was injured and in seven patients, the proximal suprascapular nerve was not available. All patients underwent a transfer from the rhomboid nerve to the suprascapular nerve. Concerning shoulder elevation, transfers from the branch of the long head of the triceps or ulnar nerve fascicle were transferred to the axillary nerve. For elbow flexion, fascicles from the ulnar nerve, median nerve, or both were used. For elbow extension, three intercostal nerves in one patient and one fascicle from the ulnar nerve in two patients were transferred to the branch of the long head of the triceps. For wrist and finger extension, palliative surgery was proposed.

All patients recovered external shoulder rotation (from 70–110º) and shoulder elevation (range, 80–140º). Active elbow flexion was coded M4 in seven patients and M3 in one patient. All patients recovered active elbow extension.

The transfer of the rhomboid nerve to the suprascapular nerve is an efficient procedure for shoulder external rotation in partial brachial plexus palsies without C5 root avulsion. The results in terms of range-of-motion are, however, poorer than with the spinal accessory nerve. Therefore, this technique is appropriate if the spinal accessory nerve is injured or if the suprascapular nerve is not available in the cervical area. This technique must be associated with another transfer to the axillary nerve for shoulder elevation. The study of more patients will be necessary to confirm these results.

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Introduction

In partial brachial plexus injuries with shoulder palsy, the restoration of shoulder external rotation is a real challenge. In terms of nerve surgery, the gold standard remains nerve transfer of the spinal accessory nerve (SAN) to the suprascapular nerve (SSN) [1]. Other nerve transfers to the SSN have been proposed, from the C7 root fascicles, to the phrenic nerve [2,3]. In all these techniques, however, the quality of the suprascapular nerve needs to be perfect. Moreover, donor nerves such as the SAN or the C7 root must be present. Therefore, in cases of SSN injury in the supra-clavicular area or if the SAN or C7 are not available, we proposed the transfer of the rhomboid nerve to the SSN through a posterior approach [4,5]. The goal of this study was to assess this technique with a short series, following the previously published anatomical study and clinical case report.

Patients and methods

This was a retrospective study of patients who underwent surgery from 2015–2018. A partial palsy of brachial plexus was present in eight male patients. The mean age of patients was 25 years (range, 21 to 31). Five patients had a C5, C6, C7 root injury,

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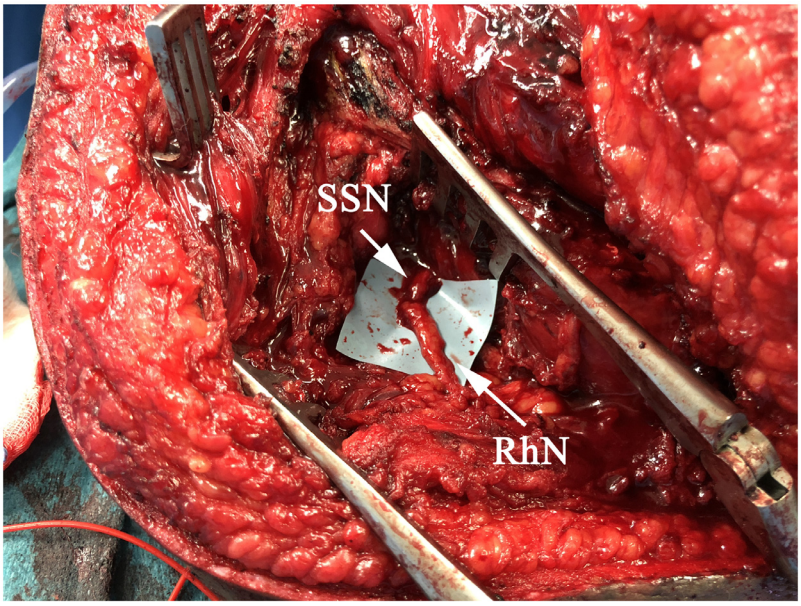

Fig. 1. Transfer of the rhomboid nerve (RhN) to the suprascapular nerve (SSN) in the supraspinatus fossae. The suture can be performed without any tension.

with shoulder, elbow and wrist extension palsy. One patient had a trapezius palsy. One patient had a C5 to C8 root injury with shoulder, elbow, and wrist extension palsy and finger and wrist flexion weakness. The mean time before operation was 5.1 months (range, 4 to 7). A cervical Pseudo-Tinel sign was present in all patients. MRI of the brachial plexus and electromyography, especially focused on the rhomboid nerve, was performed in all patients.

No root avulsion was present concerning the C5, C6, C7 roots and electromyography showed that the rhomboid muscle was present in all patients. Cervical exploration was performed for all patients. C5 and C6 were ruptured in all patients and in three patients, the C7 root was injured with no avulsion. The SSN in the cervical area was injured in seven patients (with no possible nerve graft or transfer) and the SAN was injured in one patient. The proximal branch of the serratus nerve was stimulated in all patients, resulting in good muscle contraction.

For elbow flexion, a double transfer from the ulnar and median nerve fascicles to the biceps and brachialis nerve was performed in patients with C5 and C6 root injuries; a transfer of one fascicle of the median nerve to the biceps nerve was performed in three patients with C5, C6, C7 and C5, C6, C7, C8 root injuries. For restoration of shoulder elevation, transfer of the branch of the long triceps from the radial nerve to the anterior branch of the axillary nerve was performed if the C7 root was not involved (five patients). For all of these patients, the diameter of the axillary branch was not sufficient for simultaneous reinnervation of the teres minor muscle. In patients with C5, C6, C7 or C5, C6, C7, C8 root injuries, one ulnar nerve fascicle was transferred to the anterior branch of the axillary nerve.

For restoration of shoulder external rotation, the transfer of the rhomboid nerve to the distal part of the SSN through a posterior approach was performed in all patients (Fig. 1).

Of the three patients with elbow extension palsy, one underwent the transfer of three intercostal nerves to the branch of the long triceps. The second underwent the transfer of one fascicle from the ulnar nerve to the branch for the long head of the triceps. For the third patient, intercostal nerve transfer was not possible because of rib fractures and the ulnar nerve fascicle was not possible because the only fascicle for the extrinsic hand muscle was used for shoulder restoration. Concerning restoration of the wrist and finger, in patients with C7 root injury, tendon transfers for wrist and finger extension were performed. For one patient with associated C8 injury, a wrist arthrodesis was performed (Table 1).

Results

The mean follow-up was 32 months (range, 25 to 48) (Table 2). Elbow flexion was recovered for all patients (from M3 to M4). Elbow extension was coded M3 for the patient who underwent the nerve transfer from intercostal nerves and M4 for the patient with ulnar fascicle transfer. Shoulder elevation recovered in all patients from 85 to 140°. Active external shoulder rotation recovered in all patients, from 80 to 100°. No complications were noted.

Discussion

In the treatment strategy for brachial plexus palsy, recovery of elbow flexion remains the first goal. In upper partial palsies, nerve transfers with fascicles from the ulnar and median nerve give good results according the literature [6]. Abduction and flexion of the shoulder can be recovered with grafts [7], nerve transfers from the radial nerve, or from other nerves such as the ulnar nerve fascicle or intercostal nerves, with satisfactory results [1,8,9]. Concerning the external rotation of the shoulder, the transfer of the SAN to the SSN remains the gold standard [1,10]. This transfer, however, is not always possible: the SAN can be injured in 6% of brachial plexus palsies [1]. In this case, another transfer can be proposed through the same anterior approach, with a fascicle from the C7 root, if present [2]. However, distal injury of the SSN in a double crush lesion, if not taken into account, could severely decrease the effectiveness of this transfer.

Moreover, in C5 or C6 root avulsions or rupture, the SSN may be proximally injured and cannot be transferred. In this case, the dissection must be performed deeper in the supraclavicular area up to the coracoid notch [10]. We prefer, in this situation, a posterior approach [5]. The SSN can be released distally after the coracoid notch, in order to bypass a double crush injury (proximal C5, C6 injury and associated distal coracoid notch injury). With the posterior approach, SAN can be transferred to the SSN as descried by Bandhari et al. [11]. We prefer, however, to spare the SAN to preserve the results of a future shoulder arthrodesis, in case of nerve

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Table 1
Summary of surgical strategy according to root injuries.

Patient	Root injury	Shoulder Rotation	Shoulder elevation	Elbow flexion	Elbow extension	Wrist flexion	Wrist extension	Finger extension
N°1	C5,C6	RhN- SSN	BLT-ABAx	Ul-Bi/M-Br				
N°2	C5,C6	RhN- SSN	BLT-ABAx	Ul-Bi/M-Br				
N°3	C5,C6	RhN- SSN	BLT-ABAx	Ul-Bi/M-Br				
N°4	C5,C6,C7	RhN- SSN	Ul-ABAx	M-Bi	Ul-LBLT		PT- ECRB	FCR-EDC + EPL
N°5	C5,C6	RhN- SSN	BLT-ABAx	Ul-Bi/M-Br				
N°6	C5,C6	RhN- SSN	BLT-ABAx	Ul-Bi/M-Br				
N°7	C5,C6,C7	RhN- SSN	Ul-ABAx	M-Bi	ICT-LBT		PT- ECRB	FCR-EDC + EPL
N°8	C5,C6,C7,C8	RhN- SSN	Ul -ABAx	M-Bi		Wrist fusion	Wrist fusion,	FCR-EDC + EPL

RhN: nerve of the rhomboid muscle ; SSN: suprascapular nerve; BLT: branch for the long head of the triceps muscle; ABAx: anterior branch of the axillary nerve; Ul: ulnar nerve fascicle; M: median nerve fascicle; Bi: biceps nerve; Br: nerve of the brachialis muscle; PT: pronator teres muscle; ECRB: extensor carpi radialis brevis muscle; FCR: flexor carpi radialis muscle; EDC extensor digitorum communis muscle; EPL: extensor pollicis longus muscle.

Table. 2
Results of nerve surgery.

Patient	Root injury (ROM)	Shoulder rotation (ROM)	Shoulder elevation	Elbow flexion	Elbow extension
N°1	C5,C6	M4 (90°)	M4 (135°)	M4 +	
N°2	C5,C6	M4 (110°)	M4 (140°)	M4 +	
N°3	C5,C6	M4 (100°)	M4 (140°)	M4 +	
N°4	C5,C6,C7	M3 (80°)	M4 (90°)	M4	M4
N°5	C5,C6	M4 (90°)	M4 (140°)	M4+	
N°6	C5,C6	M4 (90°)	M4 (130°)	M4	
N°7	C5,C6,C7	M3 (80°)	M4 (85°)	M4	M3
N°8	C5,C6,C7,C8	M3 (70°)	M4 (80°)	M3+	M0

RhN: nerve of the rhomboid muscle ; SSN: suprascapular nerve; BLT: branch for the long head of the triceps muscle; ABAx: anterior branch of the axillary nerve; Ul: ulnar nerve fascicle; M: median nerve fascicle; Bi: biceps nerve; Br: nerve of the brachialis muscle.

surgery failure [12]. Therefore, we transfer the rhomboid nerve terminal motor branch of the dorsal scapular nerve to the distal part of the SSN in the supraspinatus fossae [4,5]. The nerve suture is performed closer to the supraspinatus and infraspinatus muscles, shortening the time of reinnervation.

C5 root injury is not, in theory, a problem for this transfer. Anatomical studies have shown that the fibers of the dorsal scapular nerve can come from C5 but also C4, C3[13]. Therefore, this nerve can be preserved in case of C5 root avulsion. Moreover, in a study on 38 patients with C5 rupture, only 2 patients had a partial palsy of the rhomboid nerve (coded M4) [13].

Concerning the results for shoulder abduction, results cannot be attributed only to the transfer to the SSN due to simultaneous axillary reinnervation. For the recovery of the external rotation of the shoulder, however, our results are directly linked to the transfer. All patients recovered a shoulder external rotation; however, range-of-motion seems less satisfactory than with the SAN[1]. The average shoulder rotation with SAN transfer was 118° (range, 90–140°) for Bertelli et al., in partial palsies, compared to our mean of 89° (range, 70–110°). Nevertheless, Bertelli et al. reinnervated the teres minor muscle in all patients, improving shoulder external rotation. Our results were better if the C7 and C8 roots were not injured, in terms of shoulder elevation and external rotation, consistent with Bertelli and colleagues [1].

Spontaneous recovery of external rotation though the teres minor muscle could be a possibility in partial plexus palsies. However, in our patients, during the transfer from the branch of the long triceps or fascicles from the ulnar nerve to the axillary nerve, the branch of the teres minor nerve was always divided to focus all the fascicles from the BLT or ulnar nerve on the anterior branch of the axillary nerve. Therefore, spontaneous recovery could not occur in our series and cannot explain our results.

The technique of transferring the rhomboid nerve is not always possible [4]. In a previous anatomical study, the terminal branch of the dorsal scapular nerve was not a single nerve but was divided into several small branches, impossible to transfer. In this case, we advise performing the transfer of the SAN, if present, to the SSN, via the same posterior approach. If the SAN is not present, C7 fascicles, if present, could be transferred to the SSN, via an anterior cervical approach [2].

Shoulder arthrodesis can, theoretically, be performed after this transfer in case of nerve surgery failure. The serratus muscle contractions are sufficient for shoulder abduction and elevation after shoulder arthrodesis [12]. Moreover, the levator scapulae, spared in our technique, helps to stabilize the scapula. Scapular winging was not observed in our series. In fact, the dorsal scapular nerve was always present and the sparing of the nerve of levator scapulae help to stabilize the scapula. The preservation of the SAN may help to avoid weakening the lower part of the trapezius and winging scapulae [1].

The limitation of our study remains the size of our series. Nevertheless, we propose rhomboid nerve transfer in the case of SAN injury or if a posterior approach is needed for SSN dissection. While SSN injuries can be frequent in the cervical area during C5 and C6 root injuries, SAN lesion are more rare, therefore in our experience, the indication of a rhomboid nerve transfer is not very frequent.

Conclusion

The transfer of the rhomboid nerve to the suprascapular nerve is an efficient procedure for restoration of shoulder external rotation in partial brachial plexus palsies. Results are not, however, as good as with spinal accessory nerve transfer. Therefore, we propose this technique when a spinal accessory nerve injury is associated with the brachial plexus palsy or when the restoration of the suprascapular nerve though the anterior approach is not possible. In these cases, rhomboid nerve transfer is perfectly adapted and avoids the use of the spinal accessory nerve.

Disclosure

None of the authors have conflicts of interest for this publication.

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Declaration of Competing Interest

We declare no conflicts of interest.

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