Conus medullaris and cauda equina tumors: clinical presentation, prognosis, and outcome after surgical treatment

Clinical article

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Object. Intradural cauda equina and conus medullaris tumors (CECMTs) are rare. Only a few large clinical series exist to date. Therefore, clinical symptoms, surgical complications, and outcomes are poorly understood. The aim of the present study was to evaluate outcome after surgery of CECMTs and to identify the factors associated with a worse clinical prognosis based on the results of a series with sufficiently high number of cases.

Methods. All cases of intradural CECMTs treated surgically at the authors’ department between March 2006 and May 2012 were retrospectively evaluated. Arachnoid cysts and multifocal tumors were excluded. Sixty-eight adult patients met the inclusion criteria (35 female and 33 male patients; median age 56 years). Follow-up data were available for 72% (n = 49) in a median period of 9 months.

Results. Overall, 18 tumors were located intramedullary and 50 extramedullary. The majority were nerve sheath tumors (n = 27), ependymomas (n = 17), and meningiomas (n = 9). The most common preoperative symptom was pain. The rate of new transient postoperative impairment was 18% (n = 12), and new permanent deficits were observed in only 6% (n = 4). Overall neurological improvement was achieved in 62%. The reversibility of preoperative symptoms was related to the interval between the time of symptom onset and the time of surgery and to the presence of preoperative neurological deficits. Surgery of ependymoma and carcinoma metastases was associated with a higher rate of morbidity.

Conclusions. Intradural CECMTs present as a group of tumors with varying histological features and clinical symptoms. Symptomatic manifestation is usually unspecific, mimicking degenerative lumbar spine syndromes. Despite a significant risk of transient deterioration, early surgery is advisable because more than 94% of patients maintain at least their preoperative status and more than 60% improve during follow-up. The reversibility of preoperative symptoms is related to the duration between symptom onset and surgery and to the presence of preoperative neurological deficits. The prognosis for recovery from cauda equina or conus medullaris syndrome is less favorable than for other deficits. Surgery of ependymoma is associated with a higher morbidity rate than other benign entities.

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Key Words • intradural tumor • intramedullary tumor • oncology • spinal tumor surgery • spinal ependymoma • cauda equina syndrome

Abbreviations used in this paper: CCS = conus or cauda syndrome; CE = cauda equina; CECMT = CE and CM tumor; CM = conus medullaris; GTR = gross-total resection.
our study was to describe specific features of intradural lesions in the region of the CE and CM with respect to clinical outcome and prognosis after surgical treatment, as well as to identify possible factors that may impact initial presentation and further clinical courses.

**Methods**

All cases of spinal intradural tumors arising at the CM and CE that had been treated surgically from March 2006 to May 2012 at our department were retrospectively evaluated. Arachnoid cysts and multifocal tumors were excluded even if a portion of the lesion was located within CM or CE. Cavernomas of the CM were included in the evaluation, as they appear tumorlike from a surgical and clinical perspective, representing space-occupying intramedullary lesions with a tendency to enlarge and result in progressive neurological deficits due to enlargement or hemorrhages. All patients underwent resection in which a microsurgical technique was used. Hemilaminectomies or laminectomies, via a standard midline posterior approach, were performed and followed by a paramedian or median durotomy and median myelotomy or dorsal root entry zone myelotomy for intramedullary lesions. In all cases, the diagnosis was verified by histological examination. Intraoperative neuromonitoring (motor and sensory evoked potentials or intraoperative electromyography) was performed in cases involving intramedullary located lesions and in particular in technically difficult cases involving intradural extramedullary lesions.

The medical charts of all identified patients were reviewed for characteristics and duration of clinical symptoms prior to and after surgery. Conus or cauda syndrome (CCS) was assumed when a complex of the following clinical signs, to varying degrees, was present: saddle hypesthesia or anesthesia, impairment of anal and bulbocavernous reflexes, rectal and bladder sphincter dysfunction, and sexual impotence. Other symptoms frequently related to CCS, such as low-back pain, uni- or bilateral sciatica, motor weakness of the lower extremities, and impairment of medial plantar and Achilles tendon reflexes, were not considered pathognomonic for this symptom complex and thus were not regarded as incomplete CCS. In addition, the surgical approach, extent of resection, histology, and subsequent outcomes were assessed from patient documentation. Preoperative, postoperative, and follow-up MRI data were reviewed for tumor location, extent of resection, and postoperative tumor recurrence/progression.

Tumors arising from the filum terminale were considered extramedullary due to their clinical and surgical features, although some authors tend to classify these tumors as intramedullary, according to the neuroectodermal derivation of the filum. Patients with intradural metastases of nonneurogenic primary tumors and patients with malignant lesions eventually underwent adjuvant radiotherapy or chemotherapy, according to the decision made by an interdisciplinary tumor board.

For the present study, the outcome was evaluated at discharge and at the latest follow-up. As per the clinical standard, the first routine follow-up clinical examination and control MRI took place 3 months after surgery. Subsequently, follow-up examinations were performed in cases of benign lesions every year if no recurrence was suspected and in cases of higher-grade lesions every 3 or 6 months. The follow-up duration was determined by the date of the last available record.

The present study was performed in adherence with the guidelines of the Declaration of Helsinki. The research protocol was approved by the ethics committee of the Technical University of Munich. Informed consent has not been obtained because data were collected retrospectively.

**Results**

Sixty-eight adult patients were identified who met inclusion criteria (35 women and 33 men; median age 56 years [range 18–84 years]). Currently, follow-up data are available for 72% of the patients (n = 49) in a median follow-up period of 9 months (range 3–64 months). Of 68 intradural tumors, 18 were predominantly or completely intramedullary (conus lesions) and 50 were predominantly or completely extramedullary. The most common histological diagnoses were nerve sheath tumor (40%, n = 27), ependymoma (25%, n = 17), and meningioma (13%, n = 9). The vast majority were benign WHO Grade I lesions (74%, n = 50). Table 1 and Fig. 1 demonstrate the histological findings of the entire series.

Initial clinical presentations are summarized in Table 2. While 6 patients were asymptomatic, the most common preoperative symptoms were pain (87%, n = 59), sensory deficits (44%, n = 30), and motor deficits (21%, n = 14). Conus or cauda syndrome was observed in only 19% of the cases (n = 13). The median duration of symptoms before the initial diagnosis was 24 months (range 4 days to 20 years). Patients with malignant lesions (WHO Grade III and IV) had a significantly shorter duration of preoperative symptoms (mean 22.5 days, range 4 days to 6 months) compared to patients with Grades I and II lesions (mean 24 months, range 1 month to 20 years).

During surgery, 60 (88%) of the tumors were resected completely, 4 were resected subtotaly, 2 were debulked, and 2 were biopsied. No substantial differences were observed between the extent of resection of CM lesions (gross-total resection [GTR] in 89% [n = 16]) and CE lesions (GTR in 88% [n = 44]). At discharge, 41% of patients improved in terms of pain and/or neurological disorder, status in 41% was unchanged, and status in 18% had deteriorated (that is, a new neurological deficit had developed). During follow-up, the majority of patients with new postoperative deficits recovered, leaving only 6% (n = 4) with permanent new deficits, whereas 62% showed neurological improvement, including 29% of patients in whom symptoms completely resolved. Clinical outcomes are illustrated in Fig. 2.

By distinguishing between the patients without neurological deficits (patients with pain [n = 29], the “no-deficit group”) and those with deficits (n = 33, “deficit group”), we observed approximately equal rates of patients with new permanent postoperative deficits, comprising 7% and 6%, respectively. However, the rate of postoperative improvement was higher in the no-deficit group compared to the
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TABLE 1: Tumor histology, demographic features, and tumor location

<table>
<thead>
<tr>
<th>Histology</th>
<th>No. of Cases</th>
<th>% of Cases</th>
<th>Median Age (yrs)</th>
<th>F/M Ratio</th>
<th>CM/CE Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>nerve sheath tumor</td>
<td>27</td>
<td>40</td>
<td>52</td>
<td>1:2</td>
<td>1:6</td>
</tr>
<tr>
<td>WHO Grade I</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WHO Grade II</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>CE</td>
</tr>
<tr>
<td>WHO Grade IV</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>CE</td>
</tr>
<tr>
<td>ependymoma</td>
<td>17</td>
<td>25</td>
<td>60</td>
<td>3:1</td>
<td>1:3</td>
</tr>
<tr>
<td>WHO Grade I</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>1:7</td>
</tr>
<tr>
<td>WHO Grade II</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>1:1.5</td>
</tr>
<tr>
<td>WHO Grade III</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>CE</td>
</tr>
<tr>
<td>meningioma</td>
<td>9</td>
<td>13</td>
<td>68</td>
<td>8:1</td>
<td>1:8</td>
</tr>
<tr>
<td>WHO Grade I</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td>CE</td>
</tr>
<tr>
<td>WHO Grade II</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>CM</td>
</tr>
<tr>
<td>congenital tumors</td>
<td>4</td>
<td>6</td>
<td>31</td>
<td>1:1</td>
<td>1:1</td>
</tr>
<tr>
<td>lipoma</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>CE</td>
</tr>
<tr>
<td>(epi-)dermoid</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>CM</td>
</tr>
<tr>
<td>carcinoma metastases</td>
<td>4</td>
<td>6</td>
<td>77</td>
<td>1:3</td>
<td>1:1</td>
</tr>
<tr>
<td>bronchial carcinoma</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td>1:1</td>
</tr>
<tr>
<td>ovarian carcinoma</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>CM</td>
</tr>
<tr>
<td>esophageal carcinoma</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>CE</td>
</tr>
<tr>
<td>cavernoma</td>
<td>3</td>
<td>4</td>
<td>55</td>
<td>F</td>
<td>CM</td>
</tr>
<tr>
<td>paraganglioma</td>
<td>2</td>
<td>3</td>
<td>54</td>
<td>M</td>
<td>CE</td>
</tr>
<tr>
<td>WHO Grade II astrocytoma</td>
<td>1</td>
<td>1.5</td>
<td>36</td>
<td>M</td>
<td>CM</td>
</tr>
<tr>
<td>hemangioblastoma</td>
<td>1</td>
<td>1.5</td>
<td>51</td>
<td>M</td>
<td>CM</td>
</tr>
<tr>
<td>total</td>
<td>68</td>
<td>100</td>
<td>56</td>
<td>1:1</td>
<td>1:3</td>
</tr>
</tbody>
</table>

Fig. 1. Pie charts showing histology of operated tumors according to the WHO classification (left) and to the tumor entities (right).

When comparing the outcomes after surgery for extramedullary (CE/filum terminale) and intramedullary (CM) tumors, we observed better results after the intramedullary surgery in terms of lower rates of permanent impairment (0% vs 8% [n = 4]). However, the rates of postoperative improvement were slightly higher in the CE group (64% [n = 32] vs 56% [n = 10]) (Fig. 3B).

Differences in outcome were also observed between among histological types based on the analysis of the 3 most common tumor entities: nerve sheath tumors, ependymomas, and meningiomas (Fig. 3C). The best results...
were achieved after the resection of meningiomas. Ependymoma surgery was associated with the highest rate of postoperative morbidity, with a new permanent deficit in 2 patients, which represented 50% of all patients with a permanent impairment in our series. Two other patients who suffered from postoperative permanent deterioration had undergone surgery for carcinoma metastases.

We also observed differences in outcome in relation to the duration of symptoms before surgery (Fig. 3D). In groups of patients who suffered pain or neurological deficits for less than 6 months and between 6 and 12 months, the rate of postoperative improvement was higher (63% and 68%, respectively) than it was in the group of patients with pain or neurological deficits of more than 1 year’s duration (improvement rate 50%). In the group of patients with pain or neurological deficits of more than 1 year’s duration, there were significantly more patients, and their preoperative disorders were unchanged: disorders were unchanged in 45% of patients with preoperative disorders of greater than 12 months’ duration compared to 26% in patients with preoperative disorders of less than 12 months’ duration. The rate of postoperative impairment was higher in the group with the shortest duration of symptoms (< 6 months).

Cases with initial CCS are summarized in Table 3. As stated above, only 13 patients (19%) presented with this complex of symptoms, whereas in the majority of cases incomplete CCS was observed. Remarkably, CCS cases were frequently associated with additional findings, such as malignant or higher-graded entities in 5, tumor-associated hemorrhage in 3 (spontaneous rupture of tumor or capsule vessels), and previous surgery at an outside institution in 2 cases. Evaluation of early outcome data revealed that preoperative CCS status in 10 patients (77%) was unchanged, partly improved in 2 (15%), and fully improved in 1 (8%). No permanent postoperative impairment was observed in this group. During the follow-up course, only 4 patients (31%) experienced a full recovery in terms of CCS.

Surgery-related complications entailing secondary hemorrhage and making surgical revisions necessary occurred in 3 patients, wound healing disorders occurred in 2 patients, meningitis developed in 1 patient, a CSF fistula occurred in 1 patient, and pulmonary embolism developed in 1 patient.

During the follow-up period, tumor recurrences were rare, inconstant in terms of when they manifested, and independent of tumor histology. Three patients who underwent the initial surgery in our department have had tumor recurrences, to date: in 2 patients after resection of WHO Grade I ependymomas (subtotal resection in one and GTR in the other) and in 1 patient after GTR of a WHO Grade I ependymoma. The median time of recurrence-free survival was 35 months (range 8–42 months). Furthermore, 1 patient who underwent surgery for a WHO Grade I meningioma at another center (documented GTR) had a local recurrence 17 years after the surgery. Early postoperative death (within the first 30 days after surgery) was not observed. During the follow-up period, all 4 patients with intradural carcinoma metastases died after surviving a median of 5 months (range 1.5–7.5 months) due to the primary malignant disease. All other patients were alive at the time of the last follow-up examination.

Discussion

Natural History and Presentation

Lesions within the CE and CM are rare, comprising approximately 6% of all spinal cord tumors. In our study, the majority of the CECMTs occurred during the 6th decade of life (mean 56 years) and showed no sex predominance. The lesions presented a varied histological picture. Nerve sheath tumors, ependymomas, and meningiomas clearly outnumbered other CECMTs. According to previous studies, ependymomas and nerve sheath tumors are known to represent the most common entities in this location, whereas the rate of caudal meningiomas varies among studies.\(^\text{3,5,9,15,16,18,22}\) Similar to the histological features of ubiquitous intradural tumors,\(^\text{1,6,7,21}\) the vast majority of our treated lesions were benign; WHO Grade I and II tumors were diagnosed in 92% of the cases. However, according to previous articles, malignant tumors, such as secondary neoplasms, primitive neuroectodermal tumors, and malignant intramedullary astrocytomas, appear within CM and CE more frequently than in the upper regions of the spine.\(^\text{5,10,11,13,14}\)

According to our results and to previous data, in the majority of cases CECMTs are associated with very unspecific symptoms, such as low-back pain or sciatica, mimicking other more common degenerative lumbar spine diseases.\(^\text{3,13,16,21}\) As long as no functional neurological deficit is observed, these symptoms are usually treat-
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ed conservatively, with health care professionals refraining from the use of imaging diagnostics. Hence, CECMTs can remain undiagnosed for long periods of time, which is underscored by the extremely long duration (median period 24 months) of symptoms before the initial diagnosis was made in our series and reaching a duration of up to 6 years (average of values) in previous publications.13 Regarding the intra- versus extramedullary location, lesions within the CE significantly predominate over CM lesions. This observation is in accordance with the common distribution of all intradural tumors, with 30% of all spinal tumors being intradural extramedullary compared with 10% being intramedullary,4,8,25 which is also applicable to caudal intradural lesions.

Outcome

In the vast majority of cases of CECMT, favorable results can be achieved with surgery; GTR was performed in 88%. Despite the relatively high rate of transient postoperative impairment of 18%, the rate of permanent morbidity was only 6%.

Tumor recurrences were rare, observed in only 4 cases; 3 developed after the patients underwent a first surgery in our department. All of the recurrences occurred after surgery of meningioma, ependymoma, or neurinoma, which is mainly explained by the fact that these 3 are the most common CECMTs. Interestingly, in our series, the majority of recurrences (3 of 4) occurred after GTR. Similarly, in previous publications, recurrence of CECMTs was observed in very few cases; however, the majority that did occur were seen after a subtotal resection.9 All of the recurrent lesions in our series were WHO Grade I lesions. The absence of expected recurrences after surgery for malignant lesions is explained by the limited overall survival rate of these patients, averaging usually far less than 35 months (that is, the median recurrence-free survival of patients with CECMTs in our series).5,14,26 It should be noted that recurrence after the resection of CECMTs is an infrequent but possible late complication and may occur even after a very long period (up to 17 years in our series) and even after GTR of WHO Grade I lesions. Hence, lifetime clinical and radiological control examinations should be considered for all treated patients regardless of the extent of tumor resection and histological grade.

Conus or cauda syndrome was the most uncommon preoperative symptom and was usually associated with additional findings linked to acute tumor expansion, such as hemorrhages or rapid growth of malignant entities. Comparable to trauma or acute disc prolapse, the sudden compression of the CM or CE leads to damage of neural tissue and subsequent onset of CCS. The majority of CECMTs are benign slow-growing tumors that cause slowly progressive fiber compression. As has been shown in experimental studies,27 this chronic compression of the CE or CM induces a decrease of large-diameter myelinated axons, whereas increases in the number of small-diameter myelinated ax-

Fig. 3. Late outcome differences according to the following: severity of initial symptoms (A), extramedullary versus intramedullary location of the tumor (B), tumor histology (C), and duration of symptoms (D).
TABLE 3: Outcome of patients with preoperative CCS*  

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Histology</th>
<th>Location</th>
<th>Duration</th>
<th>Additional Features</th>
<th>Symptoms</th>
<th>Outcome of CCS</th>
<th>Early</th>
<th>Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>78, F</td>
<td>lipoma</td>
<td>CE</td>
<td>4 days</td>
<td>acute hemorrhage</td>
<td>+</td>
<td>unchanged</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>2</td>
<td>84, F</td>
<td>Grade I meningioma</td>
<td>CE</td>
<td>2 days</td>
<td>none</td>
<td>+</td>
<td>changed</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3</td>
<td>67, F</td>
<td>Grade II meningioma</td>
<td>CE</td>
<td>1 mo</td>
<td>none</td>
<td>+</td>
<td>changed</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4</td>
<td>67, F</td>
<td>higher grade hemangioblastoma</td>
<td>CE</td>
<td>12 mos</td>
<td>none</td>
<td>+</td>
<td>changed</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>5</td>
<td>36, F</td>
<td>caeoma</td>
<td>CM</td>
<td>3 days</td>
<td>acute hemorrhage</td>
<td>+</td>
<td>changed</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>6</td>
<td>36, F</td>
<td>higher grade hemangioblastoma</td>
<td>CM</td>
<td>5 mos</td>
<td>previous surgery</td>
<td>+</td>
<td>changed</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>7</td>
<td>68, M</td>
<td>malignant</td>
<td>CE</td>
<td>4 mos</td>
<td>none</td>
<td>+</td>
<td>changed</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>8</td>
<td>68, M</td>
<td>malignant</td>
<td>CM</td>
<td>5 mos</td>
<td>malignant</td>
<td>+</td>
<td>changed</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>9</td>
<td>81, M</td>
<td>metastasis</td>
<td>CE</td>
<td>7 days</td>
<td>acute hemorrhage</td>
<td>+</td>
<td>changed</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>10</td>
<td>74, F</td>
<td>metastasis</td>
<td>CM</td>
<td>1 day</td>
<td>malignant</td>
<td>+</td>
<td>changed</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>11</td>
<td>74, F</td>
<td>Grade I meningioma</td>
<td>CE</td>
<td>1 day</td>
<td>malignant</td>
<td>+</td>
<td>changed</td>
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<tr>
<td>12</td>
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<td>CE</td>
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<tr>
<td>13</td>
<td>68, M</td>
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<td>CE</td>
<td></td>
<td></td>
<td>+</td>
<td>changed</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

* Acute hemorrhage = acute intradural bleeding; FU = follow-up; PNST = peripheral neural sheath tumor; previous surgery = previous surgery at an outside institution leading to iatrogenic CCS; + = present; − = absent.

A previously described correlation between poor initial status and unfavorable outcome was confirmed in our series. The rate of postoperative deterioration was similar in the groups with and without objective deficits (6% and 7%, respectively). The number of patients with postoperative improvement, including those who were free of symptoms, was significantly higher in the group without preoperative neurological disorders, which creates an association between a full recovery and a better preoperative presentation.

Other important outcome factors were the histological entities of ependymoma and carcinoma metastases.

Several authors have noted that the prognosis of and outcome after surgery for some myxopapillary ependymomas seem worse than generally believed. Tumor resection can be safely achieved if the tumor is small and encapsulated (Fig. 4 left). However, due to their slowly progressive growth patterns, ependymomas frequently remain undiagnosed for a very long time and may become very large, leading to rupture of the tumor capsule, subsequent infiltration, and adherence to surrounding neural tissue (Fig. 4 right), which can hamper resection and be associated with new deficits after surgery. Additionally, surgery of large encapsulated CE ependymomas frequently results in incomplete resection, posing a risk of later recurrence.

Intradural carcinoma metastases are also known to be associated with a very limited survival and frequently complicated postoperative courses. Nevertheless, due to significantly higher rates of symptom recovery, surgical treatment of these lesions is still recommended, although it requires exceptionally meticulous planning and execution.

Remarkably, unlike commonly known outcome differences between extramedullary and intramedullary intradural tumors—that is, a significantly higher postoperative morbidity rate for intramedullary located lesions—in our series, better results were observed in the group of patients with CM tumors. According to this observation,
it should be assumed, surgically and clinically, that the prognoses of CE tumors are not identical to intradural extramedullary tumors of the upper spine and should be distinguished as a separate group. This distinction can be explained by their direct proximity and frequent adherence to CE fibers, as described above for ependymomas, which is a feature that is missing in cases of non-CE extramedullary tumors. The large number of ependymomas in the group of patients with CE tumors and subsequent histology-dependent unfavorable results may represent another explanation of these location-related outcome differences. However, it should also be noted that our series contained a significantly smaller number of CM tumors (n = 18) than CE tumors (n = 50), which considerably limits the strength of the finding of intra- vs extramedullary location as a prognostic factor. Figures 5–7 demonstrate pre- and postoperative images of intradural intra- and extramedullary CECMTs.

Limitations

Unfortunately, with the number of cases (n = 68) in the present series, it was not possible to perform an appropriate multivariate analysis in an effort to validate the statistical significance of the observed negative prognostic factors—that is, the long duration of symptoms before surgery, the presence of preoperative neurological deficits, and the histological entity of ependymoma. The reason for the number of cases is that CECMTs are very rare; to achieve a statistically adequate sample size with a single-institution analysis, the data of many consecutive years would be required; however, during such a long period of time, other inhomogeneous factors (changing operative techniques, number of involved surgeons, and so on) could additionally affect the outcome data. The aforementioned negative prognostic factors should be regarded based on observation only, partly supported by the evidence of previously published investigations.

Conclusions

Tumors of the CM and CE present a heterogeneous
clinical and histological picture. A clinical manifestation is the presence of unspecific symptoms mimicking degenerative lumbar syndromes. Despite a significant risk of transient deterioration, early surgery is advisable since the vast majority patients maintain at least their preoperative status and more than 60% have symptom improvement during follow-up. The reversibility of preoperative symptoms is related to the interval between the time of symptom onset and the surgery and to the presence of preoperative neurological deficits. The prognosis for recovery from CCS is less favorable than it is for other deficits. Surgery of ependymoma is associated with more morbidity compared with other benign entities. Meticulous care is required for CE tumors, particularly for CE ependymomas, since they are not as easily resectable as generally believed and seem to be associated with higher rate of perioperative morbidity than other benign entities at this spinal level. Tumor recurrence is generally rare but may occur independent of the tumor grade and the extent of resection. Thus, lifetime follow-up examinations are required for all surgically treated patients.

Fig. 6. A and B: Hemangioblastoma of the CM demonstrated on T2- and contrast-enhanced T1-weighted MR images; both images reveal the marked tumor vessels, which were occluded by a coil embolization via the left L-2 artery before the surgery. C and D: Complete tumor resection was achieved as shown on postoperative T2- and contrast-enhanced T1-weighted MR images.

Fig. 7. A and B: Sagittal T2- and contrast-enhanced T1-weighted MR images revealing WHO Grade I neurinoma of the CE coincident with an intervertebral disc protrusion at L2–3, causing chronically progressive pain. C and D: Sagittal T2- and contrast-enhanced T1-weighted MR images acquired 6 months after tumor resection and sequestrectomy via the same approach; the patient was free of symptoms.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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