Unidentified bright object prediction in infants with neurofibromatosis type I. 3D Multivoxel ^{1}H MRS

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Introduction

The most common neuro-imaging abnormality in Neurofibromatosis Type 1 (NF1) is high signal intensity lesions on T_2 weighted MRI, as shown in Fig. 1**a** (1, 2). Referred to as "unidentified bright objects" (UBO), unlike tumors, they do not enhance with contrast or exhibit mass effect. The range of NF1 lesions from UBO to tumor is not understood nor has their heterogeneity or metabolism been investigated (3, 4). Because of their diffuse, multi-focal nature, to study ^{1}H metabolism in NF1 tumors/UBOs requires 3D spectroscopic imaging (MRS) around the entire lesion. Unfortunately, 3D ^{1}H MRS is currently done by interleaving four 2D slices (5). Since this is inefficient due to short, ‹1.5 s, proton T_1s (6), obtaining good voxel SNRs requires ~40 min. (7). This is an obstacle in pediatric applications since the MRS is aborted if the sedated child awakes.

Methodology

The above obstacle is overcome with a 1D-4th order Hadamard (HSI)/2D chemical shift imaging (CSI) hybrid for *full* 3D volume localization (6). It covers ¼ to ½ liter VOI, producing 4 axial HSI slices of 16×16 voxels each over $6_Z \times 6_X \times 6_Y$ or 6×8×8 cm PRESS boxes, yielding hundreds of sub 2 cm^3 voxels in under 30 min.

Results and Discussion

Six children with NF1, ranging in age from 10 mos. to 11 years old, have been studied with our 3D hybrid. All had UBOs in the temporal lobe, basal ganglia, thalamus and brainstem. 3D coverage allows us to distinguish spectra of UBO from "normal brain" of a 3 yo. NF1 patient as shown in Fig. 1**a**. The UBO is clearly visible on the image and the spectra from that region and surroundings exhibit 2≥Cho:Cr ≥1.3 (P‹0.05). Comparison with a similar region in a normal 7 mo., Fig. 1**b**, shows that in *healthy* brain Cho:Cr≈1.0±0.1. When a 10 mo. female NF patient was studied, MRI did not indicate a presence of an abnormality, Fig. 1**c**. However, the MRS from her thalamus is analogous to that of the UBO in Fig. 1**a**, rather than to that of the normal age-match in 1**b**. This indicates that the disease's metabolic processes have already begun but have not yet altered her anatomy.

Conclusion

The metabolic signature, as detected by 3D ^{1}H-MRS, *precedes* a UBO's manifestation in the anatomy (MRI). The findings indicate that: *i)* UBOs exhibit increased Cho but the NAA level is similar to "normal brain"; *ii)* 2≥Cho:Cr≥1.3 in an observed or a potential UBO, but ≈1.0±10% in the same region of a normal, age-matched brain.

References

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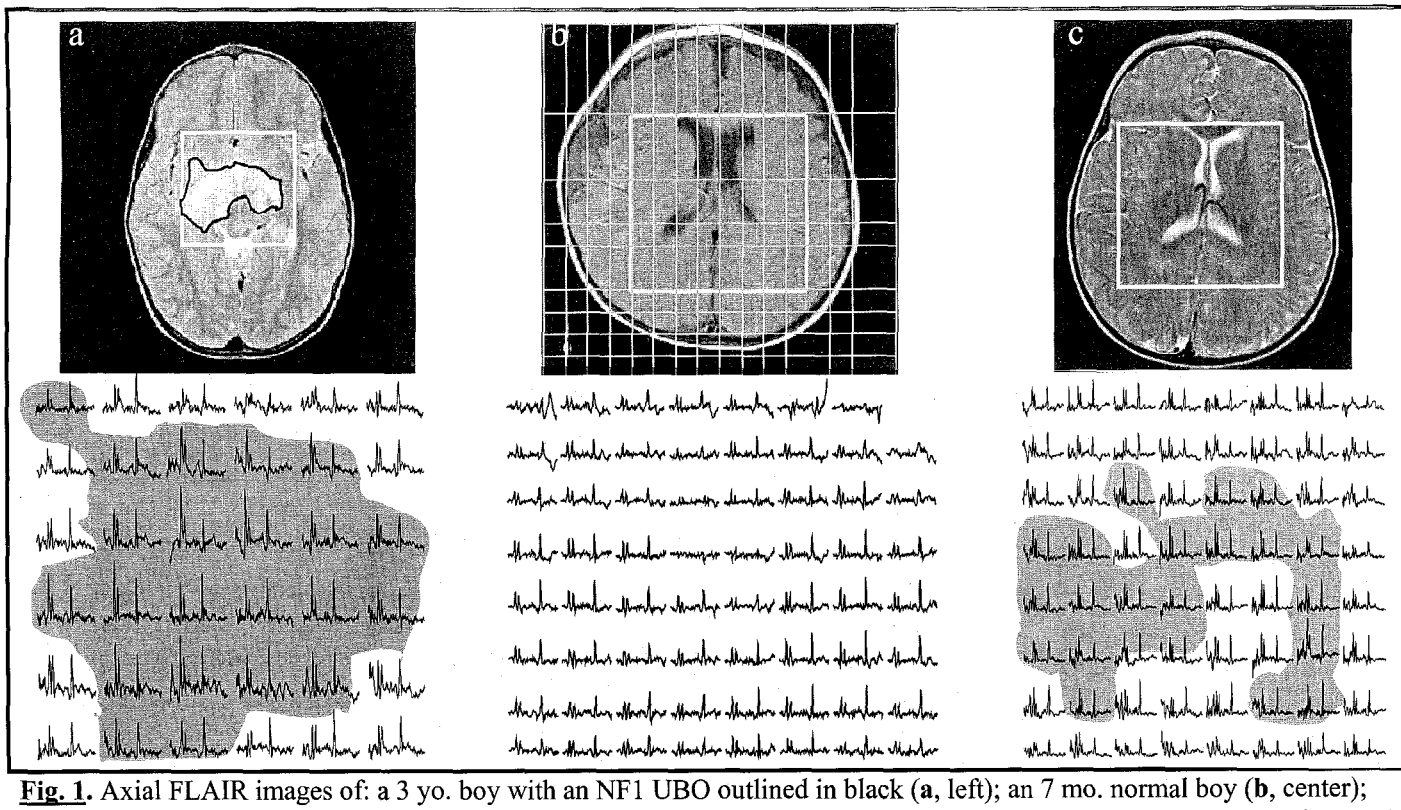

Fig. 1. Axial FLAIR images of: a 3 yo. boy with an NF1 UBO outlined in black (**a**, left); an 7 mo. normal boy (**b**, center); and a 10 mo. girl with NF1 (**c**, right). The images are superimposed with the outline of the 6×6 cm in **a** and 8×8 cm in **b** and **c** PRESS boxes (white frames). The real part of the ^{1}H spectra matrices are shown below their corresponding images. Note the 2≥Cho:Cr≥1.3 ratio in the UBO in **a** and in the "normal appearing" MRI region in **c** (shaded) in contrast to the Cho:Cr≈1.0±10% in the same region of the normal, age-matched brain in **b**.