Nerve Reconstruction with Sural Nerve Graft in Low-Resource Setting

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ABSTRACT

Introduction: Nerve reconstruction is an essential procedure in the management of nerve damage. When end-to-end primary repair is not possible, an autologous nerve graft is the gold standard for management. The sural nerve is considered the most reliable harvest site. Compared to other reconstructive options, autograft provides the best similar physiologic nerve environment for axonal regeneration. To achieve an effective neural regeneration, tension-free repair sites should be provided, as they hinder focal neural ischemia caused by disrupted microvascular flow. **Case:** A 52-year-old woman with a giant schwannoma of the ulnar nerve had a tumor excision surgery followed by sural nerve grafting in a low-resource setting where microsurgery equipment is unavailable. Maluku, with archipelago-type geography, poses significant challenges to healthcare professionals in performing guideline-based procedures. **Conclusion**: Considering the unavoidable risk of nerve damage and significant gap, tumor excision followed by nerve reconstruction using autograft was chosen in this case, resulting in a decent outcome.

Keywords: Case report, low-resource setting, nerve reconstruction, schwannoma, sural nerve graft.

ABSTRAK

Pendahuluan: Rekonstruksi saraf merupakan prosedur yang penting dalam tata laksana kerusakan saraf. Jika perbaikan primer ujung-ke-ujung saraf tidak memungkinkan, cangkok saraf autolog merupakan penanganan yang paling baik. Nervus suralis dianggap sebagai lokasi pengambilan *graft* yang paling dapat diandalkan. Dibandingkan berbagai pilihan tindakan rekonstruktif lainnya, *autograft* menyediakan lingkungan fisiologis serupa untuk saraf yang paling baik untuk regenerasi akson. Untuk mencapai regenerasi saraf yang efektif, kondisi perbaikan yang bebas tegangan sebaiknya diterapkan karena tegangan menyebabkan iskemia saraf fokal yang disebabkan oleh gangguan aliran darah mikrovaskular. **Kasus**: Seorang wanita berusia 52 tahun dengan schwannoma berukuran besar pada nervus ulnaris menjalani operasi eksisi dilanjutkan dengan cangkok nervus suralis di rumah sakit dengan sumber daya terbatas di mana peralatan bedah mikro tidak tersedia. Maluku dengan geografi kepulauannya memberikan tantangan signifikan bagi para tenaga kesehatan profesional dalam mempraktikkan prosedur berbasis rekomendasi ilmiah. **Simpulan**: Pada kasus ini, mempertimbangkan risiko cedera saraf yang tidak dapat dihindari dan celah yang signifikan, eksisi tumor dilanjutkan dengan rekonstruksi saraf menggunakan *autograft* dipilih pada kasus ini, dan menghasilkan luaran yang baik. **Rekonstruksi Saraf dengan *Graft* Nervus Suralis di Daerah dengan Sumber Daya Terbatas. Rabinda Fitriana Tuasikal, Rakha Sulthan Salim, Mo Tualeka.**

Kata Kunci: Laporan kasus, daerah dengan sumber daya terbatas, rekonstruksi saraf, schwannoma, cangkok nervus suralis.

INTRODUCTION

Peripheral nerve damages are common in clinical practice.[1,2] Tension-free end-to-end primary repair is the optimal method for nerve reconstruction, whether by traumatic or iatrogenic cause.[3,4] Whenever a long gap persists and a tension-free repair cannot be achieved, autografts are the gold standard in nerve-bridging technique.[1,2,5-7] To acquire a low-morbidity autograft, sensory nerves are frequently used as the donor nerves, with the sural nerve as the most reliable source, as it is a pure sensory nerve and provides substantial length for nerve bridging. The nerve is also anatomically easy to access with specific markers and usually found in the same location.[5,7,8]

Optimum management requires proper modalities for diagnosis, treatment, and evaluation. Ultrasonography and magnetic-resonance imaging are mainly used to diagnose and differentiate nerve sheath tumors from other neoplasms preoperatively; microsurgery instruments are needed for the nerve reconstruction procedure; and continuous follow-up is required to determine the outcome.sitasi? In low-resource settings like Central Maluku, diagnostic equipment is limited, microsurgery instruments are unavailable, and the archipelago-type of geography poses difficulty for follow-up, so this case becomes a major challenge for our institution.

CASE

A 52-year-old right-handed female came to the outpatient clinic with a soft-tissue mass at her left elbow for 18 months. No neurological complaints or history of trauma were documented. The patient felt significant enlargement and discomfort with slight

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pressure. Clinical examination showed a solid mass, mobile, and palpated 5 x 4 cm in dimension. Range of motion was within normal limits with normal motor strength. A plain x-ray was the only radiological modality, which showed a soft tissue mass without central lucency in the brachium region. Other modalities such as USG and MRI were not available in the area. The diagnosis is soft tissue tumor of the left elbow, and it was scheduled for surgical tumor excision.

During surgery, a longitudinal incision was made, and a nerve sheath tumor of the ulnar was discovered macroscopically (**Figure 1**). The tumor was released from surrounding tissue to achieve a clear view of the proximal and distal ends of the tumor; its dimensions were 7 cm in length, 6 cm in width, and 5 cm in height (**Figure 2**). Considering the size of the tumor and limited equipment, it was nearly impossible to dissect the tumor without injuring the nerve trunk and fascicles. Thus, the procedure was temporarily sustained, and the incision was closed for further discussion regarding the need for a nerve graft and its neurological effects with the patient and family.

Figure 1. Intraoperative photograph showing a giant schwannoma of the ulnar nerve.

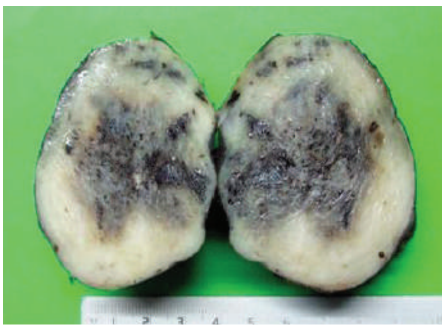

Figure 2. Longitudinal incision of the mass showing solid mass with yellowish cystic area and brown dots. The mass was 7 x 6 x 5 cm in dimension.

Tumor excision with sural nerve graft was decided as the best procedure to remove the tumor while retaining ulnar nerve function. The surgery was performed under general anesthesia in the supination position with slight lateral rotation. The previous skin incision was opened, the tumor was presented, and it was prepared to be excised.

The procedure continued with sural nerve harvesting from the ipsilateral extremity assisted with a 2.5x magnification loupe (**Figure 3**). The ipsilateral knee was flexed and positioned to place the lateral aspect of the leg in an accessible view. Skin marking was drawn approximately 2 cm posterior to the lateral malleolus, and an incision was made proximally. Dissection performed and nerve structure identified. A desired 16 cm long sural nerve was harvested to bridge a 7 cm ulnar nerve gap with a two-cabled structure. The next step is to mark the distal end of the harvested sural nerve. Bleeding was controlled, and the incision was closed with two-layer sutures.

Figure 3. Open technique for harvesting the sural nerve of the ipsilateral extremity. Black arrow indicating the sural nerve.

(Figure 1-3 documentation by Rabinda Fitriana Tuasikal)

The procedure was continued to tumor excision and nerve reconstruction. The healthy nerve fascicles at both ends were identified, and sharp dissection was performed to carefully excise the tumor. The harvested sural nerve was divided equally into two cables. Grafting of two-cabled 8 cm length nerves was performed using 6-0 nylon under a magnification loupe; tension-free grafting with maximum range of motion was then ensured. The wound was closed in two-layer sutures, and the tumor sample was sent for histological examination. Post-operatively, the patient was discharged after 3 days. Neurological examination showed anesthesia of the 4th and 5th fingers, pain and tingling sensation, and loss of muscle strength at the distribution of the ulnar nerve. Evaluation of the donor site also showed sensory deficit in the area of the sural nerve innervation.

Evaluation at one and three months after grafting showed improvement of the motor function of the ulnar nerve, documented by the ability of full flexion for fingers 4 and 5, wrist flexion and adduction, minimal claw hand posture in resting position, and slight improvement in adduction-abduction of digits. In general, the strength of the muscles innervated by the ulnar nerve is 3/5. Paresthesia and cold sensitivity were reduced at the ulnar nerve distribution, while deep and superficial sensibilities remain. The histopathological examination result was schwannoma of the ulnar nerve. The patient is arranged for routine evaluation.

DISCUSSION

In cases of nerve damage where tension-free primary repair is not possible, autograft is considered the gold standard in bridging peripheral nerve defects.[2,5] Compared to other reconstructive options, autograft provides the best similar physiologic nerve environment for axonal regeneration. To achieve effective neural regeneration, tension-free repair sites should be provided, as they hinder focal neural ischemia caused by disrupted microvascular flow.[6]

This case describes a surgically diagnosed nerve sheath tumor. Initial evaluation showed a mobile lump mass at the left elbow without Tinel sign and paresthesia. Ultrasonography can be used as the first diagnostic alternative, while MRI is considered the best modality for pre-operative diagnosis of nerve sheath tumors. Lack of typical neurological symptoms and such imaging modalities make the diagnosis difficult.[9] In a study by Ozdemir, *et al*., of 14 histologically confirmed schwannoma cases, only 5 cases were correctly diagnosed pre-operatively despite the use of USG; the others were misdiagnosed as other soft tissue masses such as lipoma, ganglion, fibroma, and xanthoma.[10]

In a low-resource area where microsurgery equipment is unavailable, a giant schwannoma was extremely difficult to enucleate, and 7

cm of nerve damage was unavoidable; and considering the gap, it is nearly impossible to primarily repair without tension in the suture site. Autograft is chosen, as it is recommended for gaps longer than 5 cm.[6]

Several reports on schwannoma were excised, even in fully sophisticated settings. In a retrospective study by Xinwei Li, *et al.*, on 92 cases of peripheral nerve schwannomas, microsurgery removal was performed using the intraoperative monitoring (INM) technique.[11] Nerve sheaths of suspected malignant tumors with the possibility of recurrence are best to be excised. The risk of nerve damage during tumor removal, particularly with large-sizedtumors, is unavoidable.[11] In our area, where certain diagnosis cannot be achieved and the enucleation process has a high risk of hemostasis issues, tumor excision followed by a nerve graft procedure is chosen.

The sural nerve is the preferred donor site for nerve grafts; it is mainly because it constitutes a purely sensory nerve, has lower morbidity, and anatomically provides 30-50 cm of nerve length for cabled fashion grafts.[8,12] The sural nerve originates from the L4-S1 roots and is a union of the lateral and medial cutaneous sural nerves, which are branches of the common peroneal and posterior tibial nerves, and courses obliquely to the posterior aspect of the lateral malleolus.[12]

Matsuyama, *et al.*, wrote in their review that bigger diameter nerve grafts are more susceptible to microvascular deprivation, resulting in central necrosis and poor axonal regeneration; therefore, a cabled fashion graft was chosen to produce a superior outcome.[8] This case used two cables of sural nerve graft for a greater chance of success. A clinical series by Lai, *et al.*, on 14 schwannoma patients presents three cases with nerve reconstruction using two cables of sural nerve.[13]

This case used a 16 cm ipsilateral sural harvest to cover a 7 cm-long gap in 2 cabled-fashion grafts. The length of the harvest was determined by adding a minimum of 10% defect length to ensure complete tension-free repair in the maximum-flexed extremity. A 6-0 nylon was used as the smallest suture available, assisted with loupe magnification. Other studies suggested 9-0 to 10-0 suture assisted with loupe or microsurgery for grafting.[8,13]

Follow-up after one month showed great improvement in ulnar motor function assessment. A study from Flores, *et al.*, with 20 cases of nerve grafting at the proximal ulnar nerve showed that 11% of the patients had 3/5 motor strength at the 28-month evaluation.[14] Ulnar sensory deficits was observed in this patient, while gradual reduction is expected as reported from the case series by Lai, *et al.*, which showed gradual sensory improvement.[13]

The patient has a sensory deficit along sural nerve innervation sites, which is the expected complication of the procedure. A systematic review by Bamba, *et al.*, reported that sensory deficit was the most frequent complication of the nerve harvest, but it gradually reduced with time. A case series of 214 patients by Ducic, *et al.*, shows sensory deficit exists in 92.8% of cases.[5] Buena, *et al.*, suggest that the sensory deficit was not classified as a complication but as the consequence of the procedure, and over time, collateral sprouting will improve the sensory function.[12] A prospective study of 38 subjects also described significant reduction of sensory deficit within 3 to 6 months after sural nerve harvest.[15] Another study by Hallgren, *et al.*, in 41 patients who underwent sural nerve graft harvest concluded that this nerve reconstruction procedure is safe and results in mild residual complication.[16] Despite persistent sensory deficit, this patient has no complaint in functional activity. This is in accordance with a study by Tada, *et al.*, which found that in sural nerve harvest, functional impairment was mild.[17]

This report has a limitation regarding the follow-up duration. Continuous evaluation is difficult in this area regarding the archipelago type of geography and lack of network coverage. The patient is susceptible to loss to follow-up.

CONCLUSION

This case highlights that nerve reconstruction performed in low-resource areas can result in a good outcome. Healthcare workers should be skillful and be able to adjust to existing conditions while still prioritizing treatment principles and clinical team ability, as well as the circumstances, outcome, morbidity, and limitation of the patient.

DISCLOSURES

Ethical Consideration

The patient had been informed and signed the consent regarding publishing the case in an academic journal without exposing her identity.

Conflict of Interest

The authors affirm no conflict of interest in this study.

Author Contribution

All authors contributed equally in the writing and revision process of this publication.

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REFERENCES

1. Dahlin LB, Wiberg M. Nerve injuries of the upper extremity and hand. EFORT Open Rev. 2017;2(5):158-70. doi: 10.1302/2058-5241.2.160071.
2. Beris A, Gkiatas I, Gelalis I, Papadopoulos D, Kostas-Agnantis I. Current concepts in peripheral nerve surgery. Eur J Orthop Surg Traumatol. 2019;29(2):263-9. doi: 10.1007/s00590-018-2344-2.
3. Kornfeld T, Vogt PM, Radtke C. Nerve grafting for peripheral nerve injuries with extended defect sizes. Wiener Medizinische Wochenschrift 2019;169(9):240-51. doi: 10.1007/s10354-018-0675-6.
4. Boyd KU, Nimigan AS, Mackinnon SE. Nerve reconstruction in the hand and upper extremity. Clin Plast Surg. 2011;38(4):643-60. doi: 10.1016/j.cps.2011.07.008.

5. Ducic I, Yoon J, Buncke G. Chronic postoperative complications and donor site morbidity after sural nerve autograft harvest or biopsy. Microsurgery. 2020;40(6):710-6. doi: 10.1002/micr.30588.
6. Sachanandani NF, Pothula A, Tung TH. Nerve gaps. Plast Reconstr Surg. 2014;133(2):313-9. doi: 10.1097/01.prs.0000436856.55398.0f.
7. Griffin JW, Hogan MV, Chhabra AB, Deal DN. Peripheral nerve repair and reconstruction. J Bone Joint Surg Am. 2013;95(23):2144-51. doi: 10.2106/JBJS.L.00704.
8. Matsuyama T, Mackay M, Midha R. Peripheral nerve repair and grafting techniques: a review. Neurol Med Chir (Tokyo). 2000;40(4):187-99. doi: 10.2176/nmc.40.187.
9. Rodriguez FJ, Folpe AL, Giannini C, Perry A. Pathology of peripheral nerve sheath tumors: diagnostic overview and update on selected diagnostic problems. Acta Neuropathol. 2012;123(3):295-319. doi: 10.1007/s00401-012-0954-z.
10. Ozdemir O, Ozsoy MH, Kurt C, Coskunol E, Calli I. Schwannomas of the hand and wrist: long-term results and review of the literature. J Orthop Surg (Hong Kong). 2005;13(3):267-72. doi: 10.1177/230949900501300309.
11. Li X, Zhong G, Xu X, Wang K, Zhu Y, Qi X, et al. Surgical strategies for peripheral nerve schwannoma based on the intraoperative neurophysiological monitoring. Laparosc Endosc Robot Surg. 2019;2(3):65-9. doi:10.1016/j.lers.2019.06.001.
12. Piedra BIT, Fichman M. Sural nerve graft [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 [cited 21 Aug 2025]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK557715/.
13. Lai CS, Chen IC, Lan HC, Lu CT, Yen JH, Song DY, et al. Management of extremity neurilemmomas: clinical series and literature review. Ann Plast Surg. 2013;71 Suppl 1:S37-42. doi: 10.1097/SAP.0000000000000042.
14. Flores LP. Comparative study of nerve grafting versus distal nerve transfer for treatment of proximal injuries of the ulnar nerve. J Reconstruct Microsurg. 2015;31(9):647-53. doi: 10.1055/s-0035-1556871.
15. Martins RS, Barbosa RA, Siqueira MG, Soares MS, Heise CO, Foroni L, et al. Morbidity following sural nerve harvesting: a prospective study. Clin Neurol Neurosurg. 2012;114(8):1149-52. doi: 10.1016/j.clineuro.2012.02.045.
16. Hallgren A, Bjorkman A, Chemnitz A, Dahlin LB. Subjective outcome related to donor site morbidity after sural nerve graft harvesting: a survey in 41 patients. BMC Surg. 2013;13(1):39. doi: 10.1186/1471-2482-13-39.
17. Tada K, Nakada M, Matsuta M, Yamauchi D, Ikeda K, Tsuchiya H. Long-term outcomes of donor site morbidity after sural nerve graft harvesting. J Hand Surg Global Online. 2020;2(2):74-6. doi: 10.1016/j.jhsg.2020.01.001.