Anatomy and Clinical Application of Suprascapular Nerve to Accessory Nerve Transfer

Dear editor and reviewers,

Thank you for the valuable and really helpful comments. They are the important guiding significance to our researches. We provided the responses in a point-by-point manner below. We have studied comments carefully and have made correction which we hope meet with approval. We would like to look forward to hearing from you regarding our submission. We are so glad to respond to any further questions and comments that you may have.

Yours sincerely,

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point-by-point responses：

Reviewer #1:
Scientific Quality: Grade D (Fair)
Language Quality: Grade B (Minor language polishing)
Conclusion: Major revision
Specific Comments to Authors: The data of suprascapular nerve and accessory nerve was measured and obtained in ten sides of cadavers in this study. Nerve transfer from the partial suprascapular nerve to the accessory nerve was performed on one patient and did the electromyography examination three months and nine months after surgery. It has been showed that suprascapular nerve transfer could be prone to improving the trapezius muscle function, less loss of function in the supraspinatus and infraspinatus muscles after suprascapular nerve transfer. In general, this is an interesting study. It confirmed that suprascapular nerve transfer could be treated with patient with accessory nerve injury. However, there are a few concerns that need to be clarified:

•From the Figure 7, the trapezius seems partial deinnervated. How to differentiate the recovery was from AN partial injury recovery or from the partial SCN transfer?

Response: Thank you for your question. The AN was cut off in this case, which could not be recovered by itself. So, the recovery of the trapezius could be identified as the recovery effect of suprascapular nerve transplantation. The results of electromyography also supported this deduction.

•Suprascapular nerve innervated the suprascapular muscle, which is important muscle of rotator cuff. From the Figure 5, the partial of the SCN seems the main broch of the SCN. How to make sure don’ t loss of the suprascapular nerve function after this transfer?

Response: In the present study, we couldn’t make sure that there was no loss of the suprascapular nerve function after the nerve transfer. Suprascapular nerve’s function should have a certain degree of loss. However, the patient’s clinical manifestation of upper limbs movement was shown in Figure 9, which indicated the similar recovery behavior between right and left sides. The results of the Constant Shoulder Scale were shown in Table 2, and suggested that the shoulder function recovered similarly between right and left sides. The amplitude of right-sided supraspinatus and infraspinatus electromyography revealed that the right side did not lose more function than the left side three months and nine months after surgery, which indicated less loss of function in the supraspinatus and infraspinatus muscles after SCN transfer.

Reviewer #2:
Scientific Quality: Grade C (Good)
Language Quality: Grade B (Minor language polishing)
Conclusion: Minor revision
Specific Comments to Authors: The study investigated anatomical features, such as nerve length and the number of branches, of the suprascapular nerve. The results of this study suggested that the suprascapular nerve has sufficient length for a donor of nerve transportation surgery. Furthermore, the authors reported that, even in a single case report, suprascapular nerve accessory nerve transfer improved trapezius muscle function after innervation with radical neck dissection. This study provides important evidence of nerve transportation using the suprascapular nerve. However, there are several points that authors need to address before the manuscript can be considered for publication.

General comments

• First, in the introduction, the authors should describe the reason why you measured the length of AN and SCN, as well as the number of branches of AN?

Response: The length of AN and SCN is measured to ensure SCN suture with AN without tension during transplantation. Anatomic information and the precise position of the AN is very important for the protection of the AN during the surgery.

•Why do these measurements provide significant insight into this area?

Response: The posterior cervical triangle is an important surgical area for neck dissection, where anatomical measurement can provide more information for surgery and ensure surgical safety and treatment effectiveness.

•Also, in the discussion, the authors need to clearly provide a reasonable explanation of why the suprascapular nerve is an appropriate donor site for nerve transfer after the radical neck dissection using the obtained data.

Response: Reasons of SCN is suitable for transplantation: They are next to each other in position, which is conducive to nerve transplantation to achieve no tension suture. The function of the AN and SCN in shoulder elevation and abduction movement is synergistic. As reported in previous studies[27-30], the AN-SCN transfer has achieved good functional recovery, but there were few studies on SCN-AN transfer. The results of our clinical outcomes showed that supraspinatus and infraspinatus muscle function were not affected much three and nine months after surgery.

[27] Bertelli J A, Ghizoni M F. Reconstruction of C5 and C6 brachial plexus avulsion injury by multiple nerve transfers: spinal accessory to suprascapular, ulnar fascicles to biceps branch, and triceps long or lateral head branch to axillary nerve. J Hand Surg Am 2004;29:131-139.（PMID: 14751116 DOI: 10.1016/j.jhsa.2003.10.013）

[28] Waikakul S, Wongtragul S, Vanadurongwan V. Restoration of elbow flexion in brachial plexus avulsion injury: comparing spinal accessory nerve transfer with intercostal nerve transfer. J Hand Surg Am 1999;24:571-577.（PMID: 10357538 DOI: 10.1053/jhsu.1999.0571）

[29] Lu J, Xu J, Xu W, et al. Combined nerve transfers for repair of the upper brachial plexus injuries through a posterior approach. Microsurgery 2012;32:111-117.（PMID: 22002897 DOI: 10.1002/micr.20962）

[30] Souza F H, Bernardino S N, Filho H C, et al. Comparison between the anterior and posterior approach for transfer of the spinal accessory nerve to the suprascapular nerve in late traumatic brachial plexus injuries. Acta Neurochir (Wien) 2014;156:2345-2349.（PMID: 25326278 DOI: 10.1007/s00701-014-2222-6）

•Therefore, I would recommend rewriting your introduction and discussion parts more precisely.

Response: According to your suggestion, we have remodified the introduction and discussion according to your recommendation.

• Second, did the authors control neck position during the measurement?

Response: When measuring the data, the specimen faced upwards, and the face and neck were in the median position.

•Although the suprascapular nerve length is enough as a donor candidate for nerve transfer, does the length of the suprascapular nerve has still sufficient length when the neck is rotated or flexed?

Response: The chosen marker points were relatively fixed during measurement, and they were less affected by the rotational movement of the head. So, it still has sufficient length when the neck is rotated or flexed.

• Third, although I do not doubt your skills in length measurement, it would be better if the authors provide data of reliability such as ICC.

Response: Thank you for your suggestion. We have added this part in the revised manuscript. During the measurement, each data value was obtained from multiple measurements by the same surveyor to reduce the occurrence of errors. We did not consider use the ICC, because the ICC is often used to assess the consistency of the different surveyors.

• Fourth, how do you obtain electromyographic data from supraspinatus and infraspinatus muscles using surface electromyography?

Response: The methods for obtaining EMG have been added in the revise manuscript. Electromyography (Dentec Keypoint, Natus Medical Incorporated, Denmark) was used for the examination. For supraspinatus and infraspinatus electromyography, external rotation of the upper arm around humerus bone with maximum strength and abduction of the upper arm to 90° for two seconds were performed, respectively. Surface electrodes were placed on the supraspinatus and infraspinatus just above and below the scapular spine and at the middle of the supraspinous and infraspinous fossa of the scapula, respectively[18, 19]. The ratio, R, of the amplitude of electromyography before and after surgery was calculated as follows:

$$R = \frac{\text{amplitude of EMG before surgery} - \text{amplitude of EMG after surgery}}{\text{amplitude of EMG before surgery}}$$

The range of R was 0 – 1. The lower the value, or the closer it was to 0, the smaller the degree of loss of muscle function.

•Also, why did not provide references for the placement of surface electrodes for upper and middle trapezius muscles?

Response: The relevant literature has been added in the revised manuscript. The descending, horizontal, and ascending parts of the trapezius muscle were detected in

this study, according to the method used by Krause et al[17]. The middle was placed at the line from the level of the second thoracic vertebra to the suprascapular angle, 3cm from the longitudinal axis of the spine. The ascending portion was placed at the horizontal line of the inferior corner of the shoulder, 3cm from the longitudinal axis of the spine. During examination of the trapezius muscle, electromyography was performed when the patient shrugged shoulders and closed shoulder blades with maximum strength and abducted the upper arm to 90° for two seconds, respectively.

17 **Krause H R**, Bremerich A, Herrmann M. The innervation of the trapezius muscle in connection with radical neck-dissection. An anatomical study. J Craniomaxillofac Surg 1991;**19**:87-89.(PMID: 2037698 DOI: 10.1016/s1010-5182(05)80613-4)

• Fifth, for me, this manuscript seems like a 90% research article and 10% case report because the authors used 10 cadavers and one clinical patient. However, most of the discussion part was described based on clinical outcome, not anatomical features. Please describe more about how you interpret the current results (sorry, this comment is similar to the first comment). Moreover, if it is possible, please display photos of the patient during shoulder elevation at each time point. Clinicians may cast doubt about that whether your patient functionally improved, although you showed electromyographic data.

Response: Thank you for your suggestion. We have added this part in the revised manuscript. We have remodified the introduction and discussion according to your recommendation. The patient's clinical manifestation of upper limb movement before (a, b), three months after (a1, b1), and nine months after surgery was shown in Figure 9.

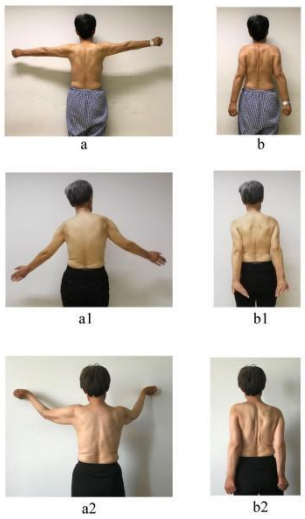

Figure 9. The patient's clinical manifestation of upper limb movement before (a, b), three months after (a1, b1), and nine months after surgery (a2, b2). The panels a, a1, a2 showed the movement

of abduction of the upper arms, and the panels b, b1, b2 showed the movement of external rotation of the upper arms.

• Finally, where is the ethical statement?

Response: The ethical statement was added to the appropriate part in the text.

Specific comments：

• Abstract Line 42-43: this study focused on the suprascapular nerve; thus, the authors should mention the reason why the suprascapular nerve is gathering attention in this field.

Response: We had mentioned the reason why the suprascapular nerve is gathering attention in this field. After cutting the accessory nerve (AN) during surgery, nerve repair is an effective method to restore trapezius muscle function, including neurolysis, direct suture, and nerve grafting. The suprascapular nerve (SCN) and AN are next to each other in position. The function of the AN and SCN in shoulder elevation and abduction movement is synergistic. The SCN might be considered by surgeons for AN reanimation.

• Line 76-82: in a core tip, why did not the authors mention the result of the length of the suprascapular nerve? Is this an original article, not a case report? Introduction The main problem of the introduction was already described as general comments. Please see them.

Response: This part has been modified according to your recommendations in the revised manuscript. In the posterior cervical triangle, we found that the suprascapular nerve could obtain enough nerve length, from its origin to the suprascapular notch, to perform SCN-AN partial nerve transplantation, and achieve tension-free suture, suggesting the feasibility of transplantation of the suprascapular nerve as a donor.

• Materials and methods Line 123-124: this section is about cadaveric dissection; so, it may be clearer that the authors described only the dissection procedure, not measurement.

Response: This section has been modified according to your recommendations in the revised manuscript. Cadaveric dissection: Cadavers were dissected, and the SCN (n = 10) and AN (n = 10) at the lateral cervical region were exposed. The SCN and AN were carefully dissected in the posterior triangle of the neck as follows. First, the

SCM was exposed after removing the superficial tissue. Second, the SCN from C5 of the brachial plexus could be found beneath and close to the lower belly of the omohyoid muscle and AN emerges in the posterior triangle at the anterior margin of the trapezius (Figure 1). Third, the SCM was elevated, beneath which we found that the accessory nerve at the anterior edge of the trapezius muscle, and the suprascapular nerve from the beginning to the scapular notch segment (Figure 2,3). Fourth, trapezius muscle was dissected to fully display the accessory nerve (Figure 4).

•Line 127-130: please recheck punctuation.

Response: This section has been modified according to your recommendations in the revised manuscript.

•Line 132: put a comma before “and”, like “descending portion, horizontal portion, and ascending portion.”

Response: This section has been modified according to your recommendations in the revised manuscript. The length and branches of AN in trapezius muscle was measured. The trapezius muscle was divided into three portions: descending portion, horizontal portion, and ascending portion.

•Line 137: each part of what?

Response: We measured the number of branches of the accessory nerve in three portions, respectively.

•Line 139: did the authors check the normality of data distribution before performing the t-test? Moreover, did the authors use a “paired t-test” or “unpaired t-test”?

Response: Before testing, the two groups of data were studied with a normal distribution (the P-value is greater than 0.05, consistent with the normal distribution), and then the paired t-test was conducted, and the p value was less than 0.05, with a significant difference.

•Line 140-141: I do not believe that t-test can reveal the relationship between two parameters. The t-test is usually used to compare two parameters.

Response: We applied the paired t-test to compare the size of the mean value of the two sets of data.

•Line 170-173: the authors would need to cite references for the electrode placement of middle and ascending trapezius muscles.

Response: Relevant literature has been cited. Electromyography (Dentec Keypoint, Natus Medical Incorporated, Denmark) was used for the examination. The descending, horizontal, and ascending parts of the trapezius muscle were detected in this study, according to the method used by Krause et al[17].

•Line 175-177: the authors would need to mention how electromyographic data were obtained from supraspinatus and infraspinatus muscles.

Response: For supraspinatus and infraspinatus electromyography, external rotation of the upper arm around humerus bone with maximum strength and abduction of the upper arm to 90° for two seconds were performed, respectively. Surface electrodes were placed on the supraspinatus and infraspinatus just above and below the scapular spine and at the middle of the supraspinous and infraspinous fossa of the scapula, respectively[18, 19]. The ratio, R, of the amplitude of electromyography before and after surgery was calculated as follows:

$$R = \frac{\text{amplitude of EMG before surgery} - \text{amplitude of EMG after surgery}}{\text{amplitude of EMG before surgery}}$$

•Line 177-178: what is "the above movement"? The authors should describe more precisely what shoulder motion the patient performed.

Response: For supraspinatus and infraspinatus electromyography, we replace "the above movement" with a detailed description: external rotation of the upper arm around humerus bone with maximum strength and abduction of the upper arm to 90°.

•Also, how long did the patient keep the shoulder motion?

Response: the patient keep the shoulder motion for two seconds.

•Do you use any filters when you analyze electromyographic data?

Response: No, we don't use any filter when we analyzed electromyographic data.

•Results If you accepted my fifth general comment, this part would be changed, especially the part about the clinical outcomes of nerve transfer surgery.

Response: Thank you for your suggestion and kind reminding. We have changed this part in the revised manuscript.

•Discussion I recommend the authors use precise conjunction words to improve the flow of the discussion part.

Response: We carefully checked the Discussion part again, and tried to use some appropriate conjunction words to improve the expression. If you found any part of the manuscript we need to improve, please don't hesitate to point it. Thank you very much!

•Line 234-235: is this sentence relating to the previous study [11]?

Response: Yes, this sentence was related to the previous study[13]. Tubbs et al.[13] reported a cadaveric study related to the SCN connection with the facial nerve. They measured the length and diameter of the SCN in 10 human cadavers. They believed using the SCN might be considered by surgeons for facial nerve reanimation.

•Line 236-237: as I mentioned before, I am not sure whether the utilized method in this study can measure the electromyographic activity of the supraspinatus and infraspinatus muscles.

Response: The relevant literature has already been cited. Surface electrodes were placed on the supraspinatus and infraspinatus just above and below the scapular spine and at the middle of the supraspinous and infraspinous fossa of the scapula, respectively [18, 19].

•Line 244-245: which study are you referring to by "these studies"?

Response: Relevant literature has been listed. These studies indicated that the spinal AN had a similar histological compatibility with the SCN[27-33].

•Line 249: in my opinion, another expression may be better instead of "electromyography displays", such as the result of electromyography or electromyographic activity.

Response: It has been modified according to your recommendations in the revised manuscript. Although the results showed that the descending portion of right trapezius muscle did not recover better than the left side, the result of electromyography indicated that the horizontal and ascending portions in right side had larger amplitude than the left side nine months after surgery.

•Line 253: regarding supraspinatus and infraspinatus muscle function, please see the general comment.

Response: The patient's clinical manifestation of upper limbs movement was shown in Figure 9, which indicated the similar recovery behavior between right and left sides. The results of the Constant Shoulder Scale were shown in Table 2, and suggested that the shoulder function recovered similarly between right and left sides. The amplitude of right-sided supraspinatus and infraspinatus electromyography revealed that the

right side did not lose more function than the left side three months and nine months after surgery, which indicated less loss of function in the supraspinatus and infraspinatus muscles after SCN transfer.

•Line 256: I am not a native English speaker, but I recommend using “However” instead of “But” here. Figure 1: this figure title is not appropriate. I think that a figure title is usually not a complete sentence. Figure 7: please provide the result of electromyography in another way that makes this easier to understand than that in the current version.

Response: Thank you for your suggestion. It has been changed according to your recommendations in the revised manuscript. However, the location of the branches from the cervical nerve is often not constant.