

Evaluation of muscle fiber tractography by Single-shot Diffusion Tensor STE EPI

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Introduction

Diffusion Tensor Toractography (DTT) is a technique for making the fiber structure visible. Recently, the research is chiefly done to the central nervous area as for it. Because T2 relaxation time is very short with skeletal muscle, the acquisition of diffusion weighted image is considered to be difficulty. It became possible by the Diffusion Tensor Stimulated Echo (DT-STE) method though enough SNR was not able to be obtained in the skeletal muscle. We originally developed and mounted single-shot DT STE-EPI pulse sequence at an MR scanner. We acquired data from a normal volunteer using DT STE-EPI pulse sequence and evaluated muscle fiber tractography.

Material and Method

DTI was done on a 1.5T MR scanner (signa Horizon Lx Ver.9.0, greatest slope magnetic field strength: 22[mT/m]) using a extreem coil. The pulse sequence programming uses EPIC ver. 9.0 (GE). I performed image analysis by IDL ver6.1 (ITT) and Tokyo University radiology development freeware - dTV II. The condition of tracking assumed FA =0.20 a threshold and set a limit without turning angle. The parameter setting of DT-STEPI is TR/ TE/ TM: 4,000/ 44.1/ 208.2[ms], Δ/δ : 225.9/ 11.4[ms], b-value: 1000[s/mm²], an MPG axis to impress: 6(xy, xz, yz, -xy, -xz, -yz). The imaging intended for a normal volunteer (5 example; Age 22.2 ± 1.11) and the part assumed it a lower thigh skeletal muscle. We had examined two mainly. At first we changed b-value (100, 400, 800, 1000 [s/mm²]) and performed tracking for tibialis anterior muscle (TA). Secondly, we measured a pannation angle of gastrocnemius muscle (GA) by tractography and compared it with references of the past. From it, we did a comparative evaluation of quantitative anatomy of skeletal muscle tractography.

Result and Discussion

DT STE-EPI pulse sequence was able to acquire a lot of SNR than the conventional pulse sequence. Figure 1 showed the image that did the tracking from data that changed b-value. It is understood that the perfusion effect is greatly reflected in b-value 100[s/mm²], and the diffusion effect between the muscle fibers is not reflected so much. Therefore, It has done tracking of other information. Moreover, b-value 400 [s/mm²] was insufficient yet. When assuming b-value 800 and 1000[s/mm²], the muscle fiber structure was depicted enough. Therefore, b-value of at least 800[s/mm²] or more is necessary to remove perfusion and to reflect diffusion enough for muscle fiber tracking. Next, we were tracked to the gastrocnemial muscle, and showed image of the result in Figure 2. We pulled a line of aponeurosis and muscle fiber on Figure2 and measured pannation angle. Results, pannation angle were measured with 20.7±2.3[deg].

References of other measurement were measured with 20.5[deg][1], 21.8[deg][2], and a similar value was obtained. Therefore, muscle fiber tracking depicts anatomy of muscle fiber. Figure 3 showed the image that had done DTT to various skeletal muscles of the lower thigh.

References

- [1] Narici MV et al, J Physiol (Lond) 496: 287-297 (1996) [2] Maganaris CN et al, J Physiol (Lond) 512: 603-614 (1998)

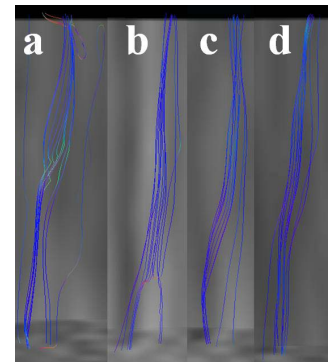


Figure.1 Muscle Fiber Tracking (tibialis anterior muscle) by some b-value 100(a), 400(b), 800(c), 1000(d) [s/mm²].

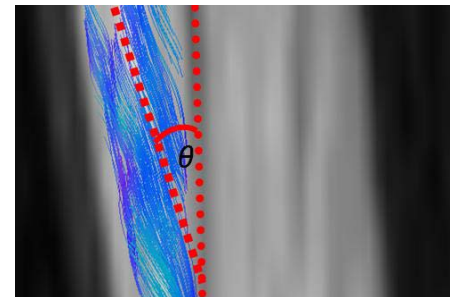


Figure.2 The determination of the pennation angle (θ) of gastrocnemius muscle.

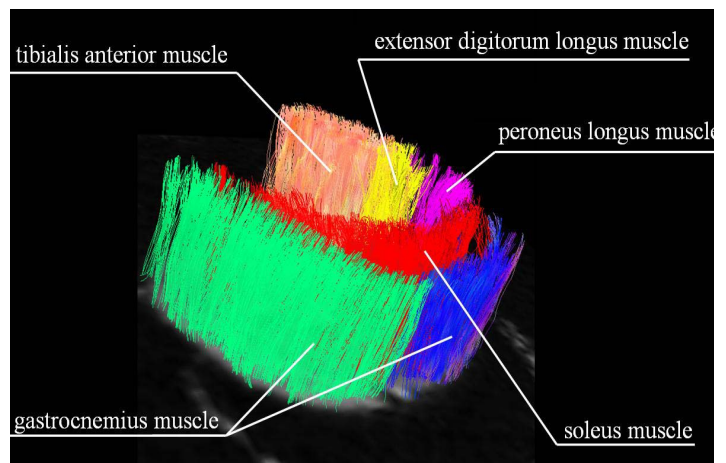


Figure.3 Fiber tracking data of skeletal muscles of the lower thigh