BMC Surgery

RESEARCH

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Excision of large median and ulnar nerve schwannomas: a case series

Chih-Hsun Chang[1,2,3], Jung-Pan Wang[4,5], Yi-Chao Huang[4,5], Cheng-Yu Yin[4,5], Kuang-Hung Chen[6] and Hui-Kuang Huang[3,4,5,7*]

Abstract

Objective Schwannomas are benign, slow-growing tumors originating from Schwann cells in peripheral nerves, commonly affecting the median and ulnar nerves in the forearm and wrist. Surgical excision is the gold standard treatment. This study presents our treatment strategies and outcomes for large-sized ulnar and median nerve schwannomas at the forearm and wrist level.

Methods From 2012 to 2023, we enrolled 15 patients with schwannomas over 2 cm in size in the median or ulnar nerve at the forearm and wrist. The study included 12 patients with median nerve schwannomas (mean age: 61 years) and 3 with ulnar nerve schwannomas (mean age: 68 years), with a mean follow-up of 26.9 months.

Results After surgery, all patients with median nerve schwannomas experienced mild, transient numbness affecting fewer than two digits, resolving within six months without motor deficits. Ulnar nerve schwannoma excision caused mild numbness in two patients, also resolving within six months, but all three developed ulnar claw hand deformity, which persisted but improved at the last follow-up. Despite this, patients were satisfied with the surgery due to relief from severe tingling pain.

Conclusions Schwannomas of the median, ulnar, and other peripheral nerves should be removed by carefully dissecting the connecting nerve fascicles to avoid injury to healthy ones. Sensory deficits may occur but are unlikely to significantly impact quality of life. However, in motor-dominant nerves like the ulnar nerve, there is a risk of significant motor deficits that could affect hand function, though not completely. Therefore, thorough preoperative discussion and consideration of interfascicular nerve grafting are essential.

Keywords Median nerve, Neurilemmoma, Schwannoma, Surgical technique, Unar nerve

*Correspondence:
Hui-Kuang Huang
huikuanghuang@gmail.com
[1]Department of Orthopedics, National Cheng Kung University Hospital, Tainan, Taiwan
[2]College of Medicine, National Cheng Kung University, Tainan, Taiwan
[3]Department of Orthopaedics, Ditmanson Medical Foundation Chiayi Christian Hospital, 539, Zhongsiao Road, Chiayi 60002, Taiwan
[4]Department of Orthopaedics & Traumatology, Taipei Veterans General Hospital, Taipei, Taiwan
[5]Department of Surgery, School of Medicine, National Yang Ming Chiao Tung University, Taipei, Taiwan
[6]Medical Integration Center, Ditmanson Medical Foundation Chiayi Christian Hospital, Chiayi, Taiwan
[7]Department of Food Nutrition, Chung Hwa University of Medical Technology, Tainan, Taiwan

Introduction

Schwannoma is a benign and slowly-growing tumor that arises from the Schwann cells of peripheral nerves. Percussion of the tumor can induce a tingling sensation in the tumor and may radiate along the distribution of the involved nerve if that nerve is sensory or mixed. These types of nerves also account for the largest percentage of schwannoma origins, compared to motor nerves. In the upper extremity, schwannomas frequently occur on the flexor side, possibly due to the dense concentration of nerve fibers in that region. The median and ulnar nerves at the wrist are most commonly involved. Surgery is the mainstay in the treatment of schwannomas [1–3]. Based on our experience with large schwannomas exceeding 2 cm in longitudinal diameter in the upper extremities, and supported by insights from existing literature, we present our treatment strategies and surgical outcomes.

Methods

This retrospective chart review study was conducted at a single institution, with the study protocol reviewed and approved by the institution's ethics committee.

From 2012 to 2023, we enrolled cases of schwannomas exceeding 2 cm in size in the median or ulnar nerve at the forearm and wrist level that underwent surgical excision, with a follow-up of at least 12 months after surgery. All surgeries were performed by a single hand surgeon (experience level III – experienced specialist) [4].

We excluded patients who had undergone any biopsy or previous surgical procedure for the schwannoma, as well as those with schwannomas located beyond the forearm and wrist level. Patients without regular follow-up within the first 12 months postoperatively were also excluded.

Approach strategies and surgical techniques

1. To determine that the tumor originates from a major nerve, imaging should confirm the presence of the tumor rising from the nerve. MRI is primarily recommended as it typically displays the tumor as hypointense in T1-weighted images and hyperintense in T2-weighted ones [5]. However, a heterogeneous appearance on MRI, with signs of degeneration and cystic cavitations, is not uncommon in schwannomas, especially in larger ones (Fig. 1) [6, 7]. In addition, on axial T2-weighted images, most of the nerve fascicles can be seen passing by the side of the tumor.

2. During surgery, if the tumor is a schwannoma, it can typically be well identified during the approach, and resection can proceed without the need for a frozen biopsy. However, if the nature of the tumor requires pathological confirmation, I recommend that further investigation be conducted within a few days to avoid complications from the initial surgical scar and adhesion formation. It is crucial to provide a thorough explanation beforehand, especially if there is a possibility of nerve resection, as in the case of neurofibroma, to ensure the patient understands the potential loss of nerve function following the surgery.
3. In forearm or wrist tumor excisions, the use of an arm tourniquet can be beneficial. While

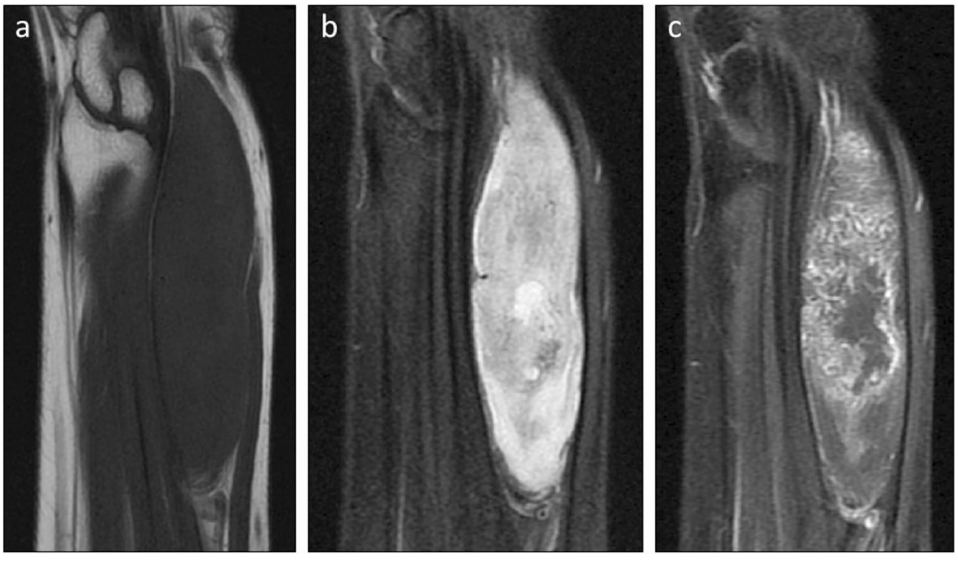

Fig. 1 The typical magnetic resonance (MR) mage iof the large-sized wrist level median nerve schwannoma showed **a**) hypointense on T1-weighted image; **b**) Heterogeneous appearance on T2-weighted image; and **c**) more obvious cystic cavitation on Fat-saturated contrast-enhanced T1-weighted images

exsanguination is typically advantageous for surgeries employing a tourniquet, based on our experience, we do not recommend exsanguination. Instead, we suggest the use of upper limb elevation to reduce blood in the circulating vessels. Retaining some blood in the vessels can assist in distinguishing small nerve fascicles from the vessels.

4. For the resection of large-sized schwannomas, a more comfortable anesthetic method is advisable. We recommend general anesthesia, as it allows surgeons to work at their own pace without being disturbed by the patient's movements.
5. In large tumors, the main nerve trunk often gets displaced to the side. It's generally safer to incise the epineurium on the side opposite to the nerve trunk to protect most nerve fascicles [8]. However, some fascicles might stretch over the tumor's surface, potentially being mistaken for fascial bands or vessels. Preoperative percussion on the tumor is crucial. If a sensory nerve fascicle is stretched atop the tumor, percussion may produce a tingling sensation specific to the affected digit(s), differentiating it from generalized tingling pain from the tumor. Surgeons should be careful in these regions to avoid harming any stretched fascicles (Fig. 2).
6. When removing the tumor, it's essential to carefully peel off any membrane-like layer covering the solid tumor, likely representing the tented epineurium. This procedure can minimize the risk of injuring non-involved nerve fascicles. We believe that most nerve function deficits may arise from inadvertently resecting the non-involved fascicles that still overlay

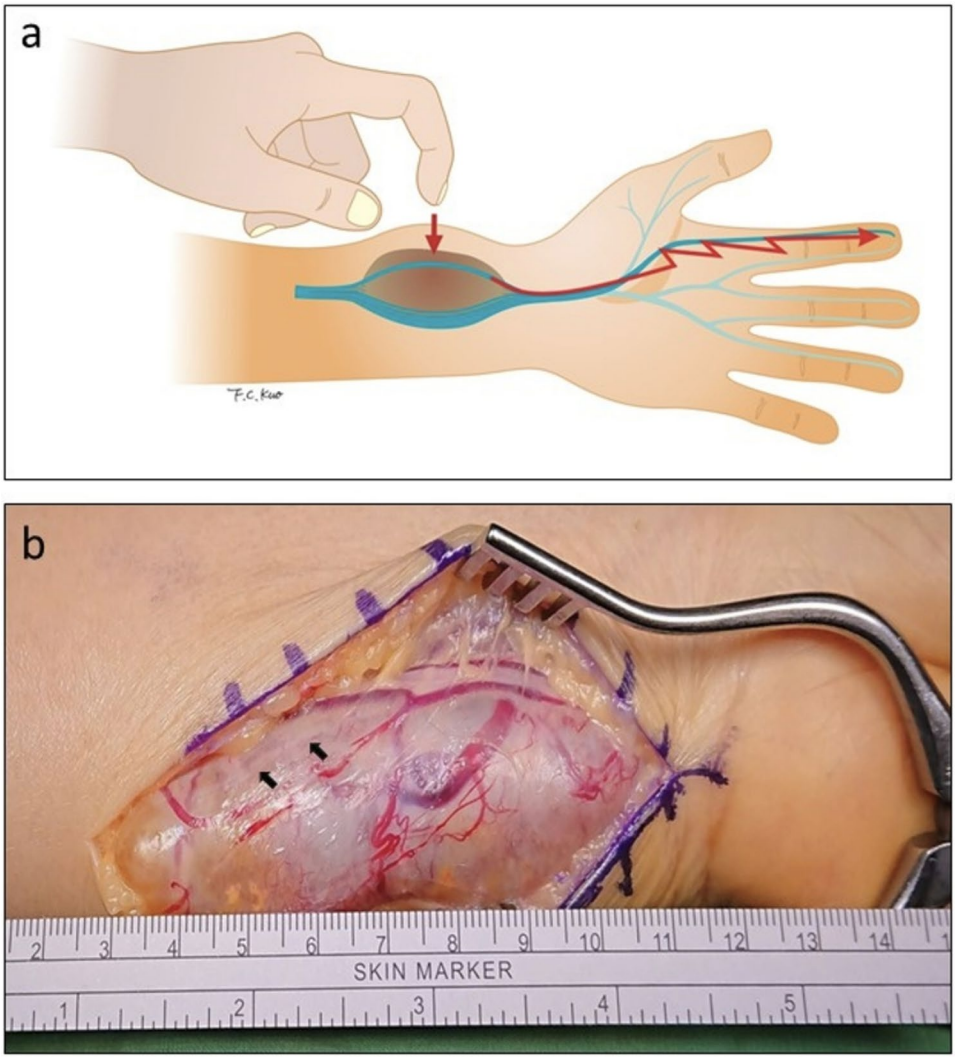

Fig. 2 **a**) An evident Tinel sign radiating to a single digit may suggest the presence of a distinct nerve fascicle on the upper surface of the schwannoma; **b**) The arrow highlights the location of the preoperative Tinel sign related to the index finger, where a nerve fascicle was subsequently identified during surgery

the tumor. Nerve stimulation can play an important role in identifying the motor component fascicles. However, the use of a tourniquet during surgery for a longer duration or the use of muscle relaxants, even for a short-term effect during intubation, can still potentially affect subsequent nerve stimulation results.

7. A significant number of schwannomas arise from a nerve fascicle. Upon meticulous separation from adjacent nerve fascicles and the epineurium, it is evident that the tumor stems from a specific fascicle. As this affected fascicle constitutes only a minor segment of the main trunk, its removal typically leads to minimal functional consequences. However, we commonly advise bridging the cut ends to neighboring nerve fascicles via end-to-side coaptation. This approach could potentially enhance recovery, particularly in sensory functions, and might also decrease the risk of traumatic neuroma (Fig. 3) [9–11].

8. Postoperative hemostasis is important, and drainage should be considered in cases of uncertain minimal oozing or delayed bleeding. After mass elimination, rebounding soft tissue swelling and any blood accumulation can lead to complications from mass effect, causing numbness or paralysis of the innervated muscles. Agents to reduce swelling, such as steroids, can be considered if there are no contraindications.
9. We must always consider the possibility of a neurofibroma, even with detailed imaging studies. This type of tumor cannot be removed with epineurium opening and marginal excision alone. It is essential to inform patients about this possibility and that there might be a need for immediate nerve grafting or reconstruction after the tumor excision, or a later-stage nerve or functional reconstruction [12, 13]. The potential for postoperative functional loss following excision should be thoroughly discussed and understood by the patient before surgery.

Results

There were a total of 12 patients with median nerve schwannomas (mean age: 61 years, range: 35–73 years) and 3 patients with ulnar nerve schwannomas (mean age: 68 years, range: 53–83 years). All the tumors were located between the mid-forearm and wrist level. For the median nerve schwannoma group, the mean pre-operative Kapandji score for thumb opposition was 9.6 (range, 8–10). In the ulnar nerve schwannoma group, all three patients tested negative for the Froment test and Wartenberg's sign before surgery. The mean follow-up duration was 26.9 months (range: 12–58 months). No tumor recurrence was noted at the last follow-up of all patients based on sonography evaluation.

Before surgery, no neurogenic deficits were noted in all the patients. Postoperatively, all patients with median nerve schwannomas experienced mild numbness, affecting fewer than two digits within the median nerve dermatome in each case, with no instances of motor deficit. All patients were able to reach their preoperative Kapandji scores at the one-month postoperative check-up. The numbness can improve to none within six months of follow-up. The excision of ulnar nerve schwannomas also resulted in mild numbness in two of the three patients over the ulnar-innervated digits, which can recover within six months after surgery. However, the ulnar claw hand deformity appeared in all three cases, with positive Froment test and Wartenberg's sign. While the numbness improved at the one-year follow-up, the ulnar claw deformity improved somewhat but was still present, and still had a positive Froment test and Wartenberg's sign. Despite this, the patients were still satisfied with the surgery, as the ulnar claw had less impact on their lives than the severe tingling pain associated with the large schwannomas.

Discussion

In this study, we present our approach and surgical techniques for managing large-sized schwannomas arising from the median and ulnar nerves. We would like to highlight and discuss not only the surgical technique but also the approach and treatment strategy for these large-sized schwannomas.

Based on our results and the literature [1, 2, 8, 12, 14], although neurological deficits are likely after the excision of schwannomas in the extremities, the sensory component of these deficits appears to have minimal impact on function and quality of life, both immediately postoperatively and after recovery. Therefore, we suggest that when the tumor arises in the sensory-dominant part of the nerve, such as the median nerve at the wrist level, the method of pure nerve fascicle division to excise the tumor alone, or our method of coaptation with the nearby fascicles, would both be advisable.

However, for the three patients in our study with ulnar nerve schwannomas at the distal forearm or wrist level, all developed motor neurological deficits, specifically presenting with ulnar claw hand deformity. Although sensory deficits were present, they were mild and did not become a significant issue. In contrast, the motor deficits had a lasting impact, despite patient satisfaction from the relief of severe Tinel's pain caused by the tumor and thorough pre-operative explanations. While the ulnar claw

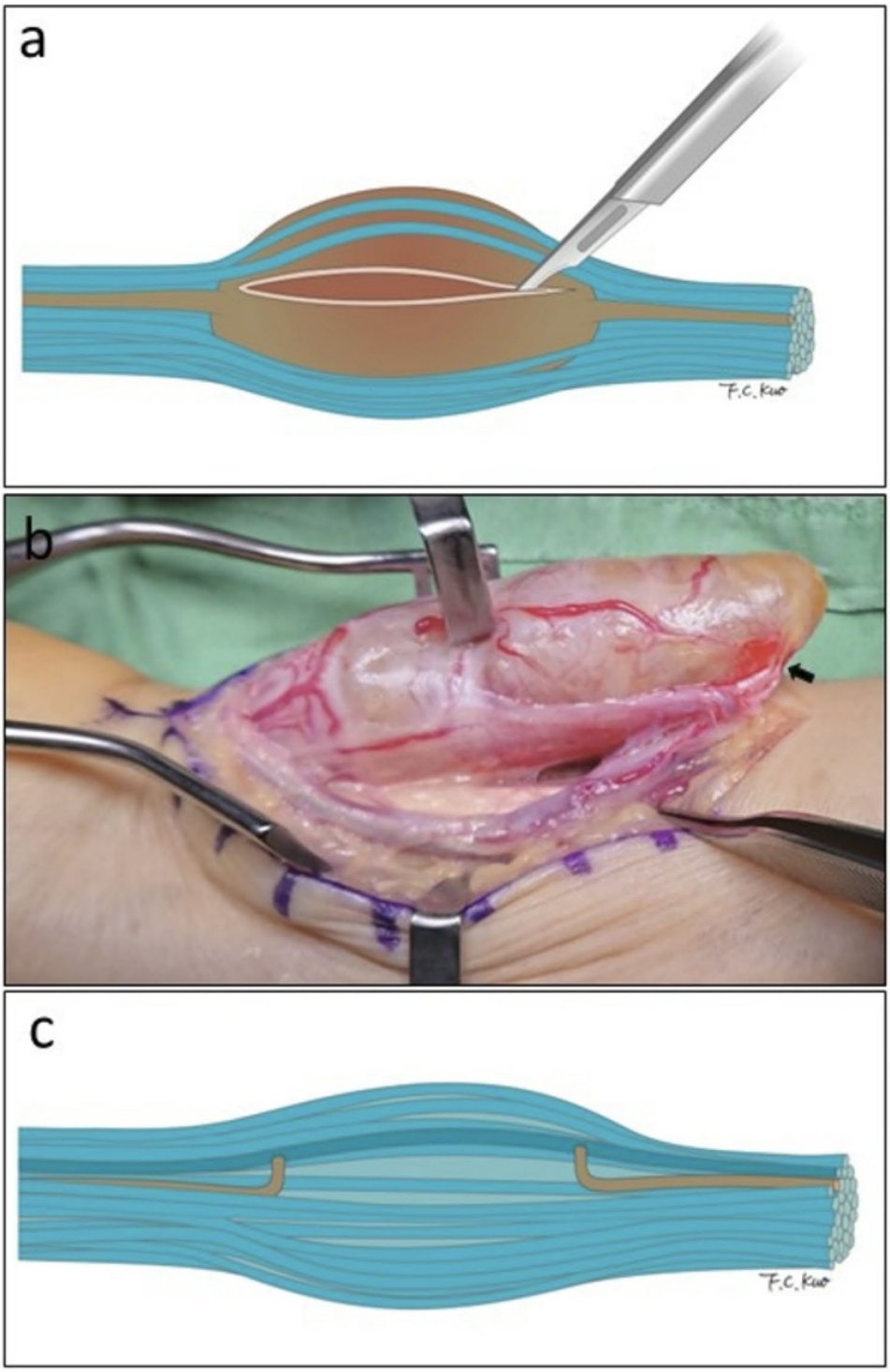

Fig. 3 **a**) Ensure the epineurium incision is made on the opposite side of the nerve trunk; **b**) As indicated by the arrow, the tumor is connected to a single nerve fascicle. The tumor can be removed from the nerve fascicle only when that specific fascicle is isolated; **c**) The severed end of the nerve fascicle can be microsurgically sutured to an adjacent nerve fascicle

deformity may improve over time, fine motor function remains affected to some degree.

Given the critical importance of motor function in nerves such as the radial, ulnar, sciatic, and peroneal nerves, incorporating interfascicular nerve grafting, as suggested by Tan et al., may enhance motor function recovery. While intraoperative nerve stimulation can help identify motor or sensory fascicles, accurately

distinguishing between them remains challenging in our experience. Dissecting the nerve fascicle proximally and distally for isolation might allow for more precise stimulation, reducing the risk of electrical contamination to nearby fascicles and leading to clearer topographical identification. However, we do not recommend extensive dissection, as it may unnecessarily compromise the nerve's circulation. This is why we suggest considering direct interfascicular nerve grafting. However, if an autograft is used, the potential sensory deficit at the donor site remains a concern. Therefore, the actual benefits of nerve grafting for improved motor function recovery warrant further investigation.

The preoperative explanation is very important, including the possible associated treatments in cases of malignancy or other neurogenic tumors, as well as potential sensory or motor impairments related to surgical excision. This is especially critical for the ulnar nerve, as significant tumor-related ulnar claw deformities have occurred in our experience. However, tumor excision is still recommended despite potential complications. This is because the continued growth of the tumor is likely to cause more symptoms, and ultimately, excision will still be necessary.

The limitations of this study include its retrospective nature, small sample size, and lack of long-term follow-up for all cases. The number of cases in the ulnar nerve group is particularly low. Additionally, we did not include schwannomas of other peripheral nerves or those located beyond the forearm and wrist level, in order to focus on specific outcomes; however, this limits the generalizability of the findings to all schwannomas. Furthermore, patients who underwent interfascicular nerve grafting were not included in this study, as there is no comparison between nerve coaptation to nearby fascicles and grafting methods. This is also a limitation of the study and highlights the need for further investigation.

A large schwannoma of the median, ulnar, or other peripheral nerves warrants surgical excision. It is not uncommon for a large tumor to appear heterogeneous on MRI. Careful planning for tumor resection and potential nerve or soft tissue reconstruction is essential, especially if the tumor's nature extends beyond a schwannoma. For schwannomas located on the distal peripheral nerve, the tumor can be separated from the nearby uninvolved nerve fascicles by meticulously peeling the epineurium and adjacent nerve fascicles away from the tumor. The tumor can only be removed by dissecting the single connecting nerve fascicle once it is fully exposed.

Acknowledgements
We thank Fang-Chun Kuo from Ditmanson Medical Foundation Chiayi Christian Hospital for the original artwork in Figs. 2 and 3. In addition, we thank the help from the Clinical Data Center, Ditmanson Medical Foundation Chia-Yi Christian Hospital for providing administrative and technical support. This study is based in part on data from the Ditmanson Research Database (DRD) provided by Ditmanson Medical Foundation Chia-Yi Christian Hospital. The interpretation and conclusions contained herein do not represent the position of Ditmanson Medical Foundation Chia-Yi Christian Hospital.

Author contributions
H.K.H. performed the operations. C.H.C. and H.K.H. drafted the manuscript. J.P.W., Y.C.H., and C.Y.Y. reviewed the data and completed the analysis. J.P.W., Y.C.H., and K.H.C. critically revised the manuscript. All authors have read and approved the manuscript.

Funding
This study was not supported.

Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The research procedures complied with the ethical standards outlined in the Approval Letter from the Institutional Review Board of Ditmanson Medical Foundation Chia-Yi Christian Hospital (IRB No. 2024070). The Ethics Committee granted a waiver of informed consent for the patients.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 11 August 2024 / Accepted: 23 September 2024
Published online: 03 October 2024

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