Neuroimaging of a pilocytic astrocytoma with anaplastic features and diffusion tensor imaging characteristics

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We report the MRI findings of an adult patient with a (rare in adults) biopsy-proven pilocytic astrocytoma with anaplastic features. Diffusion tensor imaging may potentially provide information on cell proliferation, vascularity, and fiber destruction, which can have implications for treatment and prognosis. In this case, tractography and fractional anisotropy maps demonstrated displacement of adjacent parenchyma and relatively intact fractional anisotropy, suggesting a pilocytic rather than an anaplastic astrocytoma.

Case report

A 57-year-old Caucasian female with a known history of a 20-year, stable midline cerebellar mass presented with severe gait ataxia. Conventional brain MRI scans included diffusion tensor imaging (DTI). MRI data was processed to obtain tractography and fractional anisotropy (FA) maps using GE FuncTools software. MR images were examined for extent and location of tumor as well as invasion, destruction, or displacement of brain parenchyma and white-matter tracts. A 4.0 x 3.9-cm solid cystic lesion with lobulated margins in the cerebellar vermis was observed on T2-weighted MRI (Figs. 1A, 1B), which had increased in size from prior studies. There was also herniation of the vermis with effacement of the quadrigeminal plate cistern, mild herniation of cerebellar tonsils below the level of foramen magnum, and partial obstruction of CSF outflow at the level of the 4th ventricle. Tractography (Figs. 2A, 2B) and FA maps (Fig. 3) suggested on the basis of imaging that fiber tracts surrounding the lesion were displaced, but fiber integrity (as represented by fractional anisotropy) was maintained. This suggested a less aggressive type of neoplastic lesion.

The patient underwent tumor-debulking surgery via a suboccipital craniotomy, with good outcome. The histop-
Thology showed a largely circumscribed astrocytoma with associated macrocysts, microcalcifications, eosinophilic granular bodies, and rare Rosenthal fibers, consistent with a benign entity such as a pilocytic astrocytoma (PA) (Fig. 4). However, focally localized atypical features were also present, including a hypercellular focus with increased mitotic activity and pseudopalisading necrosis, and vascular proliferation, consistent with PA with anaplastic features (Fig. 5). Immunohistochemistry demonstrated GFAP positivity, p53 negativity, and focally positive MIB1 labeling. In light of this patient’s longstanding history of a midline cerebellar mass, it is likely that this mass may have been a stable nonanaplastic PA that eventually developed anaplastic features around the time of symptom progression.

A followup MRI performed three months after resection demonstrated expected postoperative changes without evidence to suggest recurrence.

Discussion

This case presents unusual findings, as PA is unusual in adulthood. Typically, PAs present as benign cystic neoplasms (features are outlined in the summary table). PAs...
Neuroimaging of a PA with anaplastic features and diffusion tensor imaging characteristics

Figure 6. 57-year-old female with a midline cerebellar pilocytic astrocytoma with anaplastic features. Comparison case of a 68-year old male with focal glioblastoma in cerebellum on conventional T2-weighted MRI (A, arrow). Fractional anisotropy (B) map shows decreased anisotropy (arrow), and tractography axial and coronal maps (C, D) demonstrate imaging-based invasion and destruction of adjacent fiber tracts (arrows). Brighter pixels have higher anisotropy; normal fractional anisotropy is shown as white.

Pilocytic astrocytomas with anaplastic features are rare entities with notoriously unpredictable behavior. DTI with tractography and fractional anisotropy mapping can be helpful for both presurgical planning and for predicting the tumor’s behavior with regard to adjacent fiber tracts.
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Summary table

| Etiology                          | Often unknown cause, but have been seen to arise from a previous PA precursor |
|-----------------------------------|-------------------------------------------------------------------------|
| Incidence                         | Approximately 1.7% of all PAs                                           |
| Gender ratio                      | N/A                                                                     |
| Age prediction                    | Third decade                                                            |
| Treatment                         | Surgical resection                                                     |
| Prognosis                         | Difficult to predict, but most often behaves as a WHO grade 2 or 3 tumor |
| Findings on imaging               | Usually appear intense to hypointense on T1-weighted imaging and have a hyperintense cystic portion, mixed signal soft-tissue portion, and enhancement of a mural nodule |

Differential table

| Diagnosis                        | MRI                                                                 | MRI-DWI                                                                 |
|----------------------------------|---------------------------------------------------------------------|-------------------------------------------------------------------------|
| Typical PA                       | PAs usually appear intense to hypointense on T1-weighted imaging and have a hyperintense cystic portion, mixed signal soft-tissue portion, and enhancement of a mural nodule; surrounding edema may be present | Tractography and FA mapping show displacement of adjacent fiber tracts |
| PA with anaplastic features      | Similar to PA                                                        | Similar to PA                                                            |
| Glioblastoma mutiforme           | Similar to PA                                                        | Tractography and FA mapping show displacement and destruction of adjacent fiber tracts |