Surgical Strategies in the Management of Spinal Nerve Sheath Tumors

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OBJECTIVES: **Spinal nerve sheath tumors (SNSTs) are the most common lesions in the extramedullary intradural compartment. Complex and large lesions may pose technical difficulties for the operating surgeons. We discuss the management of SNSTs and technical issues including surgical approaches, spinal fixation, and dural handling with the goal of achieving good clinical outcomes while minimizing the risk of complications. We also propose a new classification for SNSTs to guide surgical treatment of these tumors.**

METHODS: **A retrospective analysis was performed of 61 patients who underwent surgery for SNSTs during the period 1995–2012. The posterior approach was used for removal of most tumors (n = 53). Lesions having a substantial extraforaminal component were accessed from the anterior or lateral approach or a combined approach. Concomitant spinal fixation and fusion was performed in 7 patients.**

RESULTS: **Most of the patients (n = 53) had clinical improvement; clinical status was the same in 4 patients and worse in the remaining 4 patients. One or more complications developed in 18 patients (29.5%). Recurrence was the most common complication (n = 7). Death occurred in 2 patients with malignant peripheral nerve sheath tumors 12 and 8 months, respectively, after surgical resection.**

CONCLUSIONS: **Lesions with large extraforaminal extension pose technical difficulty. Spinal fixation with fusion should be supplemented whenever necessary. Complications related to dura mater may be associated with significant morbidity, and all possible efforts should be made to prevent them.**

INTRODUCTION

Spinal nerve sheath tumors (SNSTs) are the most common lesions in the extramedullary intradural compartment (6). Although most SNSTs are intradural (50%–83%), they can occur in intradural/extradural locations (7%–24%) and purely extradural locations (2%–31%) (11). Approximately 10%–15% of SNSTs have a characteristic dumbbell appearance as a result of extraforaminal extension of intraspinal lesions (12). Most SNSTs are easily accessible with standard operative approaches and carry a good prognosis. Lesions with large extraspinal extension, ventral tumors, and giant lesions with extensive bony scalloping may require wider or circumferential surgical approaches, spinal stabilization, and multidisciplinary involvement (3, 12, 16, 32, 37, 45, 47, 50).

The extent of surgery may range from minimally invasive unilateral laminectomy to more aggressive surgical techniques depending on the size and location of the lesion (2, 24, 36, 37, 43). The aim of this study is to analyze critically the surgical methods and clinical outcomes in patients undergoing surgery for SNSTs at our institution and to discuss the surgical strategies for SNSTs. Based on our surgical experience and observations, we also propose a new classification for SNSTs, which is a useful guide for surgical treatment of these tumors.

MATERIALS AND METHODS

We performed a retrospective analysis of 61 patients who underwent surgery for SNSTs during the period 1995–2012 at our

Key words
- Classification
- Nerve sheath tumors
- Spine
- Surgical techniques

Abbreviations and Acronyms
EFC: Extraforaminal component
EMG: Electromyography
MPNST: Malignant peripheral nerve sheath tumor
SNST: Spinal nerve sheath tumor
VA: Vertebral artery

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institution. Institutional review board approval was obtained before conducting the study. Patient demographic features, clinical presentation, surgical details, and outcomes were recorded. Examinations were subclassified as intact, radiculopathic, radiculomyelopathic, or myelopathic. Neurologic outcomes were described as improved, stable, or worse.

Patient demographics and clinical features are summarized in Table 1. Tumors were evaluated by magnetic resonance imaging in most cases (n = 59); additional computed tomography was performed in some patients to examine the osseous destruction and foraminal widening in dumbbell-shaped lesions (n = 23). Computed tomography myelography was performed in 2 patients with neurofibromatosis with multiple lesions involving adjacent segments of the cervical spine. In most patients, evaluation of nerve root function was based on clinical assessment; electromyography (EMG) was also performed in 6 patients. Carotid angiography was performed in 2 patients with giant cervical tumors owing to close proximity of the tumors to the vertebral artery (VA). Most lesions were intradural extramedullary (n = 43), 7 lesions were exclusively extradural, and 10 intradural lesions had an extradural component. Intramedullary location arising from the lower thoracic spinal cord was also observed in 1 patient. Lumbar and cervical nerve roots were involved in most patients. We did not observe any tumor involving sacral nerve roots. Most lesions were posterior or posterolateral; however, a few schwannomas (n = 11) were located ventral or ventrolateral in the spinal canal. Preoperative percutaneous biopsy was performed in 1 patient, who was identified as having a lower thoracic malignant peripheral nerve sheath tumor (MPNST).

Table 1. Demographic and Clinical Characteristics of Patients ($N = 61$)

Variable	Number
Age (years)	
Mean	47.89
Range	10–87
Sex	
Male	29
Female	32
Symptoms	
Radiculopathy	34
Radiculomyelopathy	22
Myelopathy	5
Location	
Craniocervical	8
Cervical	16
Cervicothoracic	2
Thoracic	9
Thoracolumbar	5
Lumbosacral	21
Pathology	
Schwannoma	48
Neurofibroma	13
Histology grade	
Low	59
High	2
Position in spinal canal	
Intradural	44
Extradural	7
Intradural/extradural	10
Neurofibromatosis	8
NF1/NF2	5/3
Follow-up (months)	
Mean	34.4
Range	8–120

NF1, neurofibromatosis 1; NF2, neurofibromatosis 2.

Surgical Techniques

Surgical Approach. The posterior approach was used to remove most of the tumors (n = 53). Lamina and facet resection was carried out to the degree necessary to achieve total removal of the tumors. For large dumbbell tumors growing out of the foraminal aperture in the paraspinal region, which were not amenable to complete removal from the posterior approach, anterior or combined approaches were used. Tumors arising from the craniocervical junction were approached depending on their anatomy and extent of growth. Of 8 patients with lesions at the craniocervical junction, an extreme lateral transcondylar approach was used in 1 patient for an anteriorly located tumor. The remaining patients could be approached from the standard posterior approach; however, suboccipital craniotomy was performed in 2 patients to facilitate complete resection. The standard posterior approach alone was used in most of the cervical lesions, although the anterior approach was necessary in 4 patients. In 2 of these patients, both approaches were used in 2-stage procedures, in which the anterior approach was used in the second stage to excise residual tumor in the extraforaminal region. In general, thoracic and lumbosacral lesions were treated by the posterior approach. One patient with tumors at this location was treated through a right transthoracic approach, and another patient underwent excision of the tumor by a retroperitoneal approach. In 1 patient, a giant MPNST was resected using a lateral thoracic extracavitary approach and stabilized anteriorly and posteriorly at 1 stage.

Bone Resection. Intraspinal tumors located on one side of the spinal canal were removed by performing a hemilaminectomy (n = 8), whereas larger lesions crossing midline were excised by performing a complete laminectomy (n = 47). Laminoplasty was performed in 5 patients. In a few cases (n = 13), we used the footplate of a high-speed drill to perform lamina resection from the lateral margins. The entire section of the lamina along with the spinous process was removed en bloc by carefully cutting the underlying ligamentum flavum, avoiding inadvertent injury to the