Gliosarcoma is a distinct disease entity that is characterized by a biphasic tissue pattern with alternating areas displaying glial and mesenchymal differentiation. The tumor in our case was a rare morphologic variant of gliosarcoma with components of anaplastic oligodendroglioma and unclassifiable spindle cells. Spindle cells showed CD34 and S-100 protein immunoreactivity, which was possibly related to peripheral nerve sheath differentiation. This unique feature has not been described previously and so this case expands the spectrum of possible divergent mesenchymal differentiation, and it lends support to pluripotential stem cells being the origin of this tumor.

Key Words: Gliosarcoma; Anaplastic oligodendroglioma; CD34; S-100 protein

CASE REPORT

The patient, a 62-year-old man, was admitted to our hospital with headache and dysarthria. He denied all other symptoms, and he had no previous significant history of disease or trauma. Contrast-enhanced computed tomography and magnetic resonance imaging demonstrated a 5.5 cm sized well enhancing mass in the left temporal lobe with a large area of internal necrosis and moderate to severe peritumoral edema (Fig. 1). The histology of the stereotactic biopsy was consistent with anaplastic oligodendroglioma. The patient underwent subtotal excision of the tumor with subsequent radiotherapy. He was still free of recurrence 4 months after treatment.

Pathologic findings

Grossly, the tumors were grayish white and firm with areas of hemorrhage without any definite area of necrosis. Microscopic
examination of the tumor revealed 2 discrete components that were sometimes intermixed: the one was a typical anaplastic oligodendrogloma with increased cellularity, marked cytologic atypia, occasional mitotic activities, and endothelial vascular proliferation (Fig. 2A). Most of the cells that composed the anaplastic oligodendrogloma showed rounded hyperchromatic nuclei, perinuclear halos, and a few cellular processes reminiscent of oligodendroglial cells. They were diffusely immunoreactive for S-100 protein and CD57 (Leu-7) and, focally positive for glial fibrillary acidic protein (GFAP, Fig. 2B), but they were negative for vimentin, CD31, CD34 (Fig. 2C), smooth muscle actin, desmin, epithelial membrane antigen or epidermal growth factor receptor (EGFR). The MIB-1 labelling was markedly increased (40-50%). The other component was composed of atypical spindle cells that were mainly centered around proliferating blood vessels and accompanied by collagen deposition and focal necrosis, showing the pattern of spindle cell sarcoma (Fig. 3A, B). Most of these cells showed a spindle cell configuration with thin elongated hyperchromatic nuclei, moderate to marked cytologic atypia and occasional mitoses. The cellularity of the hypercellular areas was variable with short interlacing bundles of spindle cells to the hypocellular myxoid areas. The tumor cells were diffusely positive for CD34 (Fig. 3C), S-100 protein (Fig. 3D) and vimentin immunostaining, but other immunohistochemi-
cal markers, including GFAP, CD31, smooth muscle actin, desmin, CD68, epithelial membrane antigen, and EGFR, were negative. Immunostaining for p53 was positive in about 10% of these tumor cells and the MIB-1 labeling was focally increased (5-10%). These two discrete components were occasionally intimately admixed with each other (Fig. 4A), in which only the oligodendroglial component shows focal immunoreactivity for GFAP (Fig. 4B). The biphasic nature of the tumor was clearly emphasized by vimentin (Fig. 4C) immunostaining, which demonstrated positivity only in the sarcomatous area.

**DISCUSSION**

The histogenesis of gliosarcoma continues to be a subject of debate. However, although the previous morphologic studies have suggested an evolution of the sarcomatous component from microvascular proliferation within a highly malignant glioblastoma, the recent genetic studies have demonstrated that both the glial and nonglial compartments of gliosarcoma bear the same genetic abnormalities, thus showing evidence of their common origin, which is probably from pluripotential stem cells.

Morphologically, this case should be differentiated from oligodendrogial tumor that invades the meninges and causes a prominent desmoplastic reaction. However, the formation of separate nodules that are predominantly composed of spindle cells apart from the oligodendroglial component, and the frequent arrangement of these tumor cells around proliferating blood vessels is highly suggestive of their neoplastic nature rather than a reactive stromal reaction around infiltrating oligodendroglial cells. In addition, the different immunohistochemical staining pattern and the deposition of abundant collagen and reticulin fibers in these spindle cell components confirmed the diagnosis of a gliosarcoma.

Unlike the previously reported gliosarcomas, there are two unusual pathologic features that make our case noteworthy. First, the occurrence of a sarcoma within an oligodendroglioma remains highly exceptional and this was rarely mentioned by Feigin et al.2

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**Fig. 3.** The other component is composed of cellular areas of spindle cells forming short fascicles (A, H&E stain, ×100) and showing perivascular arrangement of plump and spindle-shaped tumor cells (B, H&E stain, ×100). Most of the tumor cells are diffusely positive for CD34 (C, Immunohistochemistry, ×200) and S-100 protein (D, Immunohistochemistry, ×200).
in 1976 and by Pasquier et al.\textsuperscript{4} in 1978, and there have been no additional reports thereafter. The case reported by Feigin et al.\textsuperscript{2} was histologically composed of an anaplastic oligodendroglioma combined with a sarcomatous component that probably had a vascular origin, and the case by Pasquier et al.\textsuperscript{4} was a typical oligodendroglioma with mixed fibrosarcomatous and angiosarcomatous components. Due to the extreme rarity of sarcomas arising in oligodendroglioma, the response to conventional therapy and the behavior of these tumors still remain to be determined. Second, the sarcomatous components in this case show diffuse immunoreactivity for CD34 and S-100 protein. Several attempts have failed to demonstrate the direct participation of endothelium in the formation of the sarcomatous component and a CD34-positive gliosarcoma has never been reported in the English medical literature.\textsuperscript{5,11} However, considering a relatively reduced specificity of CD34 immunostaining for defining the endothelial origin of tumor cells and the negative immunostaining result for CD31, which is the other well-known vascular endothelium-related marker, CD34 immunoreactivity alone in this case does not necessarily indicate the endothelial origin of the sarcomatous component. Instead, the presence of S-100 protein positive spindle cells and the deposition of collagen fibers in the sarcomatous component may suggest the possible peripheral nerve sheath differentiation.\textsuperscript{17} This can be further supported by the fact that several reports have described nerve sheath tumors within the CNS parenchyma that are unrelated to the cranial nerves and a benign “glioneurofibroma” composed of astrocytes and schwann cells in children, although these type of tumors are extremely rare.\textsuperscript{13,14}

In conclusion, the tumor in our case was a rare morphologic variant of gliosarcoma with components of anaplastic oligodendroglioma combined with unclassifiable spindle cells showing CD34 and S-100 protein immunoreactivity, and this was possibly related with peripheral nerve sheath differentiation. This unique feature has not been described previously and so this case expands the spectrum of possible divergent mesenchymal differentiation, and it support the tumor’s origin from pluripotential stem cells.

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