Pilocytic astrocytoma: NAA is not NAA

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Introduction: MRS spectra of pediatric pilocytic astrocytoma generally show low creatine (Cr) and prominent choline (Cho) signal[1] (**Fig. 1**). Most spectra, including those acquired from large lesions with no partial volume of surrounding tissue, also show residual signal that appears to be consistent with N-acetyl-aspartate (NAA). This is perplexing, considering that NAA is an axonal/neuronal marker and is generally not observed in other cell types. The goal of this study was to determine whether the precise chemical shift of this peak is consistent with NAA at 2.01 ppm (or N-acetylaspartatylglutamate (NAAG) at 2.04 ppm).

Methods: MR spectra from 9 patients with confirmed pilocytic astrocytoma (PA) were compared with control parieto/occipital grey matter (GM, N=10), parietal white matter (WM, N=10), and 9 spectra of grade II-IV astrocytoma (A/AA). The position of the peak was determined using fully automated LCModel (version 6.3-1c) software. NAA and NAAG were eliminated from the basis set and replaced by a simulated singlet that was allowed to shift more freely along the chemical shift axis. All spectra were acquired on a Philips 3T Achieva clinical scanner with single voxel PRESS sequence (TE = 35 ms, TR = 2000ms, 128 averages).

Results: ANOVA indicated that the chemical shift position of the singlet was significantly different among groups with the post-hoc analysis revealing that it is the PA that were significantly different from A/AA, GM, and WM (by ≈0.04 ppm). Chemical shifts of other metabolites were not significantly different. Focusing on tumor cases, the position of the singlet readily distinguished PA from A/AA ($p<0.000001$, Student's t-test). Absolute creatine (Cr) levels also distinguished between tumor types, however, at a considerably lower significance level ($p<0.001$).

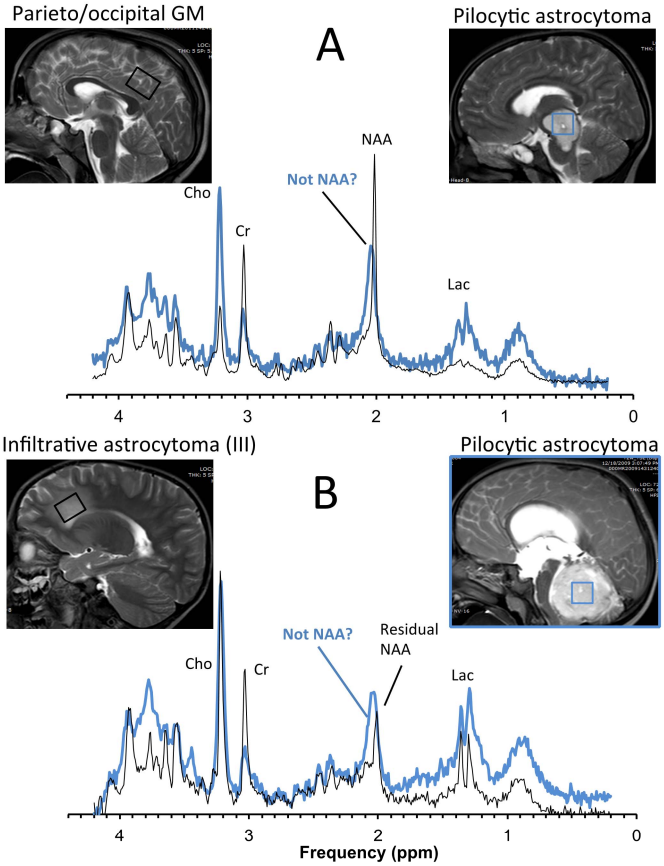

Fig. 1: *MRS of pilocytic astrocytoma (blue thick line) aligned with spectra of normal grey matter (A) and a diffuse infiltrate grade III astrocytoma (B).*

Discussion: Chemical shift analysis reveals that the position of the "residual" NAA signal in PA is not consistent with NAA. NAAG, albeit its chemical shift is close to the one observed for this resonance, is also unlikely. NAAG is a neurotransmitter present at low concentrations in the brain and stored mainly in synaptic vesicles of neurons. Possible candidates are N-acetylgalactosamine and/or N-acetylglucosamine or similar molecules which have previously been identified in humans in sinus mucocele[2]. Of note, a signal at a comparable chemical shift was also observed in other pediatric tumors (not presented in detail) such as a craniopharyngioma (**Fig. 2**). The above-mentioned chemicals exhibit additional underlying broad resonances at around 3.8 ppm, as observed in this study (cf. **Fig. 1,2**). Clinically important is that the chemical shift of the singlet can be used to distinguish between PA and A/AA. Indeed, in this preliminary analysis, the position of this peak separated PA from A/AA better than metabolite levels. Spectral resolution improves with increasing field strength and this study benefitted from being performed on a 3T system.

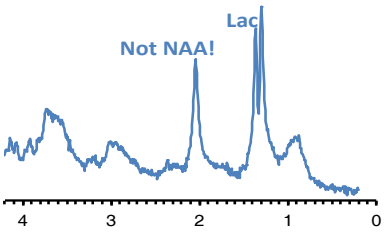

Fig. 2: *A craniopharyngioma MRS shows a prominent signal around 2.0 ppm. The chemical shift is, as observed in PA, not consistent with NAA.*

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References: 1. Panigrahy et al. AJNR Am J Neuroradiol 2006;27(3):560-572. 2. Andre et al. AJNR Am J Neuroradiol 2006;27(10):2210-2213.