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ORIGINAL ARTICLE

Operative strategies in ventrally and ventrolaterally located spinal meningiomas and review of the literature

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Introduction

Meningiomas are usually benign tumors that arise from the meninges. They occur both intracranially and intraspinally. Spinal meningiomas account for 25–46 % of all spinal canal tumors [5, 7, 17, 21, 26]. Typically, these tumors are located in the intradural extramedullary space. Due to space occupying growth they become symptomatic over time. Initial clinical symptoms are not specific and comprise of pain, sensory deficits, motor weakness, and vegetative dysfunction, respectively [13, 14, 29].

If indicated, spinal meningiomas are usually treated by surgical resection only. Technological achievements such as preoperative magnetic resonance imaging (MRI), intraoperative electrophysiological monitoring, and specialized microsurgical techniques have helped to improve the clinical outcome of patients suffering from spinal meningiomas in the last decades dramatically [9, 11, 17, 24, 26].

Similar to the treatment of dorsally attached tumors, the excision of ventrally attached tumors is usually performed via dorsal approaches as well, which is then hindered by the covering spinal cord [26]. Therefore, the surgical removal of such meningiomas is usually considered to be more difficult when compared to dorsally located tumors [21, 26]. In the present study, we thus investigate a large series of patients suffering from such ventrally located spinal meningiomas that were surgically treated in our department during a 20-year period.

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Patients and methods

Patients and clinical data

Clinical data of 164 patients suffering from spinal meningiomas treated at our institution between 1990 and 2010 were analyzed retrospectively. Tumors were classified as dorsally, dorsolaterally, ventrolaterally, and ventrally to the spinal cord depending on dural attachment (Fig. 1). According to this classification, 55 patients with ventrally and ventrolaterally located spinal meningiomas were included in this study.

The demographic data, pre- and postoperative neurological examination, radiological findings, surgical technique, intraoperative findings, surgical complications, and follow-up period were assessed. The neurological state pre- and postoperatively was classified according to the Frankel score (Table 1) [8].

Surgical technique

The lesions were approached by either (a) laminectomy with extention on one side by a facetectomy, (b) laminoplasty

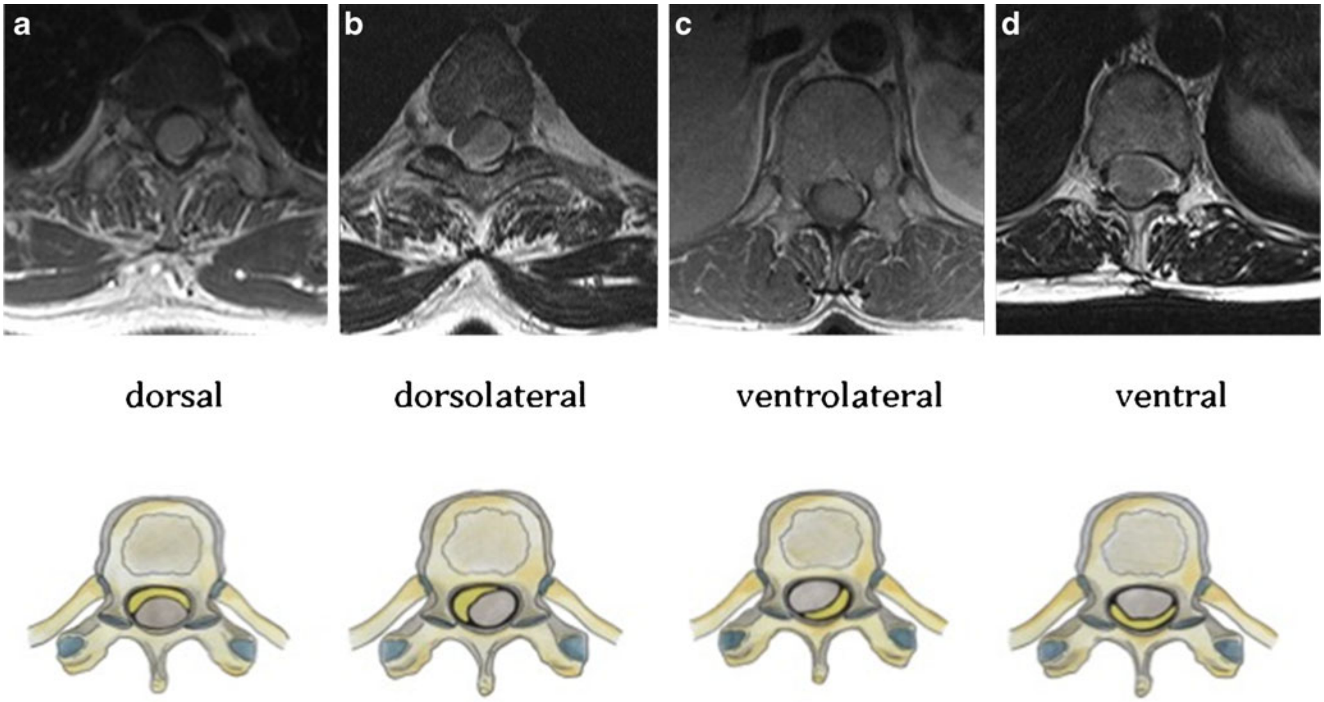

Fig. 1 Classification of the tumor–localization

with replacement of the vertebral arch using miniplates, or (c) hemilaminectomy with resection of the articular process if necessary (Fig. 2). A laminectomy was chosen in strictly ventrally located meningiomas with a small lateral part of the tumor or tumors covered by a thin layer of spinal cord on top. In these cases, the laminectomy was extended bilaterally as far as possible to access the tumor from both sides. In ventrolaterally located lesions with an extensive predominant lateral extension to one side, a hemilaminectomy or a laminoplasty was used. Another aspect was the spinal level of the tumor location. Laminectomy was predominately used in tumors of the thoracic and thoracolumbar level. In relation to the total number of approaches, a laminoplasty or hemilamnectomy was more frequently performed in the cervical spine (Fig. 3).

Routinely, a straight or T-shaped opening of the dura was performed and dentate ligaments were sectioned in order to expose the full width of the intraspinal space. Additionally, after dura opening, the dentate ligament was put under traction with a silk suture on one side for slight rotation of the cord to get a better overview. A cotton sponge was then used for protection of spinal cord tissue (Fig. 4). In some cases of tumors located at thoracic level, a rhizotomy was performed as well. The tumor tissue itself was debulked internally using ultrasonic surgical aspirator. After debulking, the remnant tissue was dissected from the spinal cord toward its dural attachment and then resected stepwise. Finally, the ventral dural attachment of the tumor was coagulated. The resection of the tumor was ultimately defined as "complete" (according to Simpson's grade I or II [25]) or incomplete. Calcification of the meningiomas by intraoperative finding was classified as complete, partial, or absent.

Table 1 Frankel score [8]

A	Complete: No sensory or motor function is preserved in sacral segments S4–S5
B	Incomplete: Sensory, but not motor, function is preserved below the neurologic level and extends through sacral segments S4–S5
C	Incomplete: Motor function is preserved below the neurologic level, and most key muscles below the neurologic level have muscle grade less than 3
D	Incomplete: Motor function is preserved below the neurologic level, and most key muscles below the neurologic level have muscle grade greater than or equal to 3
E	Sensory and motor functions are normal

The surgical procedures were performed under standard microsurgical conditions and permanent control of somatosensory evoked potentials (SSEP). Figure 5 demonstrates the operative steps in a woman, who suffered from a ventrally located spinal meningioma.

All resected tumor tissues were sent to the Neuropathological Institute of University Hospital Essen. Tumors were classified according to WHO classification.

Statistical analysis

Data analyses were done with the SPSS statistical software (SPSS statistical software for Windows release). For statistical analyses, Student's t test was used for paired or

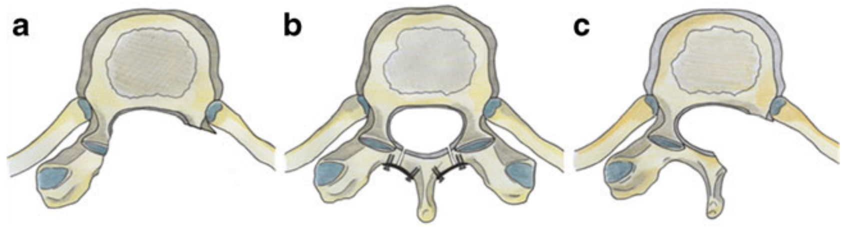

Fig. 2 Operative approaches: **a** Laminectomy extended with optional bone removal of the articular process on the *left side*; **b** laminoplasty; **c** hemilaminectomy with optional resection of the articular process on the *left side*

unpaired variables, and the Pearson chi-square test was used. A difference was considered significant if a p value of 0.05 was reached.

Results

Clinical data

The mean age of 11 male (20 %) and 44 female (80 %) patients was 65.5 years (SD, 11.9; range, 17–86 years). Neurological symptoms that led to hospital admission were sensory disturbances in 52 cases (94.5 %), gait disturbance in 47 cases (85.5 %), and motor deficits in 45 cases (81.8 %). All initial neurological symptoms are summarized in Table 2.

Duration of the initial clinical symptoms until admission to hospital ranged from 1 up to 36 months (average, 10 months; SD, 7.8). The average follow-up period was 33 months (SD, 51.5; range, 1–240 months).

Radiological findings

All of our patients underwent preoperative MRI. In six cases (10.9 %), an additional computed tomography was performed as a first line imaging. All tumors were located strictly intradurally.

In our series of 55 treated meningiomas, 12 (21.8 %) were located ventrally and 43 (78.1 %) ventrolaterally. In 29 cases (52.7 %), the meningioma was located in the thoracic level from T1 to T9, in 15 cases (27.3 %) in the cervical region from C0 to C7, and in 11 patients (20 %), it was located between level T10 and L2. An overview of tumor localization is given in Fig. 6. In the last MRI follow-up, tumor recurrence was found in one patient (1.8 %) after 5 years.

Surgical results

Laminectomy was performed in 42 cases (76.4 %), hemilaminectomy in 4 cases (7.3 %), and laminoplasty in 9 more recent cases (16.4 %). Adhesion to a nerve root was reported in 11 cases (20 %). Tumor calcification was reported in seven cases (12.7 %). Due to this, in two cases (3.6 %), a subtotal removal was necessary. A total resection, in accordance to Simpson grade II, was performed in 96. 4 %. Rhizotomy was performed in 18 patients (32.7 %). Laminoplasty was more often used in the cervical spine in comparison to thoracic and thoracolumbar levels.

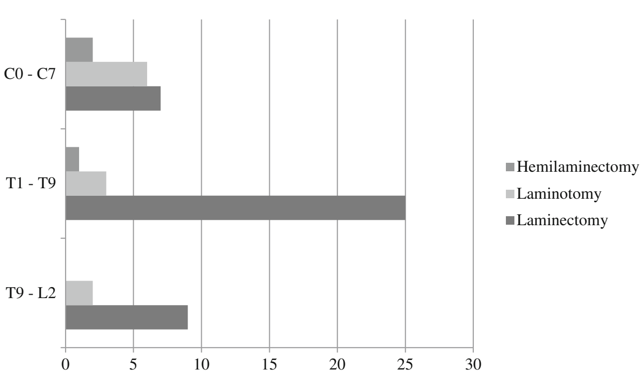

Fig. 3 Surgical approaches according to the spinal level

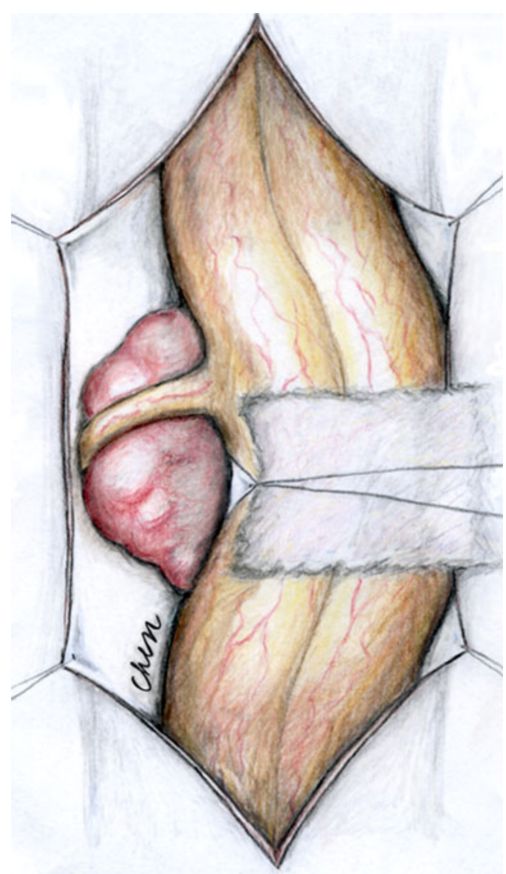

Fig. 4 Slight rotation with the dentate ligament

Histological findings

Histological analysis confirmed a fibroblastic meningioma in 16 cases (29.1 %) and meningiotheliomatous meningioma in 15 cases (27.3 %). Psammomatous meningiomas were diagnosed in nine (16.4 %), transitional meningiomas in eight patients (14.5 %), endotheliomatous meningiomas in six patients (10.9 %), and angiomatous menigioma in one patient (1.8 %). All tumors were classified grade I according to WHO classification.

Functional outcome and complications

The pre- and postoperative neurological findings according to the Frankel score are shown in Fig. 7. We observed improvement with respect to preoperative existing gait disturbances. Whereas preoperatively 27.3 % of the patients were not able to walk independently according to Frankel grade A–C, postoperatively this rate diminished to only 9.1 % (p=0.0134).

An early postoperative neurological examination showed neurological improvement in 37 patients (67.3 %) and neurological worsening in 12 patients (21.8 %). Six patients (10.9 %) showed no change in neurological examination. At the last follow-up examination, 46 patients (83.6 %) showed improved neurological outcome, 4 patients (7.3 %) showed no change in neurological outcome, and 5 patients (9.1 %) showed a persistent neurological worsening (Fig. 8). Table 3 gives an overview of the five patients (9.1 %) suffering from neurological worsening. In one case, an epidural hemorrhage was found as a surgical complication, and the patients underwent revision surgery. In one case, the meningioma was completely calcified, and resection was described as particularly traumatic. Three patients (5.5 %) worsened without apparently related intraoperative features or any abnormalities in the intraoperative monitoring of SSEP.

Postoperative complications occurred in seven cases (13.5 %). Two patients suffered from postoperative epidural hemorrhage. In one patient, tumor resection was complicated by calcification of the tumor as described above. Further complications include postoperative cerebrospinal fluid fistula in three cases (5.5 %), which was treated with lumbar cerebrospinal fluid drain. An external ventricular drain was necessary in one case (1.8 %) of bifrontal intracranial air trapping after operation in a semi-sitting position.

Discussion

General considerations

Several authors have reported their experiences with the surgical management of intraspinal meningiomas [4, 9, 12–16, 19–23, 26]. Overall, the clinical outcome after resection of the lesion is satisfying, but there remain cases with postoperative neurological worsening and unacceptable long-term outcome. The underlying reasons in this regard are discussed controversially. Schaller et al. demonstrated a relationship between histological subtypes and clinical outcome [23]. Klekamp et al. reported a better overall clinical outcome since the widespread availability of MRI and therewith earlier diagnosis of the lesion [13]. However, all authors noticed that bad clinical outcome is rather related to ventrally than dorsally located spinal meningeomas [13, 21, 22, 26].

Fig. 5 MRI scans showing anterior spinal meningioma in a 45-year-old woman. **a**, **b** Sagittal T1-weighted with gadolinium and a sagittal T2- weighted preoperative MRI scan showed an intradural extramedullary meningioma with a ventral dural attachment; **c**, **d** showed an axial T2-weighted MRI with extension of the tumor on the *left side*. Intraoperative pictures of the tumor: **e** initial presentation of the tumor with marked backward displacement of the spinal cord. Laminectomy has been extended in accordance with the prevailing lateral tumor extension; in this case on the *left side*. Dentate ligaments (*arrow*) are sectioned in order to mobilize the spinal cord and to obtain additional space for tumor removal. **f** Tumor removal by mobilization of the spinal cord with surgical cottonoids; **g** using a CUSA minimizing the spinal cords displacement. **h** The ventral dural attachment of the tumor has been extensively coagulated ▶

Clinical considerations

Female patients as shown before are overrepresented in our study. The patients' mean age in this study is comparable to other larger series reporting of meningiomas of the spinal canal. The mean age of these patients was reported from 56 up to 69 years [9, 10, 17, 21, 29].

The ventrally and ventrolaterally located meningiomas are less common compared to dorsal lesions. In this series, 55 cases (33.5 %) out of altogether 164 patients with spinal meningiomas presented with a ventral lesion. Roux et al. reported 39 % anteriorly located meningiomas [21], Yoon et al. [29] 13 %, and Solero et al. [26] 15 %, respectively.

Interestingly, especially ventrally and ventrolaterally spinal meningiomas seem to lack specific symptoms. The neurological symptoms, leading to initial diagnosis of the spinal lesion, were sensory disorders (94.5 %) in the first line. These symptoms are nonspecific symptoms, rather difficult to confirm, and indicative for numerous diseases of the central nervous systems. These unspecific symptoms may explain why the patients suffered from a long duration of symptoms until the correct diagnosis was made [4, 9, 13, 18, 21]. Klekamp and Samii reported an earlier diagnosis and a shorter duration of symptoms caused by spinal meningiomas in the magnetic resonance imaging era. In their series, a shorter duration of symptoms was one of the reasons for a better neurological outcome [13]. The authors demonstrated that MRI shortened the pre-hospital time by

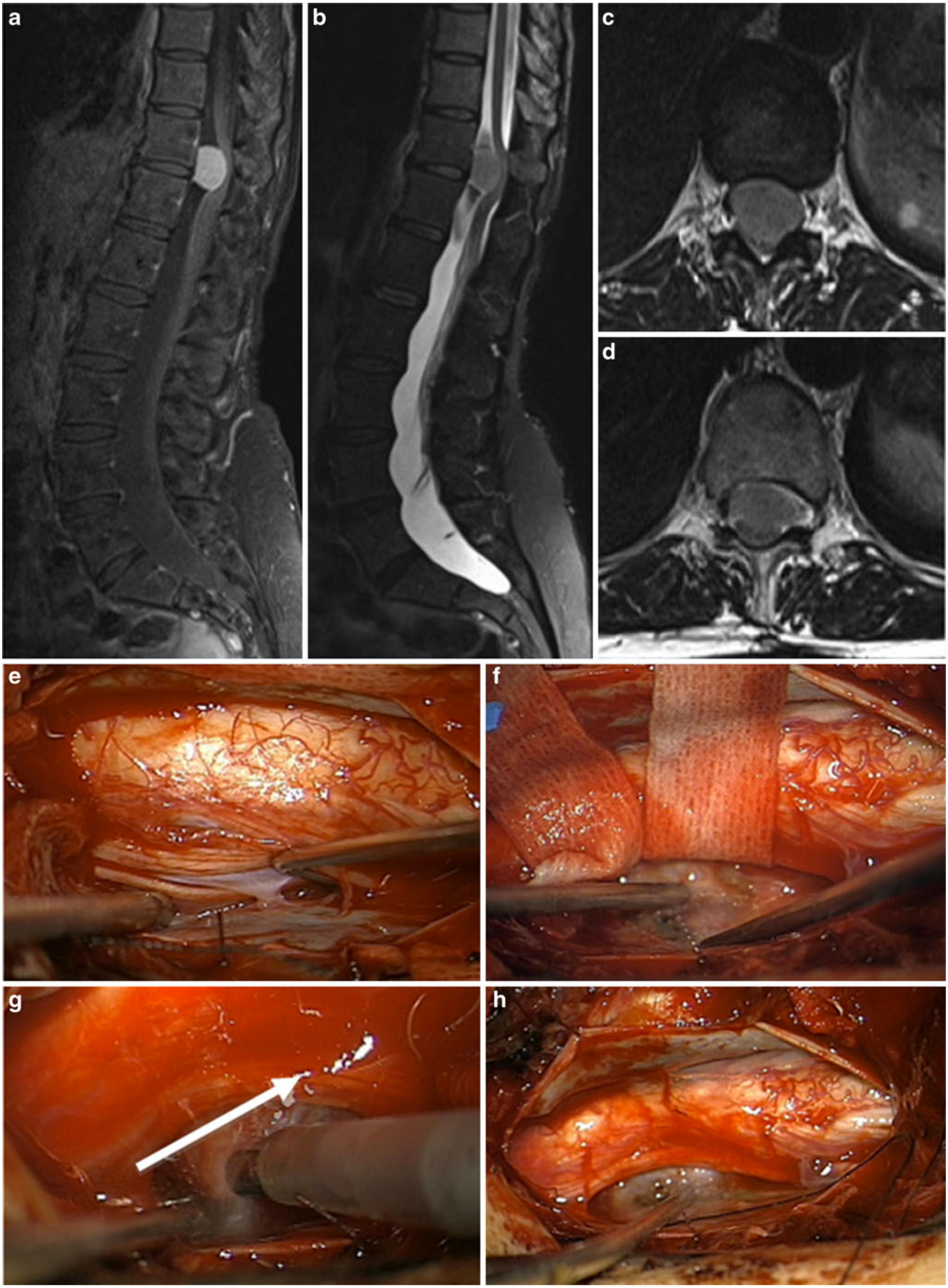
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Table 2 Preoperative neurological symptoms

Symptoms	Number of patients (%)
Sensory deficits	52 (94.5)
Gait disturbance	47 (85.5)
Paresis	45 (81.8)
Myelopathy	44 (80.0)
Bladder dysfunction	18 (32.7)
Radiculopathy	5 (9.1)

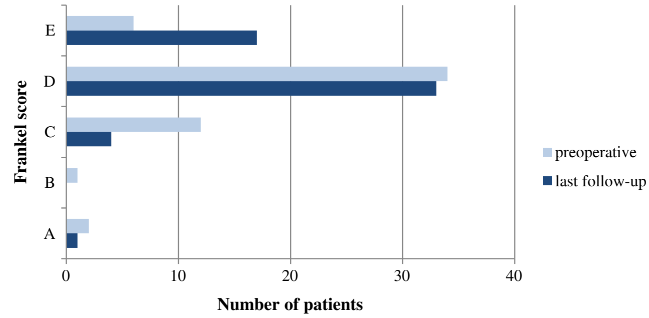

Fig. 7 Frankel score preoperative and in the last follow-up

6 months [13]. In comparison to this study, we observed a longer pre-hospital time, which was in average 10.01 months (range, 1 up to 36 months). In our study, a longer duration of symptoms did not compromise the clinical outcome. We could demonstrate that 90.9 % of our patients were able to walk independently after surgery. Klekamp and Samii showed an excellent clinical improvement of their patients in a long-term follow-up. They showed that 80 % of the patients in their study were able to walk independently after surgery. Nevertheless, we regard magnetic resonance imaging as the imaging gold standard in intraspinal meningiomas. It verifies the segment level of the tumor, provides additional information on a tumor calcification, and depicts its relative position to the spinal cord [1, 24, 28].

In our series, the most frequent localization was the upper thoracic region (T1–T9) with 29 patients (52.7 %), followed by the cervical spine (C0–C7) with 27.3 %. In 20 %, the level was the lower thoracic/lumbar level (T10–L2). All tumors were located ventrally to the spinal cord. In 78.2 % (43 cases), the tumor extended to one side. Levy et al. noted that cervical meningiomas are more often located ventrally, which means that cervical meningiomas should have a poorer prognosis; this has not been confirmed in our experience, though the majority of cervical meningiomas in our study were indeed ventrally or at least ventrolaterally attached [14].

Surgical technique

The main goal of spinal meningioma surgery is complete tumor removal with minimized spinal cord displacement [19, 26]. In this study, we exclusively performed dorsal approaches. A laminectomy was preferred in most of the cases. By laminectomy, the approach could be extended bilaterally as far as possible. Therewith the anterior part of the tumor was visualized without compromising the spinal cord, if necessary from both sides. Such a strategy allows rotating the spinal cord carefully, which provides further space for manipulation. Laminectomy has been advocated by several authors [10, 18, 21]. In previous series as well as in our own study, a secondary stabilization due to potential instability was necessary in none of our patients [2, 14, 18, 21, 27]. Especially in the thoracic spine instability due to laminectomy can be considered a very rare event, even if a facetectomy is additionally performed. In the cervical spine, however, a laminectomy should be avoided if possible. On the other hand, Menku et al. [15] recommended laminoplasty for dorsal approaches. They indicated that the vertebral lamina is an effective and safe mechanical barrier material. They argue that the replacement of the laminar flap using the titanium mini-plates is safe, well suited to serve as a standard posterior approach to intraspinal pathologies, which are offering apparent advantages over laminectomy. Generally, we agree with this philosophy and therefore performed laminoplasties in our recently treated spinal tumors in the first line. However, in our opinion, a laminoplasty can only be used in tumors, in which no facetectomy was necessary. Mainly in purely ventral located tumors a lateral bone removal with

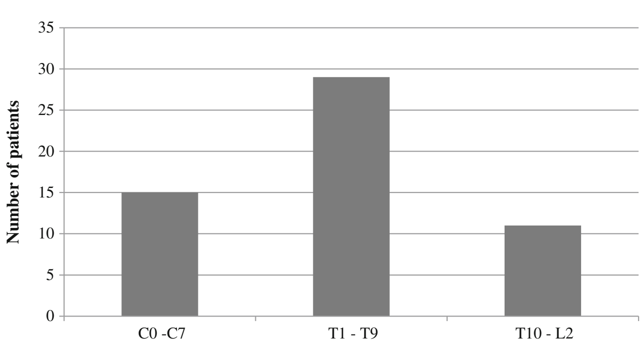

Fig. 6 Level of the spine

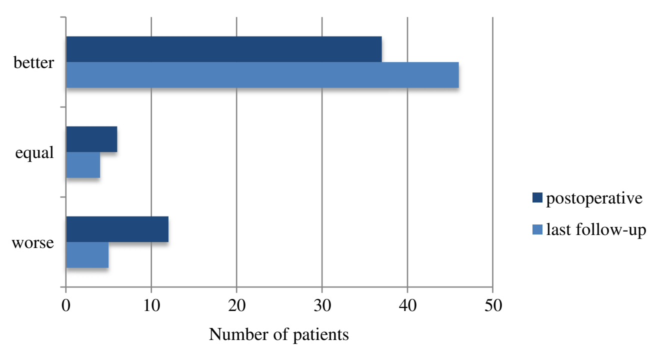

Fig. 8 Functional outcome postoperative and in the last follow-up in comparison to the preoperative clinical neurological status

Table 3 Postoperatively worsened patients in the last follow-up

Patients	Age (years)	Complications	Histological subtypes	Localization	Preoperative Frankel grade	Frankel grade in last follow-up
1	42	None	Fibroblastic	C 1	C	C [a]
2	78	Postoperative epidural hemorrhage	Transitional	T 8/9	C	C [a]
3	77	Tumor resection impaired by severe calcification	Transitional	T 7	C	A
4	80	None	Endotheliomatous	T 10	C	C [a]
5	78	None	Transitional	T 3/4	D	D [a]

[a]Patients with persistent postoperative neurological deterioration, but unchanged functional grade

facetectomy limits the repositioning of the previously dissected vertebral arches. Overall, a dorsal approach is a safe and sufficient method to remove ventrally and ventrolaterally located meningiomas. A ventral approach was not performed in our series. A tumor removal of a ventrally located meningioma via a ventral spondylectomy was reported by Angervine et al. [2]. These authors reported on a ventrally located meningioma in the cervical part of the spine. In our opinion, the ventral approach bears a high risk of complications, especially concerning the dural closure after a ventral tumor removal. Consequently, also in the recent literature the ventral approach was usually recommended for extradural pathologies [6].

In the present series, 53 meningiomas (96.4 %) were removed totally according to a Simpsons grade II removal [12, 14]. This rate is in accordance with the literature, where the rates of complete tumor removal are reported to be between 82 and 98 % [9, 10, 13, 14, 17, 26]. A subtotal removal of the meningioma was necessary in two cases (3.6 %). In both cases, calcification of the meningioma was the main reason. In this regard, we agree with Levy et al. that total excision of such calcified tumors should not be enforced if the lesion is located closely to the spinal cord itself [14].

Histological findings

Meningiomas with a calcified portion have to be evaluated more specifically. Levy et al. reported about three out of four calcified tumors that showed poor clinical outcome [14]. In our series, seven patients (12.7 %) presented with a calcified meningioma. A postoperative neurological deterioration was seen in five (9.1 %) of these cases. These are 71.4 % of all calcified meningiomas. However, all patients improved in the early period of postoperative time except one patient who developed an intraspinal epidural hematoma.

Schaller reported on the relationship between the histological subtypes and the clinical outcome of all spinal meningiomas included in his study. Psammomatous meningiomas were described as a tumor entity with a more unfavorable clinical outcome in comparison to other meningioma subtypes [23]. We could not confirm such relationship in our series.

Functional and neurological outcome

The functional and neurological outcome after surgical treatment of intraspinal meningiomas is favorable in the majority of the cases. In our series, the neurological outcome was improved or equal in 90.9 % at the time of last follow-up. Before surgery, 72.7 % of the patients were able to walk independently; after surgery, a significant improvement was seen, and this rate increased up to 90.9 % ($p=0.0134$). Other authors reported similar results ranging between 61 and 98 %, which regard to all spinal meningiomas [9, 13, 14, 18, 21, 23, 26].

A permanent postoperative neurological deterioration was reported in recent literature in 0 to 10 % of the cases [3, 4, 10, 11, 14, 22, 29]. In our series, 9.1 % of the patients were without further improvement at the last follow-up. Many factors with potential risk for permanent neurological deterioration after surgery were reported [16, 17, 21, 23, 26]. Tumor calcification is one of the main risk factors and also present in one of our patients with fixed neurological worsening after surgery.

Limitation of this study

The present study was carried out in a single center. Nevertheless, we report on a large number of patients with only ventrally and ventrolaterally located spinal meningiomas. However, the present study design did not allow a long-term clinical follow-up. This certainly limits the present study's value for a long-term prediction of the clinical outcome of ventrally located spinal meningiomas.

Conclusion

Ventrally and ventrolaterally located meningiomas can be treated with a good neurological outcome via posterior approaches.

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Comments

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In this retrospective analysis, Dr Özkan and co-authors present their surgical strategy and clinical results in 55 patients treated microsurgically for a ventral/ventrolateral spinal meningioma over a 20-year period. The majority of tumors were located in the thoracic spine. Total resection, defined as Simpson grade II removal, was achieved in 96 % of the patients, although gross calcification prevented complete tumor resection in two cases. After a mean follow-up period of 33 months (range, 1–240 months), one tumor recurrence was displayed on MR imaging. Improvement of preexisting neurological deficits was observed in 84 % of the patients, and a permanent deterioration was observed in 9 % of the cases. No neurological improvement occurred in 7 % of the patients. Importantly, most patients unable to walk preoperatively regained this important function after surgery.

I share the authors' experience that microsurgical resection of spinal meningioma is a very rewarding treatment in the majority of patients. Dramatic improvement of function particularly gait disturbance/re-ability to walk can be achieved even in long-standing cases. Also, bipolar coagulation of the dural tumor matrix, i.e., Simpson grade II resection, usually suffices to prevent tumor recurrence on long-term follow-up. In my experience, the dural attachment in the majority of tumors is lateralized to one side even in apparently ventrally located meningiomas. Therefore, complete resection is usually well feasible via a hemilaminectomy thus rendering laminectomy/laminoplasty unnecessary in most cases. This paper provides valuable data to the reader on functional results after state of the art microsurgical resection of spinal meningioma.

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The Authors present their experience with the removal of ventrally and lateroventrally located spinal meningiomas: the series is consistent

(55 patients out of 164 spinal meningiomas observed), even though it covers a long time span (20 years). The conclusion is that almost all the cases observed may be possibly removed via a posterior approach, in all its variants: laminectomy, hemilaminectomy with/without facetectomy, laminoplasty. Actually, surgery in one calcified meningioma is reported as particularly traumatic, and the patient worsened postoperatively. In the literature, very seldom has been reported an approach that is different from a posterior one, in thoracic meningiomas. Jenny et al. (1) reports on a case of transthoracic transvertebral approach to remove a calcified meningioma. Other reports of the literature (2) of anterior approaches for ventrally located lesions refer to schwannomas or neuoenteric cysts: in general, an anterior approach is suggested in cases with remarkable calcifications or, at the opposite, with bulky cystic components, and in general for recurrent tumors with significant arachnoidal scarring. The limit of this approach is the difficulty of closing the dura; however, since in the last years, we have learned how to treat this problem, particularly in anterior skull base surgery; I think that nowadays in very selected cases an anterior approach could be taken into consideration. Purely ventral meningiomas that are completely calcific should be evaluated in this possibility, balancing pros and cons. I think that even in these cases, a posterolateral with costotraversectomy approach could give sufficient space for a safe removal of the lesion; further possibilities are added by the use of surgical endoscope that can greatly help the exploration and the removal of tumors from the anterior spinal space, with a posterolateral approach.

The surgical strategy suggested and applied by the authors has been to expose the dura sufficiently to control both inferior and superior poles of the meningioma, to cut one or two dentate ligaments in order to allow a rotation without traction of the cord, and in selected cases, to associate a selective section of some dorsal roots as well (only at thoracic level). The cord was then gently rotated with traction stitches to allow a clear vision of the bulk of the tumor. Decompression, detachment, and coagulation of the dura to obtain a Simpson II removal have been carried out. Two cases operated with this technique, and without apparent intraoperative problems, deteriorated after surgery: there are no data concerning intraoperative monitoring in these patients, but it is possible that the rotation of the cord had been excessive for them, even though it has been similar to that well tolerated in different patients. This is the specific contribution of intraoperative monitoring for surgery that is to taylorize the surgical maneuvers. In other cases of postoperative deterioration, an extradural haematoma has been found: haemostasis is critical and not always easy to achieve in the extradural space. Some surgeons leave big fragments of gelfoam or of surgicel, but these may swell with blood and compress the cord after closure, particularly if a laminoplasty has been carried out. Therefore, before closure the surgical field must be perfectly clean, even in the presence of an increased vein pressure, that the anaesthesiologist may simulate with the Valsalva maneuver.

What is typical of this series, and in agreement with my personal observation, is that the diagnosis is rather late for this kind of lesions: 10 months in mean the length of preoperative symptoms (but up to 3 years) and almost one third of patients not able to walk, before surgery. It is really surprising how seldom the diagnosis is well timed, possibly because the symptoms are difficult to express in the beginning (sensory disturbance, not specific), and also because a thorough physical examination is seldom carried out both by family doctors and by neurologists referred to. The early diagnosis is particularly important because there is a direct relation between the pre- and postoperative clinical status, in this as in all other reports.

References

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2. Dickman CA, Apfelbaum RI (1998) Thoracoscopic microsurgical excision of a thoracic schwannoma. Case report. J.Neurosurg. 88: 898–902

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The paper details the surgical strategies in a total of 55 patients with ventrally and ventrolaterally located spinal meningiomas and evaluated the postoperative outcome retrospectively. Ventrally and ventrolaterally located meningiomas are less common compared to dorsally located ones, but these types of meningiomas are more challenging to remove. However, this retrospective study demonstrates that ventrally and ventrolaterally located meningiomas can be treated via posterior approaches with an appropriate long-term neurological outcome. A permanent postoperative neurological deterioration was seen in five patients (9.1 %). However, the neurological outcome was improved or equal in 90.9 % in the long-term follow-up.

A ventrolateral location of the meningioma was found in most of the patients (78.2 %) mainly treated by a laminectomy (76.4 %). Individually tailored different dorsal approaches to the spinal column were detailed, but a laminectomy was the usual approach for the microsurgical resection. Hemilaminectomies were done only in four cases (7.3 %), and laminoplasties were used in nine more recent cases (16.4 %) usually in the cervical spine. The high rate of laminectomies is explained by the location of the meningiomas, mainly in the thoracic spine. A laminectomy seemed useful especially if the dural attachment of the meningioma was unable to define exactly in the preoperative imaging and allows a slight rotation the spinal cord if necessary.

Remarkable is the relatively high rate of rhizotomies; this was performed in 18 patients (32.7 %), however, without any documented or mentioned complication related to this procedure. In total, seven patients (12.7 %) presented with calcified meningiomas. Calcification of the tumor was found as a risk factor for a higher surgical morbidity. All meningiomas were classified as grade I according to WHO classification. However, the figures were not high enough to evaluate the different histological subclasses and their influence to the surgical morbidity. Generally, this paper is relevant and helps us in our daily neurosurgical routine treating those types of meningiomas.