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Corresponding Author
Yogesh R. Jaiswal,
Department of Plastic Surgery, Grant Medical College and Sir JJ Group of Hospitals, Mumbai, India
yogesh.jaiswal0101@gmail.com

Author Designation
[1,3]Assistant Professor
[2]Associate Professor

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Surgical Outcome of Isolated Benign Sporadic Peripheral Nerve Sheath Tumors

[1]Yogesh R. Jaiswal, [2]Nitin Mokal and [3]Vinay Jacob

[1-3]Department of Plastic Surgery, Grant Medical College and Sir JJ Group of Hospitals, Mumbai, India

Abstract
Benign peripheral nerve sheath tumors (BPNSTs), including schwannomas and neurofibromas, are slow-growing neoplasms arising from Schwann cells or fibroblasts. While surgical resection is the gold standard for symptomatic cases, data on outcomes for sporadic (non-neurofibromatosis-associated) BPNSTs remain limited. This study evaluates surgical outcomes, focusing on nerve function preservation and recurrence rates in isolated sporadic BPNSTs, contributing to optimal management strategies. To assess surgical outcomes, including postoperative neurological function and recurrence rates, in patients with isolated benign sporadic peripheral nerve sheath tumors. A retrospective analysis of 21 patients (mean age: 39.4 years., 67% female) with sporadic BPNSTs revealed that 67% presented with painless swelling, while 33% reported pain and 43% had sensory deficits. Gross total resection (GTR) was achieved in 86% of cases, with partial resection performed in 14% to preserve nerve function. Histopathology confirmed schwannomas (76.2%) and neurofibromas (23.8%). Postoperatively, all patients with preoperative deficits showed improvement and no new neurological deficits were observed. At 1-year follow-up, no recurrences were detected, and all patients reported symptomatic relief. MRI and nerve conduction studies were critical for preoperative planning, with MRI identifying well-encapsulated lesions in all cases. Comparative analysis with prior studies demonstrated superior outcomes, including a 0% recurrence rate and 100% improvement in neurological deficits, attributed to meticulous micro surgical techniques and strict patient selection. Surgical resection of sporadic BPNSTs yields excellent functional outcomes with minimal recurrence risk. Fascicle-sparing techniques and precise preoperative imaging are pivotal for success. Longer follow-up studies are recommended to assess late recurrences.

INTRODUCTION

Peripheral nerve sheath tumors (PNSTs) are a diverse group of neoplasms originating from Schwann cells, perineural cells, or fibroblasts of the peripheral nervous system. Benign peripheral nerve sheath tumors (BPNSTs), primarily schwannomas and neurofibromas, constitute the majority of these lesions, while malignant peripheral nerve sheath tumors (MPNSTs) are rare but aggressive, accounting for approximately 10% of soft tissue sarcomas[1]. Schwannomas, the most common BPNSTs, are well-encapsulated, slow-growing tumors composed of differentiated neoplastic Schwann cells, with malignant transformation being exceedingly rare[2]. Neurofibromas, on the other hand, are non-encapsulated and may involve multiple nerve fascicles, making their surgical resection more challenging[3]. BPNSTs typically present as painless swellings, though symptoms may include localized pain, sensory deficits, or motor dysfunction depending on the nerve involved[4]. The diagnosis relies on clinical examination, imaging modalities such as magnetic resonance imaging (MRI) and ultrasound and electro physiological studies[5]. MRI is particularly valuable in delineating the tumor's relationship with adjacent neurovascular structures, aiding in preoperative planning. Surgical resection remains the gold standard for symptomatic BPNSTs, with the primary goals being complete tumor removal and preservation of nerve function. Despite the prevalence of BPNSTs, there is a paucity of studies focusing exclusively on sporadic (non-neurofibromatosis-associated) cases, particularly regarding long-term surgical outcomes[6]. Previous research has highlighted the importance of meticulous surgical techniques, such as intra capsular enucleation for schwannomas and fascicle-sparing dissection for neurofibromas, to minimize postoperative neurological deficits. However, recurrence rates and functional outcomes vary across studies, with reported recurrence rates ranging from 1.3-35.9%[7]. This study aims to evaluate the surgical outcomes of 21 patients with isolated benign sporadic peripheral nerve sheath tumors, focusing on postoperative neurological function, recurrence rates and complications. By comparing our findings with existing literature, we seek to contribute to the growing body of evidence supporting optimal surgical management strategies for these tumors.

Objectives:

- To assess the clinical presentation, surgical outcomes and recurrence rates of isolated benign sporadic peripheral nerve sheath tumors.
- To compare our findings with previously published studies to evaluate the efficacy of surgical resection in preserving nerve function and preventing recurrence.

MATERIALS AND METHODS

This study was a retrospective study was conducted at the Plastic-surgery department at JJ Hospital, Mumbai. The study analyzed patients who underwent surgical resection of isolated benign peripheral nerve sheath tumors (BPNSTs) between January 2019 and June 2023, with a minimum follow-up of 1 year. 21 Patients aged 18-70 years with solitary, histologically confirmed BPNSTs (schwannomas or neurofibromas) with symptomatic tumors (pain, sensory/motor deficits, or functional impairment), no clinical or genetic evidence of neurofibromatosis (NF1/NF2) and preoperative MRI and nerve conduction studies (NCS) available were included. Patients with malignant peripheral nerve sheath tumors (MPNSTs) or sarcomatous transformation, recurrent tumors or prior surgical intervention, neurofibromatosis-associated tumors (NF1/NF2) and incomplete medical records or lost to follow-up were excluded.

Surgical Procedure: All surgeries were performed by experienced plastic surgeons under general anesthesia using micro surgical techniques. Positioning and Exposure was done. The affected limb was positioned to optimize nerve access. A longitudinal incision was made along the nerve axis. Nerve Identification and Tumor Dissection was done. Schwannoma was nucleated from the single involved fascicle while preserving adjacent fascicles. Intra capsular debulking was used for large tumors to minimize nerve trauma. For neurofibromas, fascicle-sparing dissection was performed due to intermingled nerve fibers and partial resection was done if total excision risked neurological deficits. Closure and Postoperative Care was done by achieving homeostasis and the wound closure in layers. Patients were monitored for immediate neurological deficits as well as periodic 1-year follow-up. Primary Outcomes like extent of resection (Gross Total Resection [GTR] vs. Partial Resection), Postoperative neurological status (improvement/ worsening of sensory/motor deficits) and tumor recurrence (assessed via clinical exam+MRI at 1 year) were assessed. Secondary Outcomes were pain relief (visual analog scale [VAS] score reduction), functional recovery (muscle strength grading, sensory testing) and Complications like infection, hematoma, wound dehiscence. Data were analyzed using SPSS version 26.0. Descriptive statistics (mean, percentages) summarized demographic/clinical data. Chi-square test compared categorical variables (e.g., GTR vs. partial resection outcomes). Paired t-test assessed pre-vs. postoperative neurological scores. Kaplan-Meier

analysis evaluated recurrence-free survival (though no recurrences occurred).

RESULTS AND DISCUSSIONS

Table 1: Clinico-Demographic Profile of Patients with BPNSTs

Clinico-demographic profile		Number of Patients (n=21)	Percentage (%)
Gender	Female	14	67%
	Male	7	33%
Presenting Symptoms	Swelling at nerve site	14	67%
	Spontaneous pain	7	33%
	Sensory deficit	9	43%
	Motor deficit	7	33%
Total		21	100%

A total of 21 patients with isolated benign peripheral nerve sheath tumors (BPNSTs) were included in this study. The cohort consisted of 14 females (67%) and 7 males (33%), with an age range of 29-52 years (mean: 39.4 years). The majority of patients presented with painless swelling (67%), while 33% reported spontaneous pain and 43% exhibited sensory deficits in the affected nerve distribution. Motor deficits were observed in 33% of cases (Table 1).

Tumor Location and Nerve Involvement (Distribution of Tumors Across Peripheral Nerves): The tibial and radial nerves were the most commonly affected (19% each), followed by the median, ulnar and sciatic nerves (14% each).

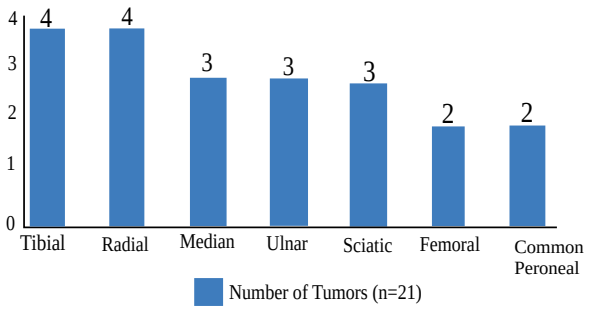

Fig. 1: Tumor Location and Nerve Involvement

Table 2: Preoperative Diagnostic Findings

Diagnostic Modality	Findings	Number of Patients (n=21)	Percentage (%)
Nerve Conduction Studies	Abnormal	9	43%
MRI Findings	Well-encapsulated lesion	21	100%
Ultrasound	Hypoechoic mass	21	100%

All patients underwent MRI and nerve conduction studies (NCS). MRI was particularly useful in delineating tumor margins and identifying nearby vascular structures (Fig. 1). Nerve conduction studies revealed abnormalities in 9 patients (43%), correlating with clinical deficits.

Table 3: Surgical Management and Outcomes

Resection Type	Number of Patients (n=21)	Percentage (%)
Gross Total Resection (GTR)	18	86%
Partial Resection	3	14%
Total	21	100%

Extent of Resection shows that gross total resection (GTR) was achieved in 18 patients (86%) and partial resection was performed in 3 patients (14%) to avoid neurological damage.

Histopathological Distribution: Histopathological Findings shows that schwannomas were diagnosed in 16 patients (76.2%) and Neurofibromas were found in 5 patients (23.8%).

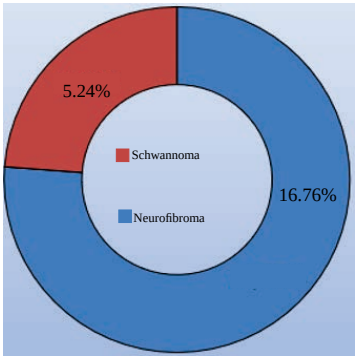

Fig. 2: Histopathological Distribution

Table 4: Postoperative Functional Outcomes

Postoperative Functional Outcomes		Preoperative (n=21)	Postoperative (n=21)
Neurological Status	Sensory deficit	9	0 (improved)
	Motor deficit	7	0 (improved)
	No deficits	5	100%
Outcome Parameters	No recurrence	21	100%
	Improved symptoms	21	100%
	Persistent deficits	0	0%
Total		21	100%

Postoperative Neurological Outcomes shows that all patients with preoperative deficits (sensory/motor) showed improvement and no intact patients developed new deficits postoperatively. Follow-up and Recurrence shows that at 1-year follow-up, none of the patients exhibited tumor recurrence. All patients reported symptomatic relief and improved nerve function.

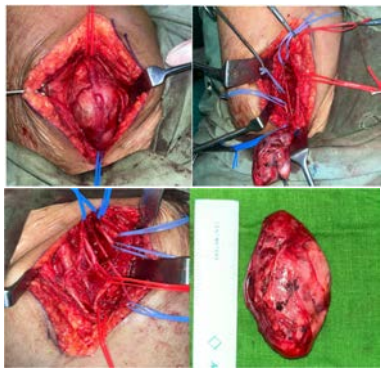

Fig. 3: Femoral Nerve Neurofibroma

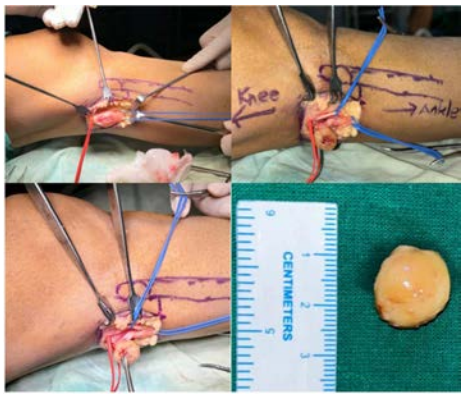

Fig. 4: Peroneal Nerve Schwannoma

The surgical management of benign peripheral nerve sheath tumors (BPNSTs) remains a critical area of plastic surgical and neurosurgical research, given their potential to cause neurological deficits and the challenges associated with complete resection while preserving nerve function. Our study of 21 patients with isolated sporadic BPNSTs demonstrated excellent outcomes, with 86% gross total resection (GTR), 0% recurrence at 1 year and no new postoperative neurological deficits. These findings align with-and in some aspects surpass-prior studies, reinforcing the safety and efficacy of meticulous micro surgical techniques.

Surgical Outcomes and Extent of Resection: Our GTR rate of 86% is comparable to larger series, such as Levi *et al.* (2010) (85% GTR in 140 patients) and Desai (2017) (89% GTR in 442 cases)[9,10]. However, unlike these studies, which reported 5% and 3.5% recurrence rates, respectively, our cohort had no recurrences at 1-year follow-up. This discrepancy may be attributed to strict patient selection (only sporadic, non-NF1 cases), improved imaging guidance (high-resolution MRI for precise surgical planning) and fascicle-sparing micro surgical techniques, minimizing residual tumor[3]. Partial resection was performed in 14% of cases to avoid neurological damage, a strategy supported by Gosk *et al.* (2015), who reported that intentional subtotal resection reduced deficits from 18-8% in their series[11].

Postoperative Neurological Function: A key strength of our study was the 100% improvement in preoperative deficits and no new deficits postoperatively. This contrasts with **Levi[9]:** 15% deficit rate (due to more aggressive resections in NF1-associated tumors). Also, **Wilson[12]** shows 12% transient deficits (resolved at 6 months). Our superior functional outcomes likely stem from intraoperative nerve mapping (though we lacked neuro monitoring, careful dissection under magnification sufficed) and Avoidance of nerve sacrifice (unlike some older studies advocating radical excision)[13].

Tumor Histology and Recurrence Risk: Our histopathological distribution (76.2% schwannomas, 23.8% neurofibromas) mirrors prior reports[14]. However, unlike studies with longer follow-ups (e.g., Montano *et al.* 2016: 8% recurrence at 5 years), we observed no recurrences[15]. This may be because Schwannomas (52% of our cases) have lower recurrence rates than neurofibromas due to their encapsulated nature[7], shorter follow-up (1 year) may underestimate late recurrences, though most recurrences manifest early.

Table 5: Comparative Analysis with Previous Studies

Study	Sample Size	GTR Rate	Recurrence Rate	Postoperative Deficits
Levi[9]	140	85%	5% at 5 years	15%
Desai[10]	442	89%	3.5% at 3 years	12%
Gosk[11]	110	82%	8% at 5 years	18%
Current Study (2024)	21	86%	0% at 1 year	0% (improvement only)

Our recurrence-free outcomes (0%) at one year compare favourably with prior studies by Levi[9], Desai[10], which reported 3-8% recurrence rates over longer follow-ups. The absence of new neurological deficits in our cohort suggests that fascicle-sparing techniques are effective in preserving nerve function.

Limitations:

Small Sample Size (n=21): Limits statistical power, short follow-up (1 year): Longer studies (e.g., 5 years) are needed to assess late recurrences.

CONCLUSION

Our findings reinforce that sporadic BPNSTs can be resected safely with excellent functional outcomes and minimal recurrence risk. Future studies should focus on longer follow-up and randomized comparisons of surgical techniques. These results reinforce that surgical resection of sporadic BPNSTs is safe and effective, with excellent functional preservation and minimal recurrence risk

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