

Effect of Multichannel Inverse Scaling Denoising in Detection of Injured White Matter in Fractional Anisotropy Maps

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Introduction

In research of Parkinson Disease (PD), using VBM on Fractional Anisotropy (FA) maps, the most common preprocessing step used nowadays is Gauss filter. There are more advanced denoising models that can improve the detection of white matter (WM) alterations.

Aims

To study the effects of a nonlinear multichannel filtering preprocessing step on VBM statistical study over FA maps.

Material & Methods

Participants

The participants were 15 healthy controls and 14 patients with PD diagnosis matched for age and gender.

Data acquisition

Diffusion Weighted Images (DWI) were acquired on a 3T Signa HDx MR scanner (GE Healthcare, Waukesha, WI) using a single-shot spin-eco EPI (echo-planar imaging) sequence. Imaging parameters were FOV = 24 cm, TR = 9100, TE = 88.9, slice thickness = 3 mm, spacing = 0.3, data matrix = 128 x 128, NEX = 2. Each DWI has an image without diffusion weighting $b = 0$ s/mm² and 15 diffusion-weighted image with $b = 1000$ s/mm².

Data processing

In a previous work [1], we adapted an iterative process, called 'inverse scale space' [2], applying it over a vectorial ROF denoising model [3]. Prior to diffusion tensor estimation, DWI were filtered using this method. Fractional anisotropy indices (FA) were obtained. The statistical method used was VBM that was performed with SPM8 package. Fractional anisotropy indices (FA) were obtained.

References

- [1] A.G. Seco de Herrera, J.F. Garamendi, E.Schiavi, J.A. Hernández-Tamames, "Filtrado Multicanal de Ruido en DWI Mediante Variación Total e Iteraciones de Bregman". XXVIII Congreso Anual de la Sociedad Española de Ingeniería Biomédica (CASEIB 2010, Madrid, Spain).
- [2] Osher S, Burger M, Goldfarb D, Xu J, Yin W. "An iterative regularization method for total variation based image restoration". Journal of Multiscale Modeling and Simulation, vol 4, 2005. pp 460-484.
- [3] Bresson X, Chan TF. "Fast dual minimization of the vectorial total variation norm and applications to color image processing". Journal of Inverse Problems and Imaging vol 2, n 4, 2008, pp 455-484.

Results

The 'inverse scale space' process applied on DWI shows an improvement over FA maps estimation (Figure a) and differences at the statistical study were found. Applying the described process, affected WM fibers tracts in PD subjects are better defined (Figure b). Also the cluster level extend and the height peak level thresholds are increased.

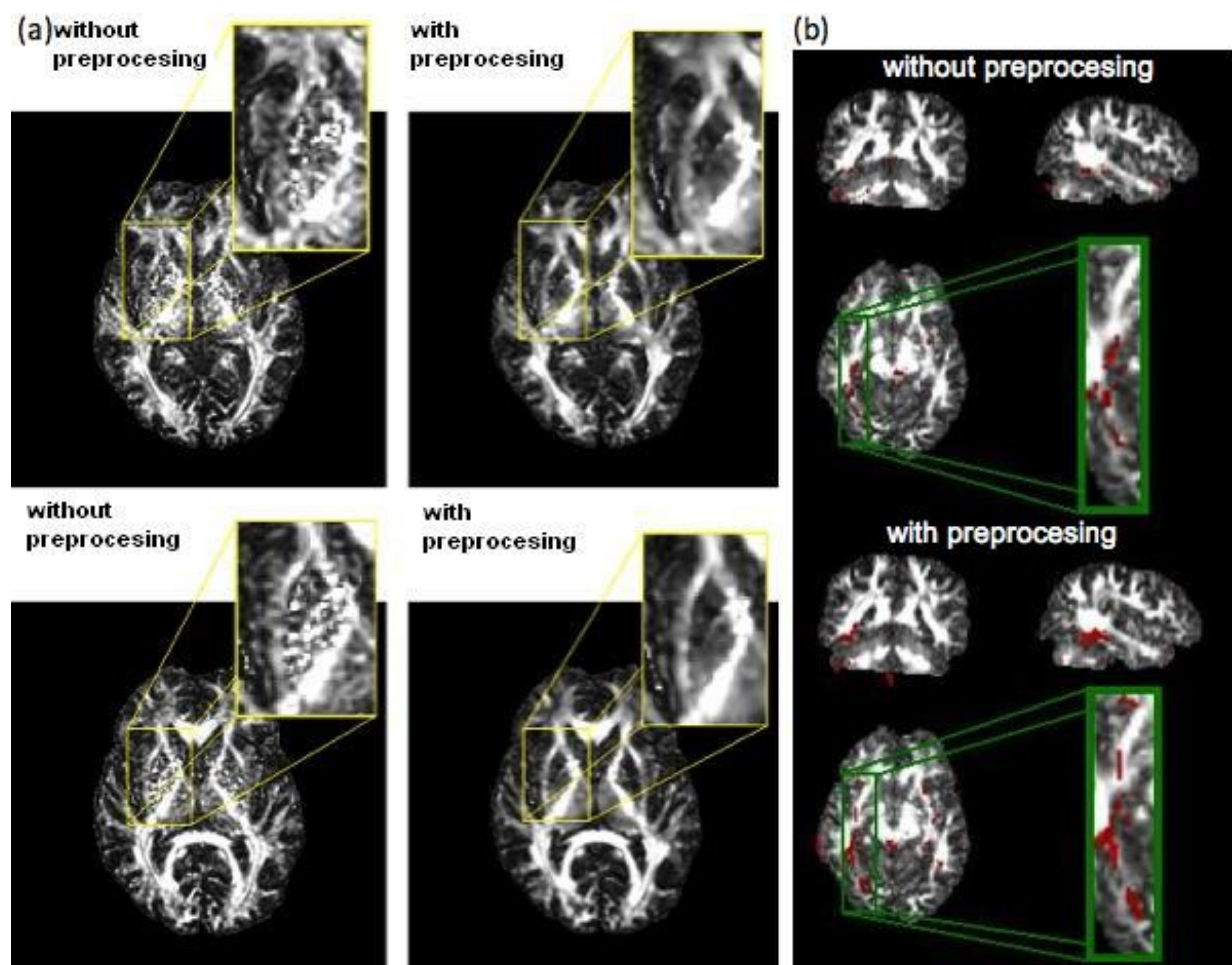


Figure. (a) At the left column, FA maps of two slices without preprocessing. At the right, with preprocessing. (b) Injured external capsule WM fibers tracts without DWI preprocessing (above) and with preprocessing (below).

Conclusions

Using 'inverse scale space' iterative scheme as a preprocessing step improves the results of VBM statistical study over FA.

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