Meningeal carcinomatosis is a rare but devastating complication of systemic malignancies. The clinical presentation of this complication varies depending on the site of meningeal infiltration. The manifestation of spinal meningeal carcinomatosis is usually characterized by paraparesis, sensory deficits, radicular pain, asymmetrical reflexes, and bowel and/or bladder dysfunction.\(^\text{21,27,42}\) We report the case of spinal meningeal carcinomatosis secondary to cutaneous malignant melanoma resulting from SAH. Subarachnoid hemorrhage resulting from a metastatic spinal tumor arising outside the CNS is extremely rare. To our knowledge, only one case has been reported in the literature.\(^\text{25}\) Additionally, there are five more cases associated with SAH secondary to a metastatic spinal tumor in the literature, but the origin of these metastatic tumors was primary CNS neoplasms.\(^\text{7,25,28,35}\) In all the previously reported six cases the patients presented with SAH and spinal or cranial neurological deficits. To our knowledge, ours is the first reported case of spinal metastatic melanoma presenting with spinal SAH and no neurological deficit before and after hemorrhage. The clinical and radiological characteristics are analyzed in light of the pertinent literature.

**Case Report**

**Presentation and Examination.** This 26-year-old man was referred to our hospital in October 2002 with a few-day history of sudden-onset back pain and subsequent mild headache. At admission, his neurological status was normal except for neck stiffness. Unenhanced and contrast-enhanced CT scanning of the brain demonstrated unremarkable findings whereas examination of fluid obtained by lumbar puncture revealed bloody and xanthochromic CSF. The biochemical analysis of the CSF was as follows: protein 317 mg/dl, glucose 49 mg/dl, and Cl 117 mEq/L. The patient was admitted to our department because of the results of this evaluation and for treatment of SAH.

The patient’s medical history was significant. Two years prior to presentation, he had undergone excision of a scrotal black nevus and ilioinguinal lymphadenectomy at another hospital. The lesion had been diagnosed as a malignant melanoma (Clark Level 4, Breslow thickness 2.8 mm). Consequently, he received immunochemotherapy. All investigations of the metastatic lesion were nondiagnostic during the intervening 2 years. Routine laboratory data including coagulation factors were within normal limits. Four-vessel cerebral angiography revealed no vascular disease. Before spinal angiography was performed, T\(_1\)-weighted Gd-enhanced MR imaging of the spine revealed multiple subarachnoid and intramedullary nodular lesions at various levels of the
spinal cord and cauda equina (Fig. 1). These diffuse lesions were considered to be metastatic melanomas because of the patient’s medical history as well as the MR imaging features of the lesions. Because there was no indication of vascular malformation on spinal MR imaging, spinal angiography was not performed. Lumbar puncture was repeated and CSF was investigated cytopathologically for verification of the diagnosis.

Cytopathological Examination. Cytocentrifuge preparations and cell blocks were prepared from the CSF specimen. The material was extremely bloody and contained scant amounts of cells that had eccentric nuclei, coarse chromatin with irregular nuclear contours, and conspicuous nucleoli (Fig. 2 left). Some of these atypical cells were binucleated (Fig. 2 right). Although immunocytochemical studies failed to show positivity for HMB-45 because of the hypocellularity, morphological findings indicated a malignant neoplasm consistent with metastatic melanoma.

Treatment. After this cytopathological examination, the diagnosis was accepted as spinal meningeal carcinomatosis secondary to malignant melanoma. Palliative craniospinal axis radiotherapy and chemotherapy were undertaken. Unfortunately, the patient gradually worsened and died 3 months later. An autopsy report could not be obtained.

Discussion
Spinal SAH is a rare condition comprising less than 1% of all cases of SAH. Its clinical picture is characterized by sudden-onset back pain, which is usually located at the level of the lesion but may radiate into the legs. Subsequently, paraparesis and meningismus develop in most cases. If the hemorrhage extends to the cerebral subarachnoid space, headache, vomiting, and confusion are observed. The most frequent causes of spinal SAH are trauma and vascular malformations. Rare causes include anticoagulation disorders, aneurysms, and collagen-based vascular disorders. In rare cases the origin cannot be determined despite exhaustive investigations.

Primary spinal tumors, especially ependymomas, are also relatively common causes of SAH. Spinal SAH associated with a primary intradural spinal tumor was first reported in 1930 by Andre-Thomas and colleagues. This tumor was an L2–3 neuroglioma. Various cases have been reported in the following years. Eventually spinal SAH associated with a primary spinal intradural tumor, as a clinical syndrome, was first described in 1951 by Fischer. According to this classic description, SAH associated with a spinal tumor is characterized by acute-onset back pain, bloody CSF, and headache.

In our patient, because there was no history of trauma, radiotherapy, anticoagulation therapy, or lumbar puncture, the hemorrhage was viewed as spontaneous. The actual mechanism of tumor-related spontaneous bleeding is controversial. In the literature it is explained in the following manner. 1) Normal vessels around the tumor can be invaded by the lesion, leading to hemorrhage. 2) Abnormal tumoral vessels (angiogenic vessels), which are thin and fragile, easily rupture because of the tumor-induced distortion and extension. 3) The endothelial proliferation of tumoral vessels may cause hemorrhage due to inadequate blood supply to the tumor, which can cause necrosis and bleeding. The location of the spinal tumor may also be an important factor in the occurrence of hemorrhage. The cauda equina and conus medullaris regions are associated with greater movements of traction along the spinal axis during physical activity. The strong physical stress may increase motion of the cauda equina and may stimulate bleeding. Therefore, vascular structures of the tumor located in the cauda equina can easily be stretched and bleed. In 1978, Djindjian, et al., reviewed 50 cases of primary spinal tumors associated with SAH from the literature and found that 88% were located in the cauda equina.

To our knowledge, SAH due to a metastatic spinal intradural tumor arising from outside the CNS has been described in only one other case, reported in 1992 by Lossos and Siegal (Case 2). This 49-year-old woman underwent surgery for a rectal adenocarcinoma, and 5 years later, she presented with SAH and paraparesis secondary to spinal
Spinal subarachnoid hemorrhage

## Signs and symptoms
Signs and symptoms depend on which part of the neuraxis is involved. In cases of cerebral involvement the patient may present with headache, confusion, vomiting, cranial nerve paresis, and seizures, whereas signs and symptoms of spinal involvement are back pain, paraparesis, and radicular findings. Lower motor neuron weakness is the most common sign, seen in almost 80% of patients. The most important diagnostic test in meningeal carcinomatosis is examination of a CSF sample obtained by lumbar puncture. The presence of malignant cells in the CSF is diagnostic. A single CSF examination reveals positive findings in 50% of the cases, whereas three examinations yield positive findings in 90% of the cases. In patients with known cancer, Gd-enhanced MR imaging may be diagnostic when subarachnoid enhancing nodules can be demonstrated in the cranium or spine. We believe that if four-vessel cerebral angiography is nondiagnostic in patients with SAH, spinal SAH should be considered in cases of previous malignancy.

Meningeal carcinomatosis is defined as the diffuse infiltration by metastasizing malignant cells of the leptomeninges and subarachnoid space. It is also known as carcinomatous meningitis, neoplastic meningitis, and leptomeningeal metastases. The overall incidence is approximately 5% in cases of systemic cancer. The metastatic route from outside the CNS to the leptomeninges and the spinal cord remains unclear. It is believed that there are three possible routes for metastases from extra-CNS tumors. The first is arterial embolization in which the tumoral cells pass the systemic circulation after lung diffusion and reach the spinal cord via the arterial bloodstream. These metastases are frequently situated in the posterior horn of the medulla spinalis which is supplied by vessels of the central artery. The second route is venous dissemination via the Batson plexus in which the paravertebral venous plexus may allow retrograde spread due to low-pressure system. It is accepted that this is the most common route of dissemination in cases of pelvic and retroperitoneal tumors. The absence of vertebral metastases, however, makes it unlikely in our case. The third route is direct invasion of the spinal roots in which the tumor cells may spread by means of perineural lymphatic vessels that accompany spinal nerves. Perineural invasion is an important mode of tumor spread, especially in cases of cutaneous malignancy. According to Weissman and Grossman this route is common when the spinal cord is affected by leptomeningeal invasion. Each of these three pathways could alone explain leptomeningeal involvement, but this entity may also be due to a combination.

Meningeal carcinomatosis may be focal or diffuse. Signs and symptoms depend on which part of the neuraxis is involved. In cases of cerebral involvement the patient may present with headache, confusion, vomiting, cranial nerve paresis, and seizures, whereas signs and symptoms of spinal involvement are back pain, paraparesis, and radicular findings. Lower motor neuron weakness is the most common sign, seen in almost 80% of patients. The most important diagnostic test in meningeal carcinomatosis is examination of a CSF sample obtained by lumbar puncture. The presence of malignant cells in the CSF is diagnostic. A single CSF examination reveals positive findings in 50% of the cases, whereas three examinations yield positive findings in 90% of the cases. In patients with known cancer, Gd-enhanced MR imaging may be diagnostic when subarachnoid enhancing nodules can be demonstrated in the cranium or spine. We believe that if four-vessel cerebral angiography is nondiagnostic in patients with SAH, spinal SAH should be considered in cases of previous malignancy.

Meningeal carcinomatosis is treated with a combination of radio- and chemotherapy (especially intrathecal). Despite aggressive treatment, the disease is associated with a very poor prognosis; most patients die within 4 months of diagnosis. Without treatment, the median survival of patients with meningeal carcinomatosis is 4 to 6 weeks.

### Conclusions

Although very rare, this case underscores several factors. 1) Spinal SAH due to spinal metastases should be considered the differential diagnosis of patients with previous malignancy. 2) Spinal SAH may manifest without paraparesis and sensory deficits. 3) Magnetic resonance imaging is nondiagnostic in patients with SAH, spinal MR imaging should be performed before invasive modalities such as spinal angiography or myelography because MR imaging may reveal the source of hemorrhage, as in our case. In addition, MR imaging provides information related to tumor type. It may be diagnostic in patients with malignant melanoma because of two specific paramagnetic characteristics of melanin: 1) the presence of free paramagnetic radicals of melanin that reduce the relaxation time of T₁- and T₂-weighted images; and 2) the presence of breakdown products originating from tumor hemorrhage. Spinal melanoma usually exhibits slight hyperintensity on T₁-weighted images and iso- or hypointensity on T₂-weighted sequences compared with that of normal spinal cord. After intravenous administration of Gd, the tumor exhibits homogeneous enhancement; however, these features may vary depending on intratumoral bleeding and melanin content.

Meningeal carcinomatosis is treated with a combination of radio- and chemotherapy (especially intrathecal). Despite aggressive treatment, the disease is associated with a very poor prognosis; most patients die within 4 months of diagnosis. Without treatment, the median survival of patients with meningeal carcinomatosis is 4 to 6 weeks.

### Summary of clinical features of spinal SAH associated with metastatic spinal tumors

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>Age (yrs), Sex</th>
<th>Primary Tumor</th>
<th>Level of Metastases</th>
<th>Clinical Findings</th>
<th>Treatment</th>
<th>Survival†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tarlov &amp; Keener, 1953</td>
<td>0.4, M</td>
<td>cervical dura sarcoma</td>
<td>T-2</td>
<td>quadriparesis, anisocoria</td>
<td>none</td>
<td>died</td>
</tr>
<tr>
<td>Papo, et al., 1985</td>
<td>35, M</td>
<td>brain ependymoma</td>
<td>diffuse</td>
<td>paraparesis</td>
<td>cervical radiculopathy</td>
<td>RT, chemo</td>
</tr>
<tr>
<td>Losos &amp; Siegal, 1992</td>
<td>16, F</td>
<td>cerebellum medulloblastoma</td>
<td>C3-6</td>
<td>paraparesis</td>
<td>op, RT</td>
<td>alive, 21 mos</td>
</tr>
<tr>
<td>Chang, et al., 2001</td>
<td>51, M</td>
<td>brain giant cell GBM</td>
<td>diffuse</td>
<td>cranial nerves palsies</td>
<td>RT, chemo</td>
<td>died, 3 yrs</td>
</tr>
<tr>
<td>present case, 2004</td>
<td>26, M</td>
<td>scrotum malignant melanoma</td>
<td>C-4, T-12, L-2</td>
<td>diffuse</td>
<td>none</td>
<td>died, 1 mo</td>
</tr>
</tbody>
</table>

† Survival after the diagnosis of spinal metastases.
imaging of the spinal cord may be important to determine the source of SAH in patients in whom four-vessel cerebral angiography has demonstrated nondiagnostic results.

References


S. Inci, et al.