Motor Nerve Biopsy of Peroneus Longus Branch of Superficial Peroneal Nerve for Diagnosis of Motor Neuropathy

Mohamed Ibrahim[1] Latha Madhavan[1] Meenakshisundaram Umaiorubahan[2] K. Ravikumar[2] Anirudha Sharma[1] Udhistiran Subbaiyan[1] Yogeshwaran Jaishankar[1] Shyamnath Krishna Pandian[1] Vishnubabu G.[1] Balaji Dhandapani[1] G Karthikeyan[1] Rajagopalan Krishnamoorthy[1] Sridhar Krishnamoorthy[1]

[1] Institute of Craniofacial and Aesthetic Plastic Surgery, SIMS Hospital, Chennai, Tamil Nadu, India
[2] Department of Neurology, MGM Healthcare, Chennai, Tamil Nadu, India

Address for correspondence Mohamed Ibrahim B.K., MBBS, MS, MCh, Institute of Craniofacial and Aesthetic Plastic Surgery, SIMS Hospital, No 1 Jawaharlal Nehru Road, Vadapalani, Chennai, Tamil Nadu, India (e-mail: chubbydoc2000@yahoo.com).

J Peripher Nerve Surg 2025;9:103–110.

Abstract

Background Peripheral neuropathy is common among general population. Motor nerve biopsy is the only diagnostic modality which can identify the etiology of motor neuropathy. The motor nerve of gracilis and motor branch to peroneal longus are the various options available for motor nerve biopsy. Our study aims to describe the surgical technique of harvest of peroneus longus branch of superficial peroneal nerve.

Materials and Methods This is a retrospective study conducted at the Institute of Craniofacial, Aesthetic and Plastic Surgery and the Department of Neurology, SIMS Hospital, Chennai, Tamil Nadu, India. Patients with clinical suspicion of motor neuropathy who underwent motor nerve biopsy of the superficial peroneal nerve were included in the study. The surgical technique is described in detail.

Results Six patients who underwent biopsy of the motor branch of superficial peroneal nerve were included in the study. All the patients in the study group were male, belonging to the age group of 15 to 60 years with majority of the patients more than 50 years (66%). The procedure was uneventful in all the patients. Eighty-three percent of patients had more than one motor branch to peroneus longus muscle. No new postoperative neurological deficit was observed. Eighty-three percent of patients were confirmed with motor neuropathy. One patient was diagnosed as diabetic neuropathy.

Conclusion Peroneus longus motor branch of the superficial peroneal nerve is a convenient and safe alternative technique of motor nerve biopsy for diagnosing patients presenting with lower limb weakness. We have described in detail the technical details of harvesting motor branch of the superficial peroneal nerve without causing further neurological deficit.

Keywords
- motor nerve biopsy
- motor neuropathy
- superficial peroneal nerve biopsy

DOI https://doi.org/10.1055/s-0045-1814747.
ISSN XXXX-XXXX.

Thieme Medical and Scientific Publishers Pvt. Ltd., A-12, 2nd Floor, Sector 2, Noida-201301 UP, India

Introduction

Peripheral neuropathy is relatively common among general population with a prevalence of approximately 2.4% and it increases to 8% in the elderly.[1,2] Motor neuropathy (MN) results from disease of the motor nerves. A nerve biopsy is indicated when the treating physician wishes to know the pathology affecting the nerve. It is often done to look for signs of inflammation or demyelination. A pathological proof of inflammation is definite in the diagnosis of inflammatory conditions such as acute and chronic inflammatory demyelinating radiculopathies. Although the sural nerve is the commonly chosen nerve for the biopsy, it is important to remember that it is a sensory nerve and hence, pathologies affecting the motor nerve predominantly, such as the multifocal MN, can be missed by a study of the sural nerve biopsy. Various investigations like nerve conduction study, magnetic resonance imaging, ultrasonography, and immunological tests like anti-ganglioside antibodies are available, but despite these investigations a motor nerve biopsy is the only diagnostic modality which can confirm the etiology of MN.

The diagnostic accuracy is better if the nerve involved in the disease process is biopsied and examined. The diagnostic accuracy improves further, if an involved distal motor nerve is biopsied as the distal muscles are more commonly involved in MN.[3] The motor nerve of gracilis and motor branch to peroneal longus (PL) are the various options available for biopsy. Since foot drop is a common presentation of MN, we prefer to biopsy the peroneus longus branch of the superficial peroneal nerve (SPN) for confirmation of diagnosis of MN. The advantages of choosing the SPN as the site of biopsy are its familiar anatomy and the presence of at least two to three branches to peroneus longus with minimal chance of denervation.[4] There are very few articles describing the technique of harvest of PL branch of SPN. Our study aims to describe the surgical technique of harvest of peroneus longus branch of SPN.

Materials and Methods

This is a retrospective study conducted at the Institute of Craniofacial, Aesthetic and Plastic Surgery and the Department of Neurology, SIMS Hospital, Chennai, Tamil Nadu, India, from January 2022 to December 2022. Six patients with clinical suspicion of MN who underwent motor nerve biopsy of the SPN were included in the study. These patients presented to our neurology department with weakness of the lower extremity. The biopsy was suggested by the treating neurologist, as a part of evaluation for lower limb weakness in addition to the laboratory tests, radiological imaging, and electrophysiological assessment. Outpatient records, inpatient files including surgery notes, investigation reports, and histopathology findings were reviewed.

All patients were operated by a single surgeon. The surgeon examined each patient and the neurological deficits were recorded prior to surgery. The lower extremity with the more severe symptoms was chosen for biopsy. The possibility of worsening of weakness and onset of new neurological deficits after surgery were discussed with the patients. The treating neurologist was also involved in this decision-making process.

Surgical Technique

The biopsy was performed in the operation room under anesthesia. Neuromuscular blockade was avoided to facilitate intraoperative nerve stimulation to identify and confirm the target motor nerves. The procedure was performed under tourniquet control to ensure a bloodless field. Patient was placed in supine position with the knee flexed and hip internally rotated. The head and shaft of the fibula was marked. A curvilinear incision from the posterior aspect of the head of fibula which crosses the fibula neck and continues anterior to the shaft of the fibula till the middle third of the leg is made (►**Fig. 1**). Incision is deepened (►**Fig. 2**). The common peroneal nerve and the area where it pierces the deep fascia is identified (►**Fig. 3**). The deep fascia is opened at this point of entry. The peroneus longus muscle is

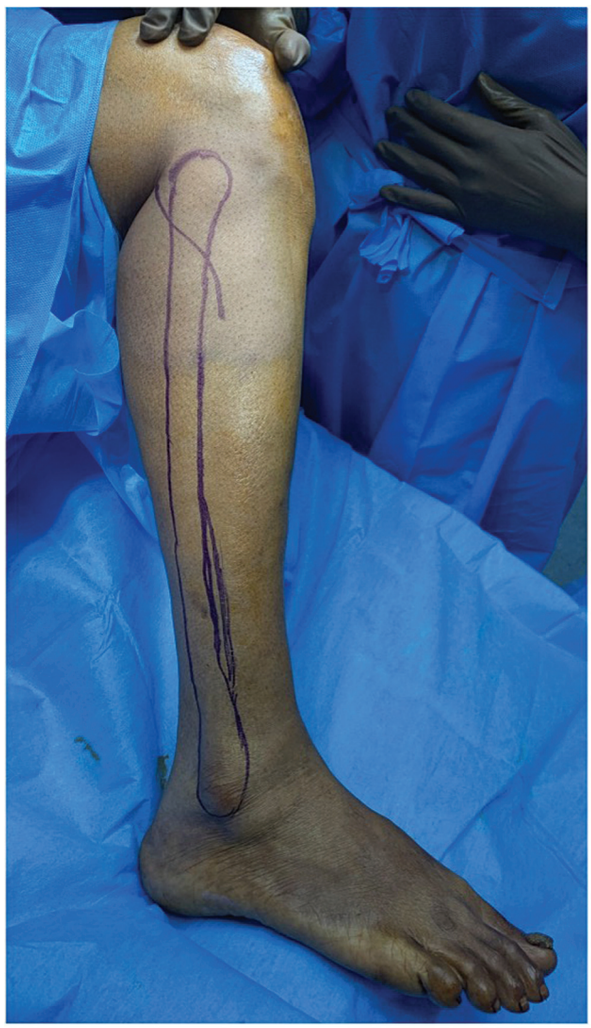

Fig. 1 Positioning of the patient and incision marking.

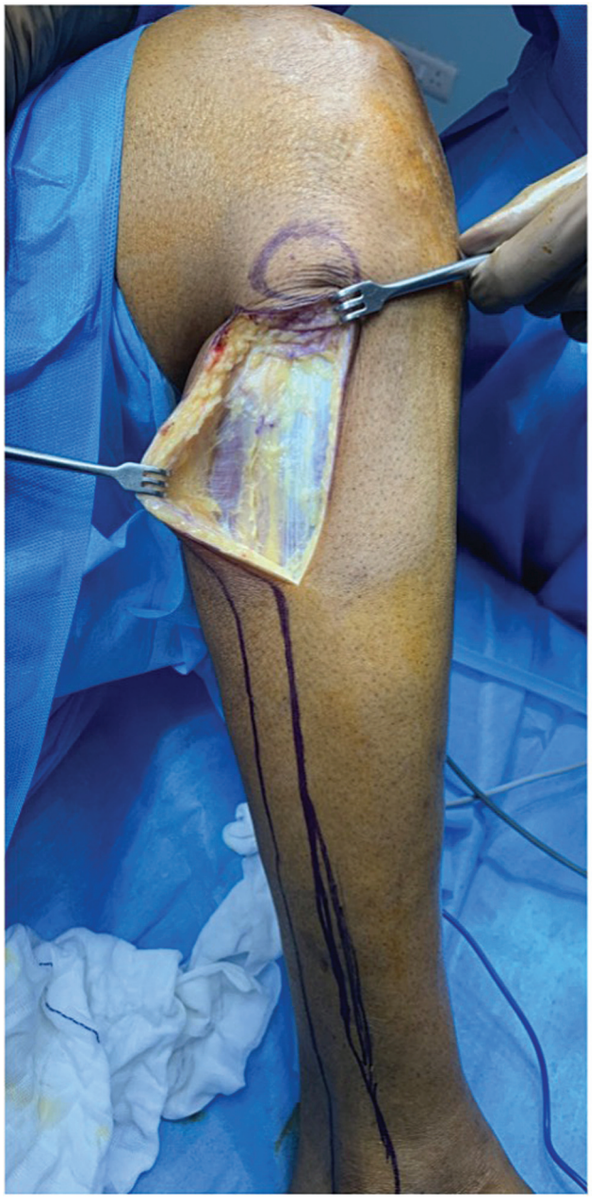

Fig. 2 Incisions deepened and peroneus longus and gastrocnemius exposed.

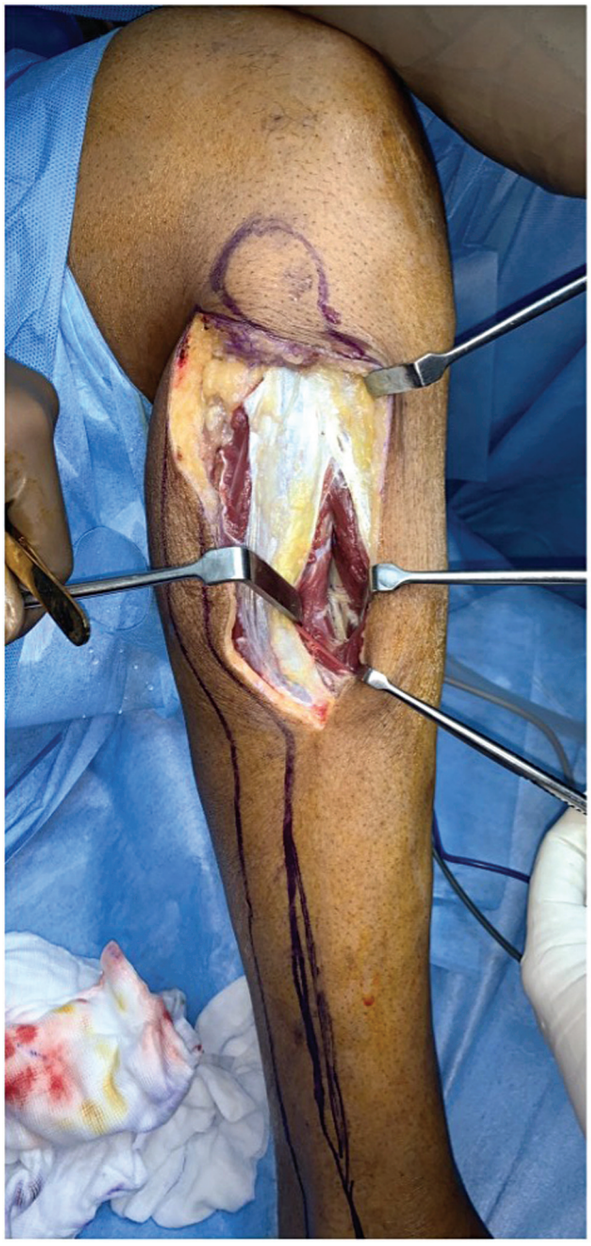

Fig. 3 Plane posterior to the peroneus longus entered to visualize the superficial branch of peroneal nerve.

identified and retracted anteriorly. Under loupe magnification the common peroneal nerve and its termination into the superficial and deep branches is visualized (►**Fig. 4**). The SPN is identified and dissected distally to identify motor branches entering the peroneus longus muscle. The muscle contraction is confirmed by intraoperative nerve stimulation using a bipolar nerve stimulator. There are at least two to three branches supplying the peroneus longus muscle. A stimulatable branch of adequate length was chosen for biopsy. If only one branch is present, intrafascicular dissection was done and a single fascicle was harvested for biopsy (►**Fig. 5**). To maximize the accuracy of the histopathological findings, at least 1 cm of the pure motor nerve should be excised. The nerve should be harvested with the vasa nervorum intact to identify signs of vasculitis. The biopsied nerve should be undamaged without any crushing of the tissues. The specimen should be preserved in glutaraldehyde solution and transported to the laboratory. Peroneus longus contraction was confirmed using nerve stimulator after biopsy. If a muscle biopsy was also required, a 2-cm long strip of peroneus longus muscle was also excised. Hemostasis was secured and the wound was closed primarily with drains (►**Fig. 6**). Gentle compression dressing was applied.

Drains were removed after 24 hours. All the patients were advised discharge the next day. Regular follow-up visits were scheduled for wound care till suture removal, which was usually done on postoperative day (POD) 10 (►**Fig. 7**).

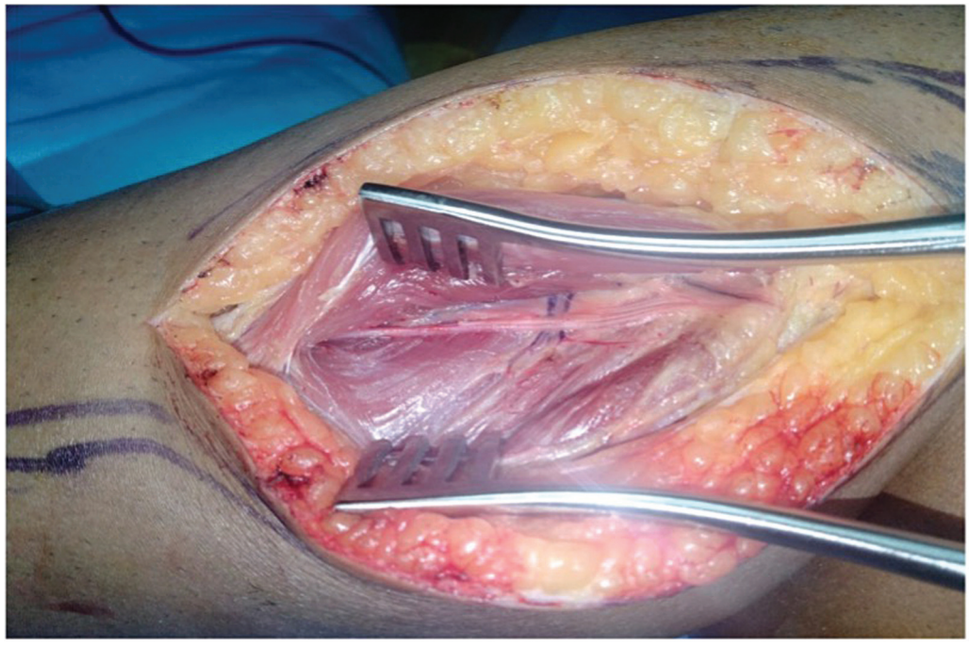

Fig. 4 Superficial peroneal nerve exposed showing single branch to peroneus longus.

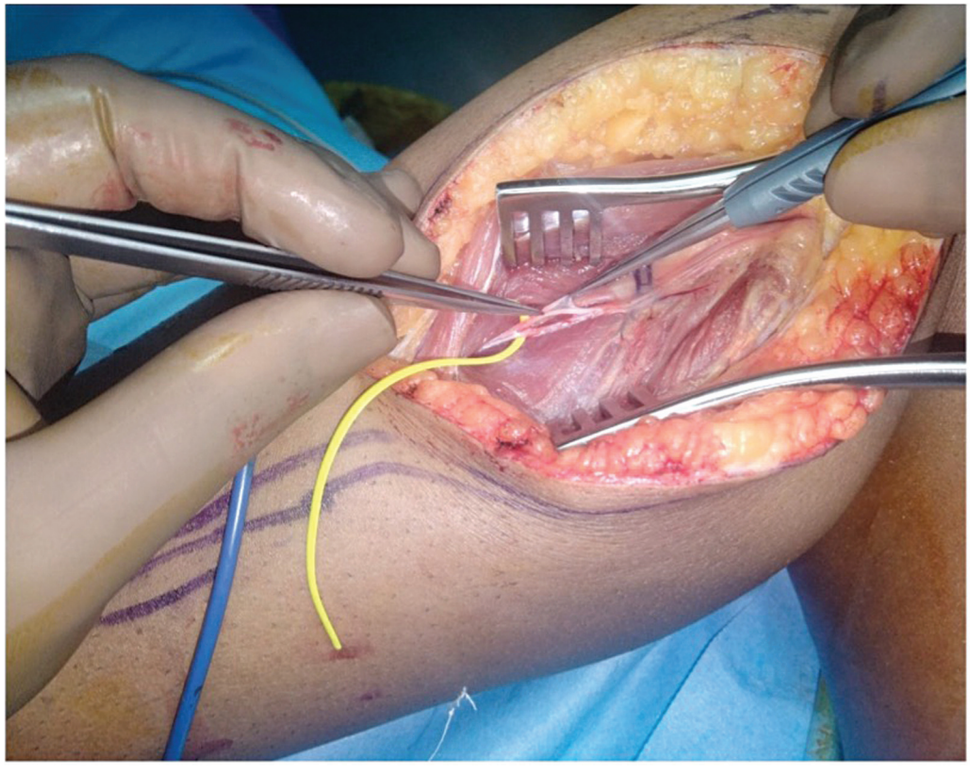

Fig. 5 Intrafascicular dissection done to harvest a single fascicle.

Patients were assessed for any new neurological deficits at the time of follow-up visits. Once the wounds had healed, the patients were transferred back to the primary neurologist and definitive treatment of the underlying neurological disease was initiated, once final biopsy reports were received.

Results

Six patients who underwent biopsy of the motor branch of SPN were included in the study. All the patients in the study group were male, belonging to the age group of 15 to 60 years with majority of the patients more than 50 years (66%). Five

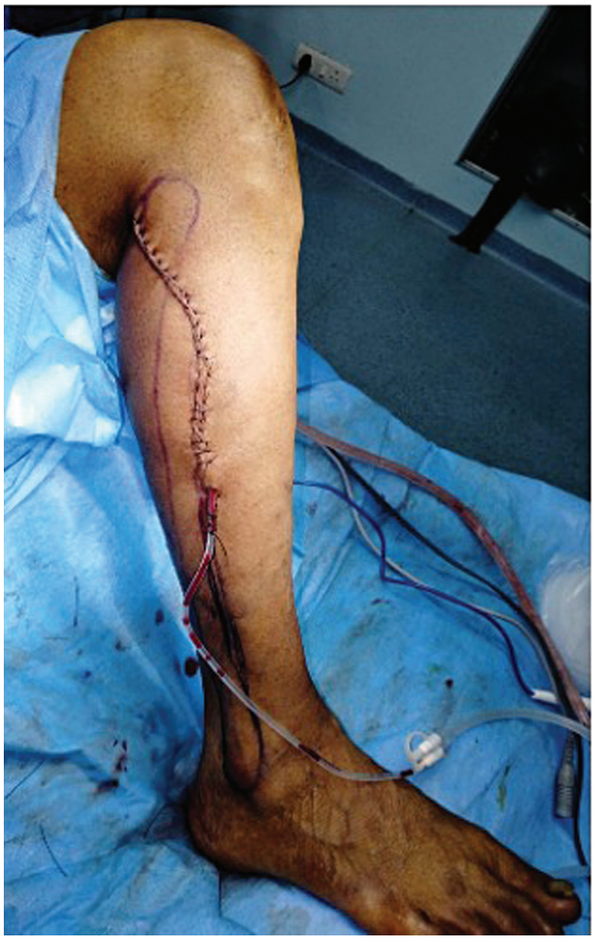

Fig. 6 Immediate postop.

out of 6 patients (83%) were discharged the next day. One patient stayed in the hospital till the biopsy reports were ready. Procedure was uneventful in all the patients.

Five out of 6 patients (83%) had more than one motor branch to peroneus longus muscle. One patient had only one nerve which was biopsied by dissecting and harvesting a single fascicle of the nerve by intrafascicular dissection under magnification. Suture removal was done on POD 10. No wound complications were in seen any of the patients. No new postoperative neurological deficit was seen.

All specimens were sent in glutaraldehyde solution. Muscle specimen was sent in saline. All the specimens were adequate for the pathological examination. Both light and electron microscopic examinations were done. Five out of 6 patients (83%) were confirmed with MN. One patient (17%) was diagnosed as diabetic neuropathy. All the patients were referred back to the neurology department for definitive management. The preoperative diagnosis and the postbiopsy diagnosis of the study group are summarized in ►**Table 1**(►**Fig. 8**).

Discussion

Nerve biopsy forms an important tool while investigating patients with symptoms suggestive of neuropathy. After

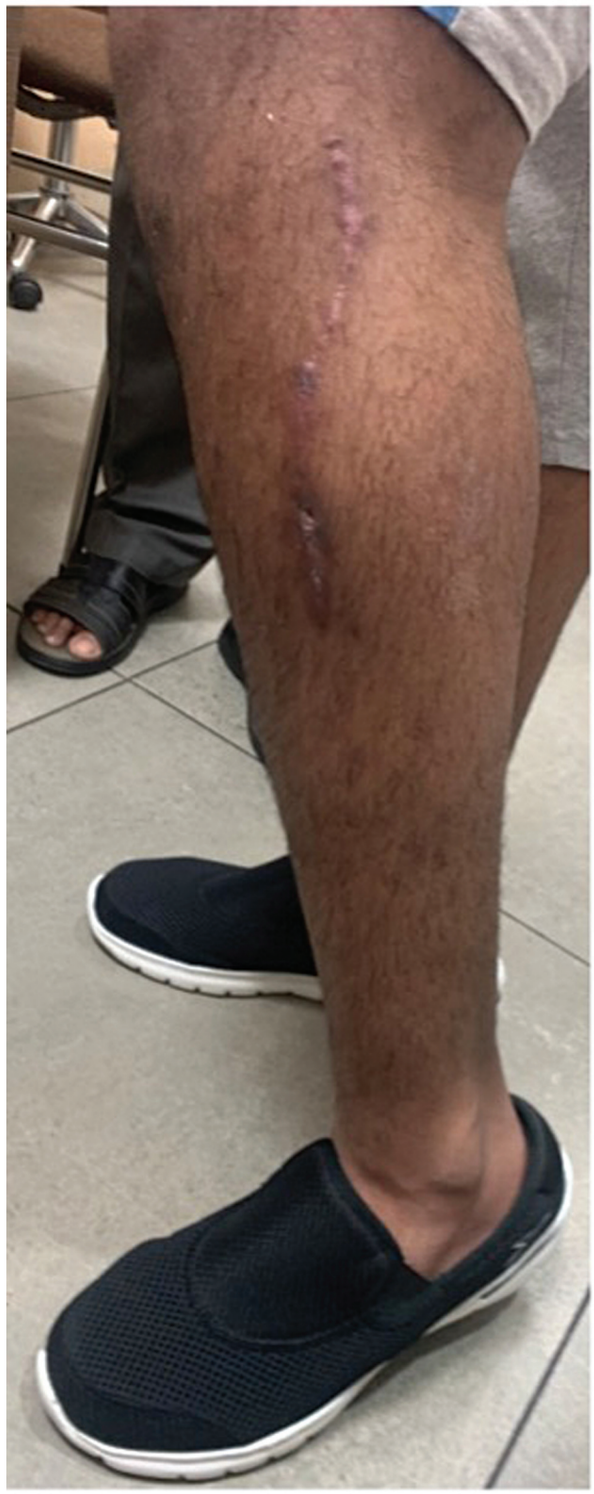

Fig. 7 Late postop.

extensive investigations, few patients may still require nerve biopsy to confirm the diagnosis.[5] Sural nerve biopsy is the gold standard for nerve biopsy so far in the literature, but it is predominantly helpful when patients presents with sensory symptoms. When the patient presents with predominantly

Table 1 Clinical features, preprocedure, postprocedure diagnosis, and histopathology findings of the study population

Sl. No.	Age/ Sex	Clinical feature	Nerve conductive study	Preop diagnosis	Procedure	Number of motor branches	Biopsy finding	Postop diagnosis
1	16/M	Bilateral foot drop	Motor demyelinating polyneuropathy of lower limbs more than upper limbs	Motor neuropathy	Peroneal nerve biopsy - left leg	2	Loss of myelinated fibers	Hereditary neuropathy –CMT-1
2	57/M	Bifacial weakness + Tongue fasciculations + Wasting of small muscles of both hands and shoulder girdle muscles Bilateral hand grip – weak Bilateral ulnar clawing+	Mild motor neuropathy of all 4 limbs	Multifocal motor neuropathy	Right peroneal verve biopsy + muscle biopsy	2	Severe axonopathy No vasculitis	Motor neuropathy
3	60/M	Right palatal weakness Bilateral foot drop	Features of severe sensory motor neuropathy	Motor radiculoneuropathy	Left peroneal biopsy	3	Axonopathy	Probable immune-mediated motor neuropathy
4	61/M	Tone: reduced in bilateral LL Bilateral foot drop		Motor neuropathy of both lower limbs	Left side peroneal nerve biopsy	1	Severe axonopathy	Motor neuropathy of both lower limbs
5	53/M	Bilateral proximal > distal weakness of lower limbs with sensory ataxia	Demyelinating symmetric polyradiculoneuropathy of lower limbs more than upper limbs	Chronic inflammatory demyelinating polyneuropathy	Left peroneal nerve biopsy	3	Epineural neovascularization and endoneural vascular hyalinization	Diabetic neuropathy
6	25/M	Bilateral foot drop	Motor demyelinating polyneuropathy of lower limbs more	Motor neuropathy	Right peroneal nerve biopsy	2	Axonopathy	Probable immune-mediated motor neuropathy

Abbreviations: CMT-1, Charcot-Marie-Tooth disease type 1; LL, lower limb; M, male.

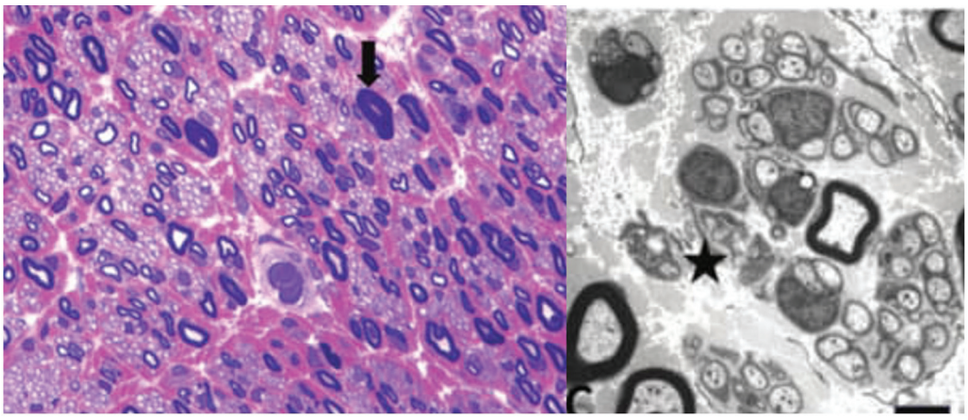

Fig. 8 Histopathological study showing numerous regenerating clusters and secondary demyelination.

motor symptoms, motor nerve biopsy will be more suitable for identifying the underlying pathology. Motor nerve biopsy with or without muscle biopsy is usually performed as a final diagnostic tool to distinguish MN from motor neuron disease since the latter is untreatable but MN, on the other hand, can be treated with favorable outcomes.[6] Five out of 6 patients included in the study were confirmed with MN and one patient was diagnosed as peripheral neuropathy. Analyzing the findings reveal that focal demyelination as one of the predominant findings. According to Stevens et al, morphometric analyses have showed that motor nerves have a higher ratio of large myelinated fibers to small myelinated fibers, compared with sensory nerves, hence motor nerve biopsy may be more reliable than sensory nerve biopsy in the diagnosis of MN.[7]

The described sites of motor nerve biopsy are the anterior obturator nerve supplying the gracilis in case of lower limb symptoms and pronator teres branch of the median nerve in case of upper limb symptoms.[8,9] The surgical anatomy of gracilis motor branch is well described. There is usually only one branch supplying the gracilis and harvesting this nerve could lead to paralysis of the entire muscle. Paralysis of gracilis may not be clinically significant in a normal individual but in patients with focal or diffuse motor weakness, this may lead to clinically significant disability. In addition, the involvement of gracilis muscle in the disease process of MN is difficult to ascertain as gracilis is not easily testable. On the other hand, one of the most commonly involved nerves in the lower limb MN is the peroneal nerve (Masakado et al).[10] Targeting a peroneal nerve branch for motor nerve biopsy in a patient presenting with foot drop is a definitive method to harvest a nerve involved in the disease process. It is also important to ensure that the biopsy does not worsen the already existing neurological deficits. There are many articles that describe SPN sensory branch harvest and peroneus brevis muscle harvest,[11,12] but there is a paucity of literature that describes the surgical technique of harvesting the peroneus longus muscle branch of SPN, which is a pure motor nerve.[13–15]

In this article, we have described the technique of harvest of peroneus longus motor nerve without causing any new neurological deficit. According to Lee et al, 76% of the entry points of the motor nerve of peroneus longus were located at a distance of 20 to 40% of the length of fibula from the from the most proximal point of head of the fibula, this roughly translates to 7.0 to 13.0 cm from the most proximal point of head of the fibula. The branching point of peroneus longus branch is at a distance of around 3 cm from the most proximal point of head of the fibula. This led us to place the incision from the posterior aspect of head of fibula to the mid third of the leg to gain exposure of the peroneus longus motor branch from its origin till its entry into the muscle including all the branches. In our study, we encountered at least two to three branches in five cases and one branch in one case. Hence, we could easily harvest one of the branches of peroneus longus branch without denervating the muscle. None of our patients had any worsening of neurological deficit like further difficulty in eversion of foot.

The length of the nerve available for biopsy is adequate for the various histopathological procedures including electron microscopy. It is also possible to harvest peroneus longus muscle or a blood vessel along with the motor nerve; this is especially helpful to identify any vasculitis or myopathy present. We have performed peroneus longus muscle biopsy along with motor nerve biopsy in one of our patients. Biopsy of the motor branch of peroneus longus muscle has facilitated confirmation of a definitive diagnosis in all our patients. This has enabled the primary physician to initiate appropriate treatment in all our patients.

Conclusion

Peroneus longus motor branch of SPN is a convenient and safe alternative technique of motor nerve biopsy for diagnosing patients presenting with lower limb weakness. It can be effectively utilized to differentiate MN from motor neuron disease. This article describes in detail the technical nuances of harvesting motor branch of SPN without producing any new neurological deficit. The added advantage here is that if needed peroneus longus muscle or an accompanying blood vessel can be harvested along with the motor nerve.

Institutional Review Board Status

Institutional review board clearance was not obtained for the study as the study was a retrospective observational study and the study protocols conformed to the Declaration of Helsinki.

Conflict of Interest

None declared.

Acknowledgments

None.

References

1 Mathis S, Magy L, Le Masson G, et al. Value of nerve biopsy in the management of peripheral neuropathies. Expert Rev Neurother 2018;18(07):589–602
2 Corbo M, Abouzahr MK, Latov N, et al. Motor nerve biopsy studies in motor neuropathy and motor neuron disease. Muscle Nerve 1997;20(01):15–21
3 Lee JH, Lee BN, An X, Chung RH, Kwon SO, Han SH. Anatomic localization of motor entry point of superficial peroneal nerve to peroneus longus and brevis muscles. Clin Anat 2011;24(02):232–236
4 Dy CJ, Lange DJ, Jones KJ, Garg R, DiCarlo EF, Wolfe SW. Diagnostic biopsy of the pronator teres and a motor branch of the median nerve: indications and technique. J Hand Surg Am 2012;37(12): 2570–2575
5 Kinoshita T, Fukushima K, Abe RT, et al. Motor branch biopsy of the pronator teres muscle in a patient with painful forearm neuropathy. Case Rep Neurol 2014;6(02):202–206
6 Nathani D, Spies J, Barnett MH, et al. Nerve biopsy: current indications and decision tools. Muscle Nerve 2021;64(02): 125–139
7 Stevens JC, Lofgren EP, Dyck PJ. Histometric evaluation of branches of mastoid portion of facial nerve. Arch Otolaryngol 1973;97(04): 330–333
8 Hameed S, Cascella M. Multifocal Motor Neuropathy. In: StatPearls. Treasure Island, FL: StatPearls Publishing; July 16, 2023
9 D'Amico RS, Winfree CJ. Diagnostic biopsy of a motor branch of the superficial peroneal nerve to the peroneus longus: a convenient alternative for motor nerve biopsy. World Neurosurg 2017; 103:526–530
10 Masakado Y, Kawakami M, Suzuki K, Abe L, Ota T, Kimura A. Clinical neurophysiology in the diagnosis of peroneal nerve palsy. Keio J Med 2008;57(02):84–89
11 Rosenberg A, Pruitt R, Saba S, Silverstein JW, D'Amico RS. Isolating the superficial peroneal nerve motor branch to the peroneus longus muscle with concentric stimulation during diagnostic motor nerve biopsy. Neurodiagn J 2022;62(01):26–36
12 Hart MG, Santarius T, Trivedi RA. Muscle and nerve biopsy for the neurosurgical trainee. Br J Neurosurg 2013;27(06): 727–734
13 Stevens JC, Lofgren EP, Dyck PJ. Histometric evaluation of branches of peroneal nerve: technique for combined biopsy of muscle nerve and cutaneous nerve. Brain Res 1973;52:37–59
14 Deutinger M, Kuzbari R, Paternostro-Sluga T, et al. Donor-site morbidity of the gracilis flap. Plast Reconstr Surg 1995;95(07): 1240–1244
15 Kang PB, Preston DC, Raynor EM. Involvement of superficial peroneal sensory nerve in common peroneal neuropathy. Muscle Nerve 2005;31(06):725–729