

EVALUATION OF BRAIN STEM ANATOMY WITH 3D-FLAIR IMAGING AT 3T

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Introduction

Three dimensional (3D) turbo spin echo (TSE) imaging with varying flip angles of the refocusing radiofrequency (RF) pulses allows a significant increase in the echo train length without excessive blurring. 3D fluid-attenuated inversion recovery (FLAIR) imaging using this technique reduces pulsation- and blood flow artifacts and yields an excellent signal-to-noise ratio (SNR) and high spatial resolution images in any plane compared to 2D-FLAIR imaging (1). The brain stem is involved in a number of neurodegenerative disorders such as Alzheimer's, Parkinson, and Huntington disease; typically it has been imaged with T1-, T2-, T2*-, and susceptibility-weighted imaging (2). Although 3D-FLAIR imaging has been used in some central nervous system diseases (3), it has not been applied to evaluate the normal anatomy of the brain stem. The purpose of this study was to evaluate the brain stem anatomy on 3D-FLAIR images to identify brain stem structures including the nuclei and white matter tracts and compare our results with findings made on diffusion tensor- (DTI) and TSE T2-weighted images (T2WI).

Materials and Methods

Our institutional review board approved this study. We prospectively evaluated 10 healthy volunteers (7 males, 3 females, age 23 - 46 years, mean 35.0 years). TSE-T2WI with a resolution of 0.5 x 0.5 x 5 mm, diffusion tensor images (DTI) with a resolution of 1.8 x 1.8 x 2 mm, and 3D-FLAIR images were obtained on a 3T-MRI scanner (Achieva, Philips). A volume isotropic TSE acquisition (VISTA) technique, comprised of a 3D-TSE sequence using a non-selective refocusing pulse and refocusing control, was used for 3D-FLAIR imaging (TR/TE 8000/355 ms, TI 2400 ms, turbo factor 110, refocusing angle 50°, spatial resolution 1 x 1 x 2 mm, reconstructed resolution 1 x 1 x 1 mm, SENSE factor 3). Color maps were created from DTI datasets. We compared 3D-FLAIR images with TSE T2WI, 2D-FLAIR images and the color maps, using the Schaltenbrand and Wahren anatomic atlas to identify the brain stem structures. Two neuroradiologists graded the visibility of the identified structures on 3D-FLAIR and TSE T2WI using a 3-point scale: 3D-FLAIR was superior to TSE T2WI, TSE T2WI was superior to 3D-FLAIR or 3D-FLAIR was equivalent to TSE T2WI.

Results

In all volunteers, 3D-FLAIR images revealed similar contrast for the red nucleus and substantia nigra when compared with TSE T2WI. On 3D-FLAIR images, white matter tracts, i.e. the superior-, middle-, and inferior cerebellar peduncle, decussation of the superior cerebellar peduncle, the central tegmental tract, the medial lemniscus, and the corticospinal tract, were visualized as high signal intensity structures; they were invisible or obscure on TSE T2WI. The structures depicted on 3D-FLAIR images corresponded well with DTI data and the brain atlas.

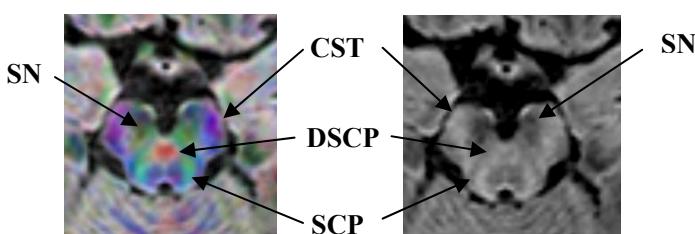


Fig.1a. A fused image of 3D-FLAIR and color map at the mid brain

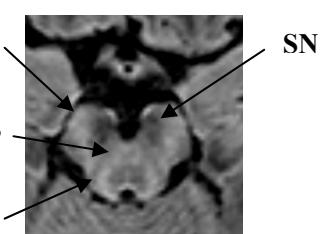


Fig.1b. A 3D-FLAIR image at the mid brain

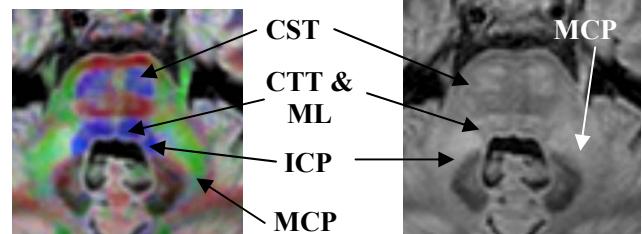


Fig.2a. A fused image of 3D-FLAIR and color map at the pons

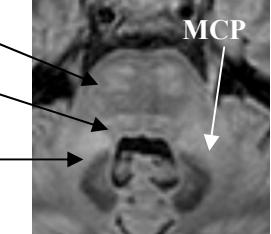


Fig.2b. A 3D-FLAIR image at the pons

SN: substantia nigra, CST: corticospinal tract, SCP: superior cerebellar peduncle, MCP: middle cerebellar peduncle, ICP: inferior cerebellar peduncle, DSCP: decussation of SCP, CTT: central tegmental tract, ML: medial lemniscus

Conclusion

3D-FLAIR images can provide detailed anatomic information of the brain stem that can not be obtained on TSE T2WI.

References

- (1) Kallmes DF et al. Radiology 2001; 221: 251-255.
- (2) Manova ES et al. AJNR 2009; 30: 569-574.
- (3) Bink A et al. Eur Radiol 2006; 16: 1104-1110.