Method for assessing reproducibility of tractography methods : Comparison between algorithms used in clinical routine.

F. TENSAOUTI[1,2], I. LAHLOU[2], J. A. LOTTERIE[1,2], and I. BERRY[1,2]
[1]Service Biophysique et Médecine Nucléaire, CHU Toulouse Rangueil, Toulouse, France, [2]Université Paul Sabatier, Toulouse III, Toulouse, France

Introduction

Fiber tracking has recently become an important tool in the analysis of the central nervous system. It has the potential to identify major white matter tracts afflicted by pathology or tracts at risk for a given surgical approach. However, the reliability and reproducibility of these techniques are known to be limited by the quality of acquired data, the underlying models and algorithms, and finally by the methods for reporting and displaying the results. In our laboratory, a software for neuroimaging [1] is developed, and recently, two kinds of fiber tracking algorithms were implemented and integrated in this software: three deterministic algorithms (tensor deflection (TD) [2], tensor lines (TL) [3], streamlines Runge Kutta (SRK) [4]) and statistical algorithm (SA) [5]. The aim of our study is to evaluate the fiber tracking strategy in terms of acquisition schemes in conjunction with different algorithms cited above.

Material and Method

The DTI-MR data were obtained from 12 healthy subjects, using a 1.5-T Philips Intera system. Each exam consisted of 3 DTI acquisitions (6, 15 and 32 directions) and a 3D-T1. A second exam, identical to the first one, was acquired 1 month later. Data were analyzed with Sisyphe. The pyramidal tract pathways were investigated in the 12 subjects. The fiber tracking was done by using the four algorithms implemented in the software. For each algorithm, quantitative comparison between tracts was calculated by using boolean operators on tractus volumes. Two tracts have exactly the same volume and pathway if the ratio volume-intersection on volume-union is 100%. This ratio is called volume agreement percentage (VAP) (VAP = intersection volume / union volume). Inter-exam reproducibility was evaluated by comparing fiber tracking results from the same acquisition scheme on the first and second exam (inter-exam). This operation was performed by the same operator. The ratio VAP is also calculated in three cases. In each case we take the fibre density distribution percentile equal to 20 %, 50 % or 80 %.

Results

For each fiber tracking algorithms, the best reproducibility result is obtained in case of 50% of fiber density and for the number of directions equal to 32 (VAP = 46.68 % for SRK, 48.99 % for TD , 53.17 % for TL and 78.23 % for SA). The results show that by using SA algorithm, the reproducibility is improved (VAP = 78.23 %). A significant difference between results was found between 6 directions and 15 directions and also between 6 and 32 directions; however for the four algorithms there is no significant difference between 15 and 32 directions.

Conclusion

The study highlights growing reliability of reproducibility results based on the number of directions employed during the acquisition and the method of tractography used. These preliminary results show clearly that the reproducibility of tractography methods can be improved by using more efficient algorithms and also by increasing the angular resolution acquisitions. The choice of adequate density fiber tract greatly improves the results. These findings underline the importance of assessing the reliability of diffusion tractography before investigating white matter pathology.