Surgical Outcome of Brachial Plexus Tumors: A Single Centre Experience and Review of Literature

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Abstract

Background Brachial plexus tumors are uncommon, and there is limited literature on the topic. In this retrospective study, we assessed our experience with brachial plexus tumors, focusing on their evaluation, management, and follow-up at All India Institute of Medical Sciences (AIIMS), New Delhi. This article includes data from patients who underwent surgery at our center over a 10-year period, performed by senior surgeons.

Methods This is a retrospective case series of brachial plexus tumors surgically treated at an apex tertiary care center in India over a period of 10 years. Data on outcome were reported at the most recent outpatient clinic follow-up. The findings of this series were comparable with the literature available.

Results Between 2014 and 2024, 28 patients underwent surgery for brachial plexus tumors, with 23 patients meeting the inclusion criteria. Among them, 82.6% presented with a palpable mass and 39.13% exhibited preoperative motor deficits. Gross total resection (GTR) was accomplished in 78.26% of cases. In total, 78.25% of the patients in the series had benign lesions, while 21.75% had locally aggressive lesions that required close monitoring.

Conclusion Despite having a complex anatomy, tumors in this region can be resected with good microsurgical skills, achieving GTR in most of the cases with minimal neurologic compromise. Patients experiencing a decline in motor function postoperatively also regain useful power in the affected limb with physical therapy. Only a small portion of patients have persistent neurologic deficit on follow-up.

Keywords
- brachial plexus
- tumor
- retrospective study
- gross total resection

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Introduction

Tumors of the brachial plexus are relatively uncommon, constituting about 5% of all tumors of the upper limb.[1,2] These tumors may arise both from neural tissue constituting the brachial plexus, for example, schwannoma, neurofibroma (benign nerve sheath tumors), and from surrounding non-neural tissue, for example, lipoma, hemangioma, and desmoid tumors.[3–5] These tumors may be associated with genetic syndromes such as neurofibromatosis type 1 (NF1) or schwannomatosis. Some of the tumors occurring as a part of genetic syndromes have a high risk of carrying malignant potential (malignant nerve sheath tumors), for example, tumors occurring in patients with NF1.[6,7] Metastatic lesions affecting the brachial plexus region originate commonly from the breast and lungs. Magnetic resonance imaging (MRI) is the diagnostic modality of choice for diagnosing these tumors supplemented by a good clinical history and neurological examination.[8] Surgical excision is the mainstay of treatment of symptomatic, enlarging lesions or lesions thought to be malignant. Adjuvant therapies like chemotherapy and radiotherapy are reserved for individual cases based on the extent of resection, histopathology, and recurrences. Tumors affecting the brachial plexus distort the already complex anatomy of the brachial plexus, necessitating operating surgeons to have an in-depth knowledge of the anatomy and its frequent variations. The first instance of surgery on brachial plexus is from 1886 where it caused significant morbidity to the patient.[9] Since then, surgical approaches to the brachial plexus have undergone a multitude of changes to preserve both anatomical and functional status of the nerves and adjacent structures involved.[8,10]

As we know these are rare tumors, we set out to characterize these tumors further with special emphasis on clinical presentation, neurological status, surgical approaches used and outcomes along with postoperative complications. We report a single-center experience over an extended period of time that includes all tumors of the brachial plexus, including those in the surrounding region.

Materials and Methods

Study Design

In this retrospective series, medical records of patients undergoing surgery for brachial plexus tumors at an apex tertiary care center were reviewed and verified. Patients in all age groups were included in the study. Tumors originating from both the nerves and the surrounding structures were included in the study. Patients who were initially operated on outside the study center were excluded from the study.

Retrieval of Data

Patients who underwent surgery for brachial plexus tumors were selected from the institute's neurosurgery operating theater (OT) list. These patients were evaluated for their pre- and postoperative clinical status, radiology, surgical procedures used, and postoperative results. Further, changes in motor, sensory, and pain characteristics were noted. Intraoperative neuromonitoring was used in all cases and histopathology reports were noted in all cases. Data on outcome were reported at the most recent outpatient clinic follow-up.

Statistical Analysis

Raw data were entered into Microsoft Excel (Office 2008 for Mac; Microsoft, Redmond, Washington, United States). Baseline characteristics were summarized using descriptive statistics. All statistics were calculated with SSPS (17.0 for Mac; SSPS, Inc., Chicago, Illinois, United States). Only mean values were reported for the following variables: age at surgery, estimated blood loss, operative duration, and follow-up duration. We performed an analysis to see the improvement in motor function with time, nature of pathology (benign vs. malignant/non-neural nerve sheath tumors), extent of resection (subtotal vs. gross total), and age (greater than or less than the median age of all patients).

Results

Demographic Details

From 2014 to 2024, 28 patients had undergone surgery for brachial plexus tumors at our institute. Due to unavailability of all records, we excluded five patients from the study. ►**Fig. 1** shows the brachial plexus MRI of an NF2 patient with bilateral brachial plexus schwannoma. One patient had a recurrent lesion, for which she underwent her second surgery which took place after 6 years of the first surgery. One patient had two lesions that were removed at the same sitting. Three patients in this study were syndromic, one being with NF1 and two with NF2. The demographic details along with symptomatology are detailed in ►**Table 1**. The majority of the patients were males, with 15 (65%) being males. The most common presenting complaint was a long-standing palpable lump, present in 19 patients (82.6%), followed by painful lump or radiculopathy, present in 10 patients (43.47%). Nine patients (39.13%) had motor weakness at presentation. The median duration of symptoms was 32.82 months (range: 5–72 months). Only three patients (13.04%) patients had a diagnostic dilemma preoperatively for which they had undergone a preoperative biopsy. Sixteen patients (69.56%) had tumors located in the supraclavicular region, while 2 patients had infraclavicular tumors (8.69%). Four patients (17.39%) had large tumors spanning both the supra- and infraclavicular regions and two of these patients had large tumors with an intrathoracic extension.

Intraoperative and Histopathological Findings

The supraclavicular approach was utilized for resection of tumors in 16 patients (69.56%) and was the most common approach in this series (►**Fig. 2**). The infraclavicular approach was used only in two patients (8.7%). Four patients (17.4%) had extensive disease involving the supra- and infraclavicular brachial plexus and required combined approaches along with a clavicle split. Two of these patients required thoracotomy for resection of the intrathoracic part. One patient (4.35%) required an anterolateral approach for resection of the tumor. Five patients had extensive disease

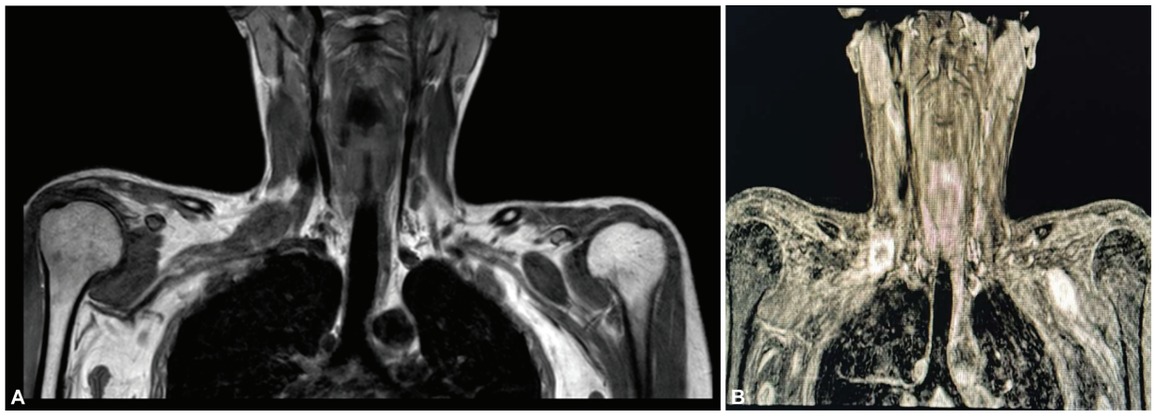

Fig. 1 (A) Shows dumb-bell shaped tumors along the trunks of brachial plexuses bilaterally. Lesions are T1 homogenously hypointense. (B) shows homogenous contrast enhancement of both the lesions on CE MRI.

extending from the intraspinal region to the supraclavicular region. All these patients required spinal surgery for resection of the intraspinal component of the tumor in addition to the supraclavicular approach for resection of the supraclavicular tumors. Eleven patients (50%) had tumors arising from the nerve roots, 8 patients (36.36%) had tumors arising from the trunk, and 3 patients (13.63%) had tumors arising from the cords. Gross total resection was achieved in 18 patients (78.26%). One patient with a diagnostic dilemma underwent incisional biopsy of the lesion. Schwannoma (►**Fig. 3**) was the most common pathology in our patients, seen in 12 patients (52.17%). Neurofibroma was the next common diagnosis, seen in six patients (26.08%), followed by fibromatosis in four patients (17.39%) and Castleman's disease in one patient (4.35%).

Table 1 Demographic details of patients in the study

Demographic details	
Age (y)	
Mean	29.21
Range	14-57
Gender	
Male	65.2% (15/23)
Female	34.78% (8/23)
Pain at presentation	
At site of lesion	21.73% (5/23)
Distant to lesion	21.73% (5/23)
Painful lump with radiculopathy	8.69% (2/23)
Palpable lump at presentation	
Present	82.6% (19/23)
Absent	17.39% (4/23)
Sensory motor symptoms at present	
Sensory loss	26.08% (6/23)
Motor weakness	39.13% (9/23)
Both	13.04% (3/23)
Duration of symptoms (mo)	
Mean	32.82
Range	5–72
Associated syndromes	
Neurofibromatosis type 1 (NF1)	4.34% (1/23)
NF2	8.69% (2/23)
Preoperative biopsy	
Obtained	13.04% (3/23)

Postoperative Outcome

Follow-up data were available for 18 patients and are listed in ►**Table 2**. The median follow-up was 60.44 months in the study (range: 1–119 months). Out of nine patients who had preoperative motor weakness, seven patients (77.78%) had improvement in power postoperatively, while two patients (22.22%) had no improvement postoperatively. Additionally, three patients (13.04%) with normal preoperative power had a decline in power in the postoperative period. One of these patients had hoarseness of voice postoperatively and required ear, nose, and throat (ENT) consultations for the same. Nine patients (90%) with a preoperative painful lump or radiculopathy had reduction/improvement in pain postoperatively, and it was the same in one patient (10%) postoperatively. Only one patient (5.55%) in the follow-up had recurrence of lesion for which she underwent a redo surgery. One patient (5.55%) with diagnosis of fibromatosis required postoperative sorafenib (kinase inhibitor); otherwise, none of the patients required postoperative chemotherapy or radiotherapy owing to excellent surgical resection and local control of disease.

Discussion

Tumors of the brachial plexus are a surgical challenge owing to their complex anatomy, which is further complicated by the distortion caused by the tumors. The advent of microscopes and improvement in microsurgical skills and

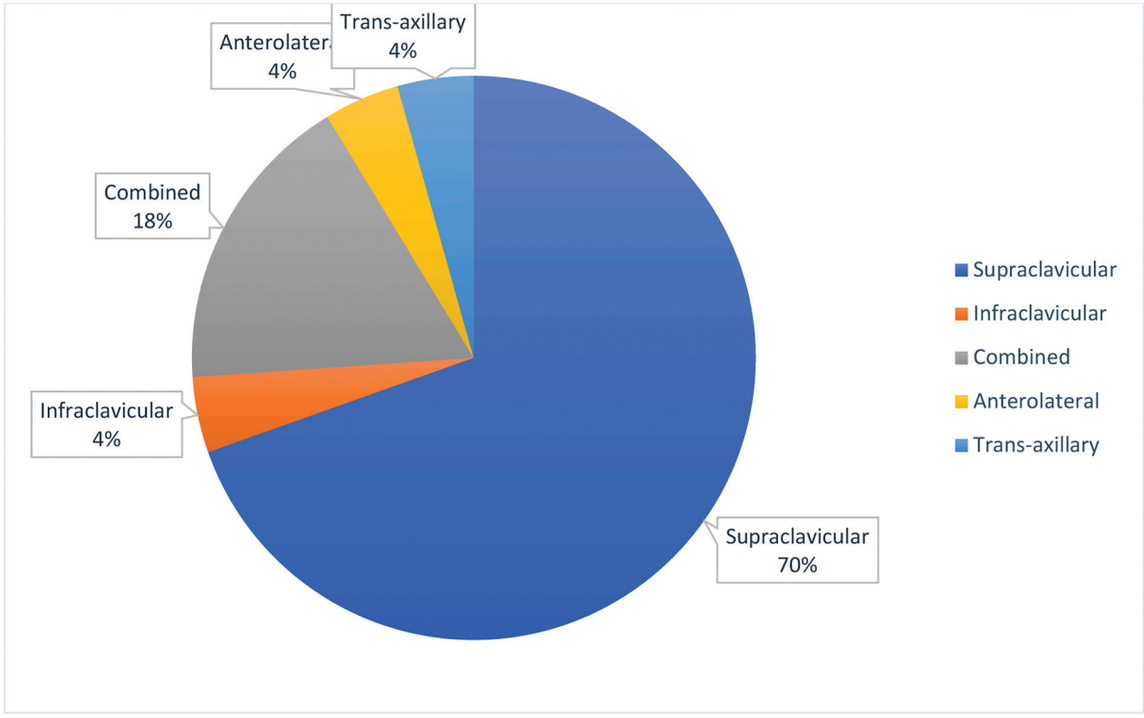

Fig. 2 Pie chart showing surgical approaches used in the study.

radiology along with intraoperative neuromonitoring has heralded an era where these tumors can be maximally excised with excellent functional outcome.[11,12] Ganju et al,[11] Desai,[12] and Pisapia et al,[13] in their series, have shed light on surgical approaches and anticipated difficulties when operating on such tumors.

The mean age of the patients undergoing surgery in our study was 29.21 years, which is similar to that reported in

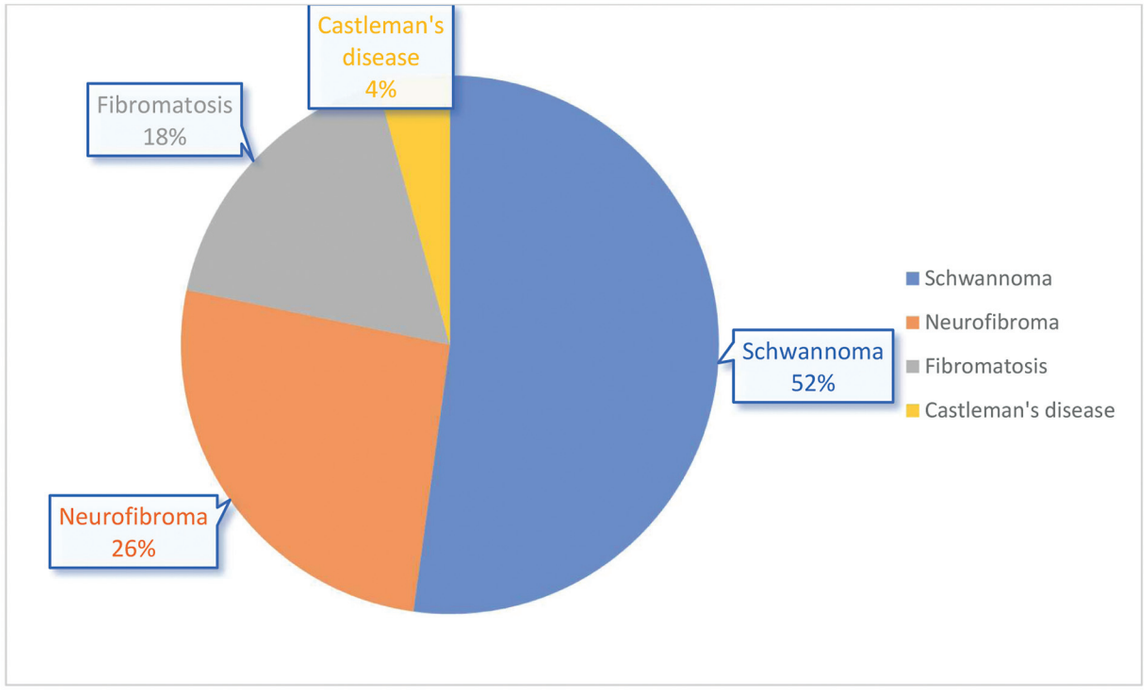

Fig. 3 Pie chart showing histopathological diagnosis of tumors excised in the series.

Table 2 Postoperative outcomes of patients who had undergone surgery for brachial plexus tumors

Post-op details	
Resection	
GTR	78.26% (18/23)
NTR	4.35% (1/23)
STR	13.04% (3/23)
Biopsy	4.35% (1/23)
Follow-up	
Median	60.44 mo
Range	1–119 mo
Post-op motor function	
Improved	77.78% (7/9)
Same as pre op	22.22% (2/9)
Deterioration	13.04% (3/23)
Post-op pain status	
Improved	90% (9/10)
Same as pre op	10% (1/10)
Tumor recurrence	
Yes	5.55% (1/18)
No	94/45% (17/18)
Post-op chemotherapy/targeted therapy	
Yes	5.55% (1/18)
No	94.45% (17/18)
Post-op radiation	
Yes	0% (0/18)
No	100% (18/18)

Abbreviations: GTR, gross total resection; NTR, near total resection; STR, subtotal resection.

other case series.[7,11,12] The most common presenting symptom in this series was a long-standing palpable lump, followed by pain, either local or radiating, which is also in line with other series.[7,11,12] Thirteen percent of the patients in this series had neurofibromatosis, which was 9% in Desai's[12] series and 17% in Pisapia et al's[13] series.

Contrast-enhanced MRI (CEMRI) has been the diagnostic modality of choice for diagnosing these tumors. Patients with small, asymptomatic tumors, not causing any cosmetic deformity, were usually followed up, whereas lesions causing neurological or mechanical symptoms or cosmetic disfigurement were taken for surgery.

Gross total resection was achieved in 78.26% of the patients in this series, while it was 65% in Ganju et al's[11] series and 68% in the series by Pisapia et al.[13] In our series, 77.78% of the patients with preoperative motor deficit had improvement postoperatively, while it was 19% in Pisapia et al's[13] series. Postoperative motor deficit in this series was 13.04%, while it was 10% in Pisapia et al's[13] series. Ninety percent of the patients in this series with preoperative pain or radiculopathy had improvement in postoperative pain, which is similar to what Huang et al[7] and Desai[12] reported. Five patients in this series had dumbbell-shaped tumors with both brachial plexus and intraspinal involvement. These patients underwent excision of the intraspinal component of the tumor first, followed by excision of the extraspinal component later in a staged manner, similar to Desai's[12] approach. Serious complications were not encountered in this series. However, complications like subclavian or other vascular injuries have been reported previously.[11,14] Schwannoma was the most common (52%) tumor in this series like other previous series.[11,12,14] Our series also underscores the need for good microsurgical skills for a better outcome in patients with desmoid tumors of the brachial plexus as highlighted by Dharanipathy et al.[15]

The most important limitation of the study arises from its retrospective design along with limited follow-up. Also, like previous studies, we have focused mainly on pre- and postoperative pain and motor power status and not on measures of life quality.

Conclusion

Despite having a complex anatomy, tumors in this region can be operated with good microsurgical skills, achieving GTR in most of the cases with minimal neurologic compromise. Patients experiencing a decline in motor function post operatively also regain useful power in the affected limb with physiotherapy. Only a small portion of patients have persistent neurologic deficit on follow up.

Declaration of Patient Consent

The authors confirm that they have obtained all necessary patient consent forms. In these forms, the patients have granted permission for their images and other clinical information to be published in the journal. They understand that their name and initials would not be disclosed and that efforts will be made to protect their identity, although complete anonymity cannot be guaranteed.

Funding

None.

Conflict of Interest

None declared.

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