Hyperhidrosis, namely enhanced sweating, is a disturbance caused by sympathetic dysfunction of the central or peripheral nervous system. Intramedullary spinal tumors presenting as hyperhidrosis are rare. Ganglioglioma is a rare tumor that accounts for 0.4%–9% of all primary CNS neoplasms, and may occur predominantly in the supratentorial area. Spinal gangliogliaoma accounts for 1.1% of all intramedullary tumors.

We report a rare case of intramedullary thoracic spinal cord ganglioglioma that caused hyperhidrosis, with unique MRI findings.

Case Report

History and Examination. This 16-year-old boy presented with abnormally enhanced sweating on the right side of his neck, upper extremity, and chest that had been occurring for 6 years. At the age of 12 years he developed numbness and pain in the left thigh. After 4 years he was referred to our department because MR images revealed an intramedullary tumor at the right side of the spinal cord at the T2–3 level. The tumor showed partial enhancement after Gd administration. The patient underwent removal of the tumor via hemilaminectomy of T2–3. Only subtotal resection was achieved because the margins of the tumor were unclear. Histopathological examination revealed ganglioglioma. Hyperhidrosis gradually improved after surgery. Hyperhidrosis is a rare clinical manifestation of intramedullary spinal cord tumors, and only a few cases have been reported in the literature. The location of the tumor origin, around the right gray matter of the lateral spinal cord, may account for the hyperhidrosis as the initial symptom in this patient. Physicians should examine the spinal cord using MRI studies when a patient has hyperhidrosis with some motor or sensory symptoms of the extremities.

Key Words • hyperhidrosis • intramedullary spinal cord tumor • ganglioglioma
Intramedullary spinal ganglioglioma presenting as hyperhidrosis

level. The signal intensity of the tumor was isointense on the T1-weighted image (Fig. 1A) and hyperintense on the T2-weighted image (Fig. 1B). There was no syringomyelia, cystic change, or edema of the spinal cord. The Gd-enhanced T1-weighted image demonstrated only partial enhancement at the right dorsal spinal cord (Fig. 1C). A CT scan showed no calcification or bone remodeling at the T2–3 level. Thoracic radiographs revealed mild scoliosis (Cobb angle 11°).

Surgical Treatment. Surgical removal of the tumor was performed with the patient placed prone after induction of general anesthesia. After right hemilaminectomy of T-2 and T-3, the dura mater was opened. The right lateral column of the spinal cord showed local swelling with dilated veins dorsally (Fig. 2A). Myelotomy was performed via the right dorsal root entry zone. The tumor looked dark red and bled easily (Fig. 2B). Because the margin between the tumor and the normal spinal cord tissue was unclear, approximately 50% of the tumor was resected. Histopathological diagnosis was ganglioglioma (WHO Grade I, Fig. 3).

Postoperative Course. Postoperatively, the patient showed worsened motor weakness of the right lower extremity and decreased sensation in the left lower extremity. Postoperative MR images demonstrated decreased size of the intramedullary tumor (Fig. 2C and D). Deteriorated motor weakness, left leg pain, and the hyperhidrosis gradually improved. With rehabilitation the patient could walk without assistance, and he was discharged at 4 weeks after surgery. There was no tumor recurrence during the 2-year follow-up period.

Discussion

Hyperhidrosis in Intramedullary Tumors

Hyperhidrosis, a sweating disturbance, is characterized by the secretion of sweat that exceeds the normal physiological needs of the body. This condition is usually classified into 2 types, primary and secondary. Secondary hyperhidrosis has many causes, which have been reported to include spinal cord injury posttraumatic...
syringomyelia, or Chiari malformation with syringomyelia. Hyperhidrosis is a rare symptom of intramedullary spinal cord tumors; only 3 cases of hyperhidrosis caused by this type of tumor have been reported in the literature. The histopathological diagnosis in these cases was astrocytomas in 2 and gangliocytoma in 1 (Table 1). Therefore, this is the first case report of hyperhidrosis caused by spinal ganglioglioma. Including our case, the duration from onset to diagnosis ranged from 6 months to more than 10 years, and the clinical response to the resection was generally good.

Mechanism of Hyperhidrosis

The sweating pathway originates in the preoptic area of the anterior hypothalamus and descends uncrossed through the medial portion of the lateral funiculus of the brainstem to synapses on preganglionic neurons in the intermediolateral column of the spinal cord. The sympathetic preganglionic neurons are distributed in the lateral horn from T-1 to L-2. List and Peet reported that the face and eyelid were supplied by the spinal segments of T1–4, the upper limbs by T2–8, the trunk by T4–12, and the lower limbs by T10–L2. In cases of tumor location at the T2–3 level, the supposed area of hyperhidrosis will be the face and the upper limb, but in our patient the hyperhidrosis actually included the neck, arm, and chest, probably because one preganglionic sympathetic neuron may innervate several postganglionic fibers.

In our case, the tumor probably arose around the right gray matter of the lateral spinal cord, and caused dysfunction of the preganglionic sympathetic neurons initially. Then, numbness and pain in the left lower extremity and motor weakness of the right lower extremity appeared due to compression of the right spinothalamic and the pyramidal tracts by the tumor. Thus, hyperhidrosis can be the initial symptom of a slowly growing intramedullary tumor such as ganglioglioma in the gray matter of the lateral spinal cord.

Neuroradiological Findings of Spinal Ganglioglioma

Spinal ganglioglioma has been reported to affect young people (mean age 12 years), to occur predominantly in the cervical region, and to have an average length of 8 vertebral body segments. The thoracic region is the second most frequently affected region of the spinal cord. Tumor cysts were present in 46% of the patients in whom MRI studies were performed. The lesion appearance was mixed intense (84%) on T1-weighted images, and there was a homogeneous (60%) or heterogeneous (40%) signal on T2-weighted images. With Gd administration, the tumor showed patchy (65%), focal (19%), diffuse (4%), or cord surface (58%) enhancement, although 15% displayed no enhancement. The spinal ganglioglioma in our case was located on the right side of the spinal cord, with partial cord surface enhancement. Preoperative diagno-
Intramedullary spinal ganglioglioma presenting as hyperhidrosis

TABLE 1: Literature review of cases of hyperhidrosis caused by intramedullary spinal tumors*

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>Patient Age (yrs), Sex</th>
<th>Symptom Duration</th>
<th>Location</th>
<th>Distribution of Hyperhidrosis</th>
<th>Histo Findings</th>
<th>Tx</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chatterjee et al., 2004</td>
<td>56, F</td>
<td>6 mos</td>
<td>FM–T2</td>
<td>head, neck</td>
<td>astrocytoma</td>
<td>STR</td>
<td>resolved completely</td>
</tr>
<tr>
<td>Jacob et al., 2005</td>
<td>19, F</td>
<td>10 yrs</td>
<td>C7–T3</td>
<td>face, neck</td>
<td>gliangiocytoma</td>
<td>STR</td>
<td>stable</td>
</tr>
<tr>
<td>Klüüner et al., 2007</td>
<td>17, M</td>
<td>&gt;10 yrs</td>
<td>T1–2</td>
<td>face, neck</td>
<td>low-grade astrocytoma</td>
<td>GTR</td>
<td>resolved completely</td>
</tr>
<tr>
<td>present study</td>
<td>16, M</td>
<td>6 yrs</td>
<td>T2–3</td>
<td>neck, upper limb, chest</td>
<td>ganglioglioma</td>
<td>STR</td>
<td>resolved partially</td>
</tr>
</tbody>
</table>

* FM = foramen magnum; GTR = gross-total resection; histo = histopathological; STR = subtotal resection; Tx = treatment.

References

**Disclosure**

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

Author contributions to the study and manuscript preparation include the following. Concept and design: Murakami, Koyanagi, Kaneko, Yoneta, Keira, Wamibuchi. Acquisition of data: Murakami, Koyanagi, Kaneko, Yoneta, Keira. Analysis and interpretation of data: Murakami, Koyanagi, Kaneko, Keira. Drafting the article: Murakami, Koyanagi, Kaneko, Keira. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Murakami. Administrative/technical/material support: Koyanagi, Wamibuchi. Study supervision: Koyanagi, Wamibuchi, Hasegawa, Mikuni.

**Conclusions**

The unusual clinical presentation resulted in a delayed diagnosis in our case. Physicians should examine the spinal cord using MRI studies when the patient has hyperhidrosis with some motor or sensory symptoms in the extremities.

**References**


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