Leptomeningeal dissemination of cerebellar pilocytic astrocytoma

Case report

KAZUHIKO MISHIMA, M.D., MASANAO NAKAMURA, M.D., HIROHIKO NAKAMURA, M.D., OSAMU NAKAMURA, M.D., NOBUKI FUNATA, M.D., AND NOBUYUKI SHITARA, M.D.

Department of Neurosurgery and Pathology, Tokyo Metropolitan Komagome General Hospital, Tokyo, Japan

A case of surgically treated pilocytic astrocytoma in the cerebellar vermis is reported in a patient who subsequently demonstrated multiple subarachnoid nodular masses in the cerebrum and spinal cord 6 years after the initial surgery. The nodular tumors did not indicate a growth tendency on computerized tomography or magnetic resonance imaging over a 2-year observation period. The histology of the nodular masses in the cerebrum and spinal cord was similar to that of the original tumor. The bromodeoxyuridine labeling index indicated low proliferative activity (0.5%). The peculiar pattern of dissemination of the pilocytic astrocytoma is described.

KEY WORDS • pilocytic astrocytoma • dissemination • bromodeoxyuridine labeling index

Cerebellar pilocytic astrocytomas occurring in children have one of the most favorable prognoses of all intracranial tumors. Juvenile pilocytic astrocytomas are usually extremely benign, and it is well established that, even with incomplete resection, patients have survived for years without progression of the tumor. However, several cases of late malignant recurrence of pilocytic astrocytoma have been reported, with some authors suggesting that the malignant transformation after a prolonged interval was induced by radiation therapy. It has also been considered that the benign astrocytoma underwent malignant transformation because the recurrent tumor contained areas that showed histological features identical to those of the original tumor. Other case reports with early recurrence suggest that areas of focal anaplasia within a benign cerebellar astrocytoma were missed when the initial tumor specimen was examined.

The case reported here is unusual in that, 6 years after surgery, a histologically benign astrocytoma disseminated to the supratentorial and spinal regions without pathologically malignant transformation or apparent regrowth of the primary tumor. The growth rate of the disseminated tumor was very low and the biological behavior was quite different from that of malignant glial tumors.

Case Report

This 6-year-old boy was initially evaluated at another neurosurgical center for symptoms of increased intracranial pressure. Computerized tomography (CT) performed at that time demonstrated a multicystic tumor in the cerebellar vermis and obstructive hydrocephalus with no dissemination (Fig. 1). A ventriculoperitoneal shunt was placed, and 30 Gy of radiation therapy was administered. Subsequently, the tumor was totally resected. Histologically, a juvenile pilocytic astrocytoma was diagnosed (Fig. 2). Postoperatively, a total dose of 40 Gy was administered to the posterior fossa. During the 6 years after the operation, the patient did well and showed no signs of recurrence.

Examination and Operation. Six years after the initial operation, at the age of 11 years, the patient was referred to our hospital with the diagnosis of leptomeningeal dissemination. Neurologically, the child remained asymptomatic. A cranial CT scan revealed a small enhanced mass lesion in the fourth ventricle; however, there was no evidence of recurrence of the primary vermin tumor. Gadolinium-diethylenetriamine penta-acetic acid (Gd-DTPA)-enhanced cranial magnetic resonance (MR) imaging demonstrated multiple leptomeningeal nodular, round masses with no
Disseminated pilocytic astrocytoma

![Image](image_url)

**Fig. 1.** Initial contrast-enhanced computerized tomography scan showing a multicystic mass in the cerebellar vermis.

Evidence of cerebellar tumor recurrence (Fig. 3B). On Gd-DTPA-enhanced spinal MR imaging, subarachnoid metastases were demonstrated at T-3 and T-4 (Fig. 3C). However, the nonenhanced T- and T-weighted images (Fig. 3A) did not clearly visualize the metastatic deposits. Cytological examination of the cerebrospinal fluid (CSF) was negative. To clarify the histology of the tumor, a right frontotemporal craniotomy was performed. A soft, reddish-gray tumor was located mainly in the subarachnoid space of the sylvian fissure and was partially adherent to the brain parenchyma. The tumor was totally resected.

**Pathological Examination.** Histologically, the disseminated tumor was essentially the same as the original neoplasm. No nuclear atypism, mitotic figure, necrosis, or vascular endothelial proliferation was observed. Rosenthal fibers were abundantly present. Immunohistochemical stains revealed the presence of glial fibrillary acidic protein in the tumor cells. A diagnosis of pilocytic astrocytoma was made for this tumor (Fig. 4).

**Postoperative Course.** Radiation therapy with a total dose of 40 Gy was delivered to the cervical and upper thoracic spinal regions. Three months after completion of radiation therapy, the tumors at T-3 and T-4 showed no change in size on MR imaging and the spinal cord was still compressed. Therefore, a decompressive laminectomy from T-2 to T-4 was performed. These tumor masses were primarily extramedullary in location. Histologically, they were similar to the previously resected tumor from the sylvian fissure. To estimate the proliferation potential of the original, we also analyzed the bromodeoxyuridine (B UdR) labeling index (LI) of these tumors. Two hours before spinal tumor resection, the patient received a 150-mg intravenous infusion of BUdR over a period of 30 minutes; the BUdR LI of these tumors was 0.5%. Two years after the diagnosis of dissemination, the radiological findings of the residual nodular masses had not changed and the patient remained well.

**Discussion**

This case is unique in that the cerebellar tumor showed no local recurrence and the disseminated tumor demonstrated no anaplastic features. Moreover, the size and number of the disseminated tumor nodules did not change over a 2-year follow-up period.

A long interval between the first radiological signs and the beginning of clinical symptoms is one of the characteristic features in this type of CSF dissemination. Generally, seeding of an anaplastic astrocytoma or glioblastoma herald the end stage of disease. Therefore, the growth character, biological behavior, and clinical course of the disseminated pilocytic astrocytoma were clearly different from that of the malignant gliomas. It has been reported that the BUdR LI reflects the growth activity of gliomas and is closely correlated to patient prognosis and survival duration. Hoshino, et al., reported that low-grade gliomas with a BUdR LI of 1% or more showed a tendency to recur rapidly, whereas patients in whom the glioma BUdR LI is less than 1% survived longer. The BUdR LI and clinical course in this case were consistent with these findings.

The possibility exists that the multiplicity of pilocytic astrocytomas might be due to the multiple genesis of the tumors. However, the tumor in this case was located mainly in the CSF space and was loosely attached to the brain parenchyma. Therefore, CSF dissemination of the original tumor is most likely in this case.

One mechanism for dissemination is that the viable tumor cells gain access to the subarachnoid or ventricular fluid spaces. In patients with cerebellar pilocytic astrocytomas, extension into the subarachnoid space is common but is not necessarily associated with aggressive behavior or leptomeningeal seeding. McCaughlin reported five cases of extracerebellar pilo-
tumor appears to be aggressive surgery where possible. Recently, the efficacy of MR imaging has been evaluated in patients with meningeal tumor spread.\textsuperscript{2,15} Although noncontrast-enhanced MR imaging is rather insensitive, Gd-DTPA-enhanced MR imaging is useful when searching for leptomeningeal tumor deposits to prevent patient deterioration.

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 with contrast-enhanced MR imaging is important even in cases of histologically benign pilocytic astrocytoma.

\textbf{Reference}


\textbf{Fig. 3.} Follow-up magnetic resonance images obtained 6 years after the initial operation. Multiple nodular masses in the subarachnoid spaces that cannot be detected on the axial T$_1$-weighted image of the head (A) are seen on the Gd-DTPA-enhanced T$_1$-weighted image (B, arrowheads). A sagittal Gd-DTPA-enhanced T$_1$-weighted image (C) of the spine demonstrates several enhancing nodular lesions (arrow) adjacent to the spinal cord.

\textbf{Fig. 4.} Photomicrograph of the disseminated tumors (brain and spinal) showing pilocytic astrocytoma without malignant features. Rosenthal fibers are also seen. H & E, $\times$ 32.

cytic astrocytoma demonstrating subarachnoid spread and invasion of surrounding structures. They concluded that a tumor showing nuclear pleomorphism or oligodendrocytomatosus areas had a poor prognosis. Shapiro and Shulman\textsuperscript{18} reported three of 72 patients with histologically benign cerebellar astrocytomas in whom the tumor seeded the spinal subarachnoid space without malignant transformation. They mentioned that the seeding did not indicate the patient's imminent demise and believed that this was part of the natural history of this tumor.

The treatment of the disseminated tumor remains controversial. In our patient, radiotherapy to the disseminated lesions was ineffective. Kepes, \textit{et al.}\textsuperscript{1} and Auer, \textit{et al.}\textsuperscript{2} demonstrated the ineffectiveness of radiotherapy in controlling dissemination. With this background, the most reliable treatment of the disseminated
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Address reprint requests to: Kazuhiko Mishima, M.D., Department of Neurosurgery, Tokyo Metropolitan Komagome General Hospital, 3-18-22, Komagome, Bunkyo-ku, Tokyo 113, Japan.