Leptomeningeal dissemination of pilocytic astrocytoma via hematoma in a child

Case report

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A case of recurrent pilocytic astrocytoma with leptomeningeal dissemination (LMD) is described. A cerebellar tumor was diagnosed in a 3-year-old boy, in whom resection was performed. When the boy was 6 years of age, recurrence was treated with surgery and local radiotherapy. At age 13 years, scoliosis was present, but the patient was asymptomatic. Twelve years after initial surgery LMD was demonstrated in the lumbar spinal region without recurrence of the original tumor. This tumor also was subtotally removed. During the procedure, a hematoma was observed adjacent to the tumor, but the border was clear. Histological examination of the spinal cord tumor showed features similar to those of the original tumor. There were no tumor cells in the hematoma. The MIB-1 labeling index indicated no malignant change compared with the previous samples. Radiotherapy was performed after the surgery. The importance of early diagnosis and management of scoliosis is emphasized, and the peculiar pattern of dissemination of the pilocytic astrocytoma and its treatment are reviewed.

KEY WORDS • pilocytic astrocytoma • leptomeningeal dissemination • MIB-1 labeling index • radiation therapy • scoliosis
report are to emphasize the importance of MR imaging both at presentation and during the follow-up course in patients with these conditions, as well as to alert the clinician to consider a diagnosis of intramedullary tumor in patients in whom scoliosis is evident at an early stage.

**CASE REPORT**

**History.** A 3-year-old boy was initially evaluated at an outside neurosurgical department for symptoms of increased intracranial pressure in 1989. Computerized tomography scanning performed at that time demonstrated a huge circumscribed tumor in the cerebellar vermis and obstructive hydrocephalus (Fig. 1A). A VP shunt was placed (Fig. 1B), and subtotal removal of the tumor was undertaken. The histological diagnosis was juvenile pilocytic astrocytoma. Adjuvant therapies were not administered, and the patient was discharged to out-patient care where no deterioration was reported. Three years after the initial operation, moderate regrowth of the tumor was revealed. In 1992, the patient was transferred to our hospital at his family’s request and we excised the tumor subtotally. The histological diagnosis remained pilocytic astrocytoma (Fig. 2A). The MIB-1 labeling index was approximately 9% (Fig. 2B). At that time, a total radiation dose of 55 Gy was administered to the posterior fossa. During the 9-year period after the operation, the patient did well, and by 2001 no signs of recurrence were demonstrated on cranial MR imaging (Fig. 1C and D). When the boy was 13 years of age in 1999, the VP shunt malfunctioned after the peritoneal tube became obstructed. Reconstruction of the shunt system was undertaken, and the postoperative course was uneventful. Although there were no discernable lower-extremity impairment nor genital or rectal dysfunction, an abdominal radiograph demonstrated scoliosis that had not been radiographically apparent in 1992 (Fig. 3).

**Examination.** In July 2001, when the patient was age 15 years, he complained of pain in the right femur and increasing difficulty in urinating. After spinal MR imaging was performed at an outside institution, he was transferred to our hospital; a diagnosis of lumbosacral LMD was suspected. 

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**Fig. 1.** A: A nonenhanced CT scan obtained at the time of initial treatment (1989) when the patient was age 3 years, demonstrating a mass of moderate low density in the vermis, as well as obstructive hydrocephalus. B: Enhanced CT scan acquired after insertion of a VP shunt in 1989, revealing a well-enhanced circumscribed mass. C: Axial Gd-DTPA-enhanced T1-weighted MR image demonstrating no tumor recurrence, obtained in 2001 when the patient was age 15 years. D: Sagittal Gd-DTPA-enhanced T1-weighted MR image also demonstrating no tumor recurrence in September 2001.

**Fig. 2.** Photomicrographs of sections of the tumor resected in the cerebellar vermis in 1999. A: Typical histological features of juvenile pilocytic astrocytoma characterized by heterogeneous appearance of bipolar spindle-shaped astrocytes. No mitotic activity is evident. H & E, original magnification ×62. B: Immunohistochemical staining for MIB-1. The MIB-1 labeling index is approximately 9%. Original magnification ×100.

**Fig. 3.** A: Chest and upper abdominal radiograph obtained in 1992 when the patient was age 6 years demonstrating no scoliosis. B: Radiograph obtained at age 13 years, revealing scoliosis in the lumbar area.
Neurological examination at admission revealed no muscle weakness, sensory disturbance or laterality of deep tendon reflexes in the lower extremities. Pain on percussion, however, was demonstrated in the spinous process in the L2–4 area. Physiological examinations revealed decreases in both bladder and anorectal function. On T1-weighted spinal MR imaging an isointense mass in the L5–S1 intradural area was revealed (Fig. 4A), and on T2-weighted imaging a circumscribed cystic mass was observed in the L-5 intradural area (Fig. 4B). Whole-spine MR imaging revealed no other abnormal findings. Cytological examination of the CSF likewise showed no abnormal features.

Operation. To clarify the histological nature of the tumor and to ameliorate the symptoms, an L4–S1 laminectomy was undertaken.

The spinal dura was incised from L-4 to S-1 (Video Clip). We then identified the mass through the thick arachnoid membrane. After the arachnoid membrane was incised, we obtained a biopsy sample from the caudal side of the tumor. The tumor was soft and easily aspirated. We identified nerve roots on both lateral sides of the tumor; these were tightly adherent to the wall of the tumor. Therefore, we decided to debulk the tumor but leave the wall.

After removing the tumor, we identified another mass at the L-5 level, which seemed to be the cystic mass that had been observed on the previous T1-weighted sagittal MR images (Fig. 4C). The content of this mass was a substantial hemorrhage. After evacuating and debulking the mass, we resected it almost totally.

Pathological Examination. Histologically, the tumor was essentially the same as the previous neoplasm (Fig. 5A), and no malignant changes had occurred. Immunohistochemical stainings showed the presence of glial fibrillary acidic protein (Fig. 5B) in the tumor cells. The MIB-1 index was approximately 9% (Fig. 5C), which was the same as that demonstrated by the previous study of the cerebellar tumor conducted in 1992. A diagnosis of pilocytic astrocytoma with LMD was determined for this tumor. The hematoma contained hemorrhagic and necrotic tissue (Fig. 5D) but no tumor cells.

Adjuvant Therapy and Postoperative Course. Radiotherapy (total dose of 55 Gy) was delivered to the lower lumbar region. The patient was discharged 2 months after admission, with no neurological deficit. Follow-up Gd-DPTA-enhanced T1- and T2-weighted MR imaging demonstrated no recurrence of the tumor and good postoperative outcome (Fig. 6A and B).

**DISCUSSION**

This case is unique in that the cerebellar tumor showed no local recurrence and the disseminated tumor had no anaplastic changes. Metastatic disease from a pilocytic astrocytoma is rare, estimated to occur in only 4% of patients.\(^{16}\) Pilocytic cerebellar astrocytoma with LMD without simultaneity has been reported in a total of eight patients, including the present one (Table 1).\(^{5,8,10,11,13,19}\)

**Idiopathic Scoliosis: a Rare Manifestation of Intrinsic Spinal Cord Tumors**

In most cases radiological evaluation of scoliosis is limited to conventional radiographs of the spine.\(^{15}\) In the present case, we should have noticed the idiopathic scoliosis 2 years previously. Scoliosis may indeed be the only presenting feature, and awareness of alternative diagnostic possibilities is important, primarily to prevent inappropriate correction of the deformity alone and, secondly, because early diagnosis and treatment can greatly improve the prognosis for patients with spinal cord tumors.\(^{74}\) Despite its rarity, the association of scoliosis with tumors of the spinal cord is important for many reasons. If the neurological deficit is slight, children are too often thought to suffer from idiopathic scoliosis and treated accordingly. This is more likely to occur because they are often of the same age group as the majority of children suffering from idiopathic scoliosis—that is, 8 to 14 years of age. Corrective treatment of the scoliosis may be harmful to the child. If, on the other hand, the child presents with an advanced neurological deficit, the possibility of a spinal cord tumor may not be considered because they are rare and difficult to diagnose in children.
Operative and Pathological Findings

Intraoperative examination, shown in the Video Clip, revealed that the hematoma was characteristic in that it was attached to the tumor and the borderline between them was clear. There were no vascular malformations or abnormal vessels. Histopathological examination showed no tumor cells. There has been one report about spontaneous hemorrhage due to juvenile pilocytic astrocytoma, but the authors concluded it was not related to the pathological findings.12 When considering the mechanism, scoliosis may also become an issue. The pilocytic astrocytomas located in the cerebellar vermis and the lumbar spinal region were both diagnosed as having the same origin, and the spinal region astrocytoma resulted from LMD. There was no evidence of endothelial proliferation, necrosis, or mitosis to suggest malignant change.

Mechanism of the LMD

A long interval between the first radiologically detected signs and the beginning of clinical symptoms is one of the characteristic features in this type of LMD. Generally, seeding of an anaplastic astrocytoma or glioblastoma heralds the end stage of disease. The growth character, biological behavior, and clinical course of the disseminated pilocytic astrocytoma were clearly different from those of malignant glioma.2 Several mechanisms have been proposed to explain the spread of intracranial tumors by CSF pathways. It has been hypothesized that malignant transformation, cellular anaplasia, surgical manipulation, natural history, or multiplicity may contribute to the spread of the tumor. Specifically, recent studies of cell adhesion molecules have helped to clarify the mechanisms that allow adhesion: in recent studies involving CD44 investigators have found that this adhesion molecule may play a role in astrocytic invasion and adhesion.14 Recurrent and disseminated pilocytic astrocytoma may not preclude long-term survival, because it rarely shows malignant transformation. Shapiro and Shulman18 reported three of 72 patients with histologically benign cerebellar astrocytomas in whom the tumor seeded the spinal subarachnoid space without malignant transformation.18 They noted that the seeding was not indicative of a rapidly fatal course and believed that this was part of the natural history of this tumor.

Treatment Controversy

Radical resection of the tumor, either alone or in conjunction with radiotherapy and chemotherapy, has been recommended as initial treatment.9 The treatment of the disseminated tumor, however, remains controversial. In our patient we found LMD without the presence of histological anaplastic transformation. Furthermore, after resection, radiotherapy alone was an effective treatment for the cerebellar tumor, and it has been efficacious for the...
spinal dissemination. The selection for the treatment was made because of a high MIB-1 labeling index for pilocytic astrocytoma and because the tumor was a circumscribed mass. Additionally, we did not choose to administer intrathecal therapies because of the absence of abnormal CSF results. Radiotherapy may be important in the anaplastic change of low-grade astrocytoma in children. Auer, et al., demonstrated the ineffectiveness of radiotherapy in controlling dissemination. Recently, it has been reported that chemotherapy including cyclophosphamide, carboplatin, and etoposide may be beneficial in the management of this tumor and can delay the need for radiotherapy. If chemotherapy is beneficial, radiotherapy can be held in reserve. To evaluate the effectiveness of radiation, we will undertake a further follow-up review in which Gd-DTPA-enhanced MR imaging is performed.

In conclusion, although seeding from a cerebellar pilocytic astrocytoma rarely occurs, it is difficult to predict the occurrence of dissemination even by histological examination. Therefore, careful follow-up review involving both cranial and spinal Gd-DTPA-enhanced MR imaging is important even in cases of histologically benign pilocytic astrocytoma.

Acknowledgments

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References


TABLE 1
Summary of reported cases with LMD of cerebellar pilocytic astrocytoma without simultaneity*

<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>Age (yrs), Sex†</th>
<th>Treatment of Primary Tumor</th>
<th>Timing of LMD (yrs)</th>
<th>Disseminated Sites</th>
<th>Treatment of LMD</th>
<th>Follow Up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civitello, et al., 1988</td>
<td>8, F</td>
<td>total resection</td>
<td>6</td>
<td>hypothalamus, basal cistern, spinal cord</td>
<td>lomustine, VCR, spinal RT</td>
<td>alive at 17 mos</td>
</tr>
<tr>
<td>Mishima, et al., 1992</td>
<td>6, M</td>
<td>total resection, 40-Gy RT (local)</td>
<td>6</td>
<td>4th ventricle, T3–4</td>
<td>total resection, 40-Gy RT (local)</td>
<td>alive at 24 mos</td>
</tr>
<tr>
<td>Pollack, et al., 1993</td>
<td>4, M</td>
<td>total resection</td>
<td>4.75</td>
<td>basal cisterns, ventricles</td>
<td>carboplatin, VCR</td>
<td>alive at 17 mos</td>
</tr>
<tr>
<td>Mamelak, et al., 1994</td>
<td>11, M</td>
<td>total resection, 54-Gy RT</td>
<td>0.33</td>
<td>T10–11</td>
<td>none</td>
<td>alive at 46 mos</td>
</tr>
<tr>
<td>McCowage, et al., 1996</td>
<td>5, F</td>
<td>total resection</td>
<td>3</td>
<td>C-2 conus medullaris multiple intracranial</td>
<td>cyclophosphamide</td>
<td>alive at 10 mos</td>
</tr>
<tr>
<td>Jamjoom, et al., 1998</td>
<td>8, M</td>
<td>VP shunt</td>
<td>2</td>
<td>multiple intracranial</td>
<td>30-Gy RT (whole brain)</td>
<td>alive at 5 mos</td>
</tr>
<tr>
<td>Tamura, et al., 1998</td>
<td>6, M</td>
<td>total resection</td>
<td>4</td>
<td>C7–T1</td>
<td>30-Gy RT (whole spine)</td>
<td>alive at 76 mos</td>
</tr>
<tr>
<td>present case</td>
<td>3, M</td>
<td>subtotal resection, 55-Gy RT (local)</td>
<td>12</td>
<td>L3–S1</td>
<td>subtotal resection, 55-Gy RT (local)</td>
<td>alive at 5 mos</td>
</tr>
</tbody>
</table>

* RT = radiotherapy; VCR = vincristine.
† Reflects age at initial diagnosis.


