Complication Avoidance in the Resection of Spinal Meningiomas

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Key words
- Complication
- Meningioma
- Spinal meningioma
- Surgery

Abbreviations and Acronyms
IONM: Intraoperative neurologic monitoring
Tc-MEPs: Transcranial motor evoked potentials

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Citation: World Neurosurg. (2015) 83, 4:627-634.
http://dx.doi.org/10.1016/j.wneu.2014.12.015

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

BACKGROUND: **Surgical resection is considered the treatment of choice for spinal meningiomas and can be safe and effective; however, neurologic and surgical complications occur. This article reviews the factors that may predict susceptibility to this postoperative decline and addresses therapeutic choices, adjunctive therapies, and technologic applications that may help avoid complications.**

METHODS: **A literature search was conducted for articles related to spinal meningiomas addressing surgical treatment, adjuvant treatment, and technologic applications related to management and minimizing of complications.**

RESULTS: **There were 16 surgical series identified, comprising 1090 patients with median mortality of 1% (range, 0%—4%), nonneurologic surgical morbidity of 4% (range, 0%—24%), and permanent neurologic deterioration of 6% (range, 0%—21%). Common complications were cerebrospinal fluid leaks and fistulas, venous thromboembolic disease, myocardial infarction, and neurologic deterioration with either transient or permanent neurologic deficits. Predictive risk factors of neurologic decline included pathoanatomic features of lesion calcification, anterior dural attachment, infiltrative tumor, and tumoral adherence to the spinal cord and patient-specific factors of preoperative neurologic and advanced age.**

CONCLUSIONS: **Alongside surgery, selection of more direct approaches and use of adjuvant radiotherapy in patients with higher grade lesions and recurrent disease may lead to improved outcomes. New technologies, including microsurgical technique, intraoperative electrophysiologic monitoring, intraoperative ultrasound, and ultrasonic aspiration, may improve the safety and limit the complications of resection.**

INTRODUCTION

Meningiomas of the spinal column account for ~8%—12% of all meningiomas and 25% of primary spinal tumors (17, 36, 58). Meningiomas in the spine are histopathologically and structurally similar to intracranial meningiomas, but their varied location in the spinal canal can complicate their resection. The incidence of these lesions increases with age, and prevalence is greater in women. Clinical presentation is highly variable and includes pain, progressive myelopathy, and acute neurologic deterioration (17, 51). Contrast-enhanced magnetic resonance imaging (MRI) remains the imaging modality of choice, complemented by computed tomography (CT) when there are concerns about lesion calcification (15, 17, 58). Nearly three quarters of spinal meningiomas occur in the thoracic compartment (51), and there is significant variability in the anatomy of the dural attachment—anterior, lateral, or posterior—in the canal (17, 30). After surgical resection, the rates of recurrence of spinal meningioma are similar to rates of meningioma arising in the cranial compartment (36, 47). Recurrences have been reported in 0%—17% (median 4) of cases (5, 15, 17, 22, 23, 30, 39, 43, 44, 48, 51, 55, 56, 58, 61), and recurrence was noted more frequently in tumors that were ventrally attached (44), previously recurrent, infiltrative, partially resected, or with arachnoid scarring (23).

With modern neurosurgical techniques, these lesions can be resected with good functional outcomes. The marked heterogeneity of lesional pathoanatomy has made it challenging to determine from small case series optimal surgical management strategies and adjuvants to minimize complications. The objective of the present study was to review the literature on surgical management of spinal meningiomas with specific attention to complications and their avoidance.

MATERIALS AND METHODS

A literature search of the PubMed database and gray literature was conducted to identify literature on the complications of spinal meningiomas and the commonly applied surgical techniques, use of technologic advances, and choice of therapeutic interventions. Terms also searched included "long term complications of spinal meningiomas," "complications of spinal meningiomas," "surgical complications of spinal meningiomas," "anterior approach spinal meningiomas," "posterior approach spinal meningiomas," "meningioma dura resection," "laser and neurosurgery," "intraoperative ultrasound and meningioma." A meta-analysis was impossible given the lack of clinical trials pertaining to the treatment of spinal meningiomas and complication avoidance.

Figure 1 shows a typical spinal meningioma, with posterolateral attachment of a calcified thoracic lesion. Key surgical considerations to see this patient through the operative intervention with success include surgical approach (anterior vs. posterior), specific intraoperative techniques to facilitate resection of the lesion (en bloc vs. piecemeal vs. ultrasound-guided aspiration), and adjuvant techniques to minimize neurologic morbidity (microsurgical technique, intraoperative electrophysiologic monitoring).

RESULTS AND DISCUSSION

Complication Rates of Spinal Meningioma Surgery

Major complications of surgical treatment of spinal meningiomas are classified as related to general hospitalization and surgery-specific morbidity and mortality, risks to surgical intervention to the spine, and risks specifically related to the resection of the meningioma. In this literature review, 16 articles were found analyzing operative management of 1090 patients with spinal meningioma; rates of morbidity, mortality, and neurologic deterioration are summarized in Table 1.

In surgical case series of spinal meningiomas, the median mortality rate was 1% (range, 0%–4%). Postoperatively, median nonneurologic and neurologic morbidity rates were 4% (range, 0%–24%) and 6% (range, 0%–21%) of patients, respectively (5, 8, 9, 17, 30, 39, 43, 47, 48, 55, 56, 58, 61). Specific risks related to the resection of spinal meningiomas included cerebrospinal fluid leaks and fistulas and neurologic deterioration, alongside more general surgical risks of venous thromboembolic disease, cardiac and respiratory complications, and infectious complications (5, 6, 8, 9, 17, 30, 39, 43, 47, 48, 51, 55, 56, 58, 61).

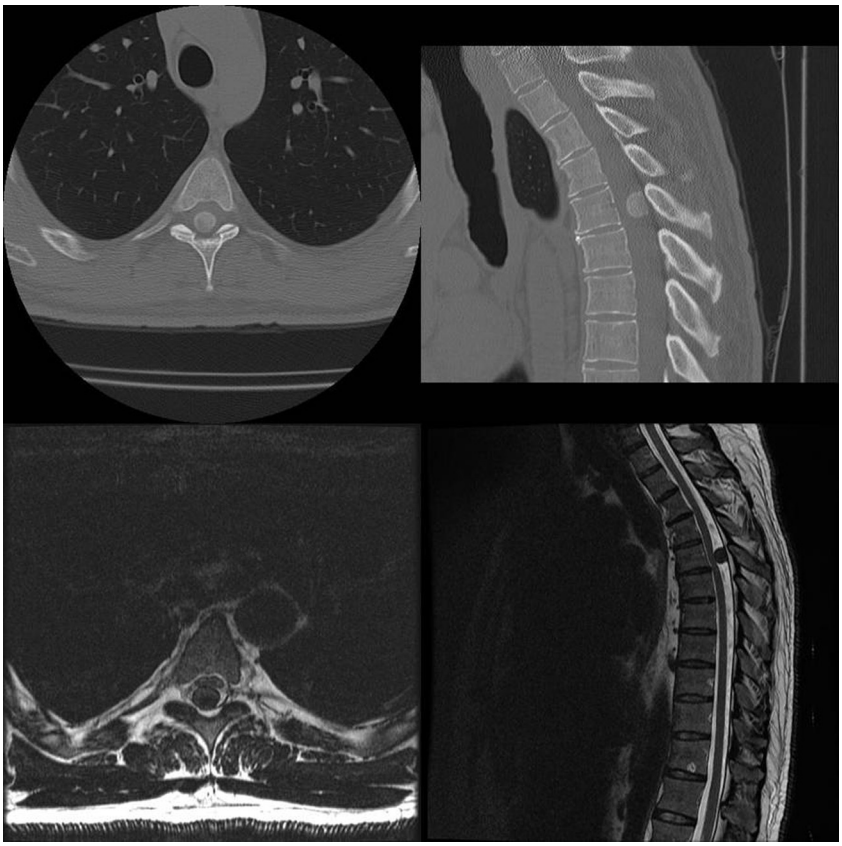

Figure 1. Axial (*left*) and sagittal (*right*) computed tomography (*upper*) and magnetic resonance imaging (*lower*) scans of a 44-year-old man presenting with slowly progressive myelopathy secondary to a homogeneously calcified meningioma.

Risk factors for postoperative neurologic deterioration are reported to include meningioma calcification (30, 39, 48, 51), anterior dural attachment (30, 39, 48), infiltrative tumor and tumoral adherence to the spinal cord 22, 23), poor preoperative status (43, 61), and advanced age (51).

Lesion calcification was most consistently reported as important in overall neurologic function, likely the consequence of requiring more spinal cord manipulation to resect such lesions. Preoperative computed tomography imaging can be useful and is recommended to assess this feature of the tumor before resection (15, 17, 58) and help establish plans for a safe and optimal surgical approach. For example, in a series of 131 patients by Sandalgliocu et al. (51), 3 of the 4 patients who experienced permanent neurologic deterioration had homogeneous meningioma calcification identified by preoperative imaging.

Surgical Approaches

If surgery can be performed safely and with acceptable morbidity, tumor resection is the first-choice treatment for compressive symptomatic spinal meningiomas. Most of these are histologically benign and are associated with a favorable postsurgical neurologic and oncologic prognosis (5, 17, 22, 23, 30, 39, 43, 48, 58). Cushing and Eisenhardt (9) recognized that "a successful operation for a spinal meningioma represents one of the most gratifying of all operative procedures" with the complete resection providing neurologic stabilization with a low likelihood of recurrence. The surgical objective involves complete resection, with only a limited role for adjuvant treatments at the outset indicated for aggressive histologic subtypes or recurrent disease. Advances in neuroimaging, microsurgery, and spinal monitoring continue to make this objective more safely achievable.

Extent of Tumor Resection. The neurologic surgical objective is resection to decompress the spinal cord safely and adequately. The oncologic surgical objective is complete lesion resection to minimize the likelihood of tumor recurrence. Completeness of surgical resection is often dictated by the site from where these lesions arise and the surgical approach selected. Because meningiomas arise discrete from the spinal cord tissue, safe dissection is permitted to separate the