Calcified Spinal Meningiomas

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OBJECTIVE: **To analyze outcomes of patients surgically treated for calcified spinal meningiomas and to determine factors associated with surgical morbidity.**

METHODS: **Between January 2000 and June 2013, a total of 54 patients underwent surgical resection of a spinal meningioma: 37 of these cases showed various degrees of calcification, confirmed by histopathologic analysis. The clinical evaluation was performed according to the American Spinal Injury Association Impairment Scale. At the last follow-up, neurologic status improved in 19 cases and remained unchanged in 20 cases; just 1 case worsened. According to the American Spinal Injury Association Impairment Scale, neurologic status was classified into 3 levels: poor (A + B), fair (C), and good (D + E). Neurologic status improvement (NSI) during postoperative time (considered as a transition from one lower level to the higher) was analyzed in relationship to the patient's age, length of clinical history, spine level, meningioma's position inside the spinal canal, and its degree of calcification.**

RESULTS: **A statistically significant relationship between NSI and the degree of ossification of the meningioma was observed. in particular, a direct relationship with microcalcified meningiomas and an inverse relationship with ossified meningiomas. No relationship was observed between NSI and patient's age, length of clinical history, and the site of the lesion into the vertebral canal.**

CONCLUSIONS: **The univariate analysis confirms that the degree of calcification affects the outcome, because extensive tumor calcification is associated with an increased surgical morbidity probably.**

INTRODUCTION

Approximately the 25% of all primary tumors of the spine are represented by the spinal meningiomas, which come just after neurilemmomas in terms of frequency.[1-3] Meningiomas are prevalent in middle-aged subjects, with predilection for women over men by a ratio of 2:1 for intracranial meningiomas and up to 9:1 for spinal meningiomas[4]; from 75% to 85% occur in women.[5] Spinal cord lesions, like those elsewhere, grow from intradural, extradural, or transdural attachments, then stretch the arachnoid over them and sometimes incorporate the arachnoid, but rarely the pia.

The clinical presentation and its severity depend on the location of dural attachment and the size of the meningioma. Completely extradural meningiomas are rare.[1,6] Approximately 80% of spinal cord meningiomas occur in the thoracic spine,[1,7,8] second in frequency the cervical spine, and last the lumbar spine. Although spinal meningiomas are not uncommon, grossly calcified and ossified cases are uncommon and account for only 1%–5% of all spinal meningiomas.[9] Diagnosis is best made with magnetic resonance imaging (MRI), but calcifications in the context of meningioma could be identified with computed tomography (CT) scans.

Calcification of the meningioma has to be considered more specifically for functional results[10]: in this paper, we propose a classification model for spinal calcified meningiomas, based on the degree of calcification (microcalcified, macrocalcified, and ossified meningiomas) to find an eventual relationship with the

Key words
- Calcification
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Abbreviations and Acronyms
ASIA: American Spinal Injury Association
CT: Computed tomography
MRI: Magnetic resonance imaging

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surgical outcome. There are only few reports[1,11,12] in the literature describing the postoperative outcome of spinal meningiomas, even less about functional outcome after surgery for spinal ossified meningiomas. For this reason, we decided to analyze the impact of histologic calcification subtypes on functional outcome.

METHODS

Patient Population

Between January 2000 and June 2013, a total of 57 patients underwent surgical resection of a spinal meningioma at the Department of Neurosurgery of "Sapienza" University of Rome, Italy. Thirty-seven of these patients who had spinal calcified meningiomas (for a total of 40 meningiomas) were reviewed retrospectively. Patients with craniospinal meningiomas were excluded. The female sex was clearly predominant, with 34 female patients and 3 male patients (female/male ratio 9:1) indentified. The patients' age ranged from 22 to 82 years with a mean age of 62 years. There were 2 cases of multiple localizations: one patient presented concurrently a cervical (C6–C7) and a thoracic (T7–T8 and T9–T10) meningioma and was subjected to 2 surgical resections in the same month; in the second case, the first presentation was cervical (C6–C7), which was removed surgically, and 4 months later the patient was reoperated for the resection of a dorsal meningioma (D7–D8). Another patient with a dorsal meningioma (D7–D8) had a recurrence after 2 years in the same site. The length of clinical history ranged from a minimum of 3 months to a maximum of 6 years.

Classification

In this paper we attempt to propose a classification of calcified meningiomas based on the degree of calcification. There are few reports in the literature concerning the degree of calcification in spinal meningiomas.[1,11,12] Our proposal of classification includes 3 degrees of calcification: the lowest degree corresponds just to an histologic evidence of psammomatous pattern (microcalcified meningioma); the intermediate degree corresponds to the presence of grossly visible calcifications (macrocalcified); and the upper degree corresponds to a total ossification (ossified):

- ossified (macroscopically solid tissue);
- calcified (there are some site of solidification in tissue); and
- microcalcified (histhologically defined calcification).

Features of Meningiomas

In our study, we found 40 cases in 57 total cases with total, macroscopic, or microscopic calcification meningioma: we divided these lesions first by histologic features and then by morphologic characteristics. Based on histologic criteria (according with World Health Organization classification), in our series there were psammomatous in 29 cases (72.5%), meningothelial with psammomatous bodies or calcifications in 7 cases (17.5%), and presenting ossification pattern in 4 cases (10%). According to the morphology (described in surgical reports), the number of psammomatous-type meningiomas without visible calcifications was 27 (67.5%), classified as microcalcified; the number of meningotelial meningiomas with visible calcifications was 8 (20%), classified as macrocalcified; and the number of ossified meningiomas was 5 (12.5%), which we considered entirely calcified lesions (or ossified).

Regarding spinal level, in our series, there were 31 thoracic meningiomas (77%), 7 in cervical spine (17.5%) and 2 in the lumbar spine (5%). Posterior dural attachment to the spinal cord (the base of attachment is on the dorsal dural plane) was found in 16 cases (40%) of which 11 was microcalcified, 2 were macrocalcified, and 3 were ossified; meningiomas with anterior base of attachment to the spinal cord (on the dura which involves the ventral portion of spinal cord) were 13 (32.5%); of which 9 was microcalcific cases, 3 were macrocalcified cases, and 1 was ossified; in the remaining 11 cases (27.5%), dural attachment was lateral to spinal cord, of which 7 cases was microcalcified, 3 macrocalcified, and 1 was ossified. The corresponding data are shown in Table 1.

Radiology, Surgical Technique, and Intra- and Perioperative Management

Contrast-enhanced spinal MRI was the diagnostic tool of choice and performed routinely for preoperative evaluation in all patients (Figure 1). We also performed a preoperative CT scan in all patients, especially those with a questionable presence of calcification within the meningioma, as shown in preoperative MRI, or patients with some osseous abnormality in vertebral anatomy. On CT scans, 3 masses entirely replaced with calcification were seen with a greater density compared with the adjacent bone marrow density (Figures 2 and 3). Even limited calcification increases density sufficiently enough to be detected on CT, and the locations or distribution patterns of calcifications within masses were variable.[13] On MRI, signal intensities of calcification did not concur with that of calcified foci within a mass, as seen on CT images. In all cervical cases, preoperative angio-MRI was performed, demonstrating the patency and size of the opposite vertebral artery and its ability to carry the entire circulation.

CT and MRI are complementary methods of diagnosing a calcified spinal meningioma, especially in cases replaced entirely by calcification.[13] All the surgical procedures were made via the posterior approach and comprised laminectomy ($n = 38$; 95%) and laminotomy ($n = 2$; 5%). In 27 cases (67.5%) laminectomy comprised 2 levels: the vertebral level involved by the mass and

Table 1. Localizations of Meningiomas

Position	Microcalcified	Macrocalcified	Ossified
Anterior	9	3	1
Lateral	7	3	1
Posterior	11	2	3

Series distribution of intracanalar localization of meningiomas. Location of the meningioma was anterior to the spinal cord in 13 cases (32.5%), of which 9 was microcalcified cases, 3 was macrocalcified cases and 1 ossified. Eleven meningiomas was lateral to the spinal cord (27.5%), of which 7 cases was microcalcified, 3 macrocalcified, and 1 ossified. Posterior location was the most frequent one with a number of 16 cases (40%), of which 11 were microcalcified, 2 were macrocalcified, and 3 ossified.