Analysis of the Stiffness Anisotropy Structure using MR Elastography in the Skeletal Muscle

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Introduction MRE method is calculated based on assumption that there is isotropy in the biotissue. However, anisotropy exists in the biotissue. Especially, the skeletal muscle is internal organs with strong anisotropy it is composed by fiber. When the stiffness of the skeletal muscle is evaluated, this anisotropy becomes a problem. Then, this research aimed at the analysis and the evaluation of the anisotropy by MRE.

Material and Method MRE was done on a 3.0Tesla MR scanner (Achieva, phiiips) using the Flex M coils. I performed image analysis by (The MAYO clinic Free Ware) and Image J (NIH). Imaging pulse sequence was non-MSG MRE sequence. The parameter setting is TR/TE:40/3.6[ms], FA:20[deg], Matrix: 256×256, Vibration frequency: 50[Hz]. The experiment object was assumed to be man healthy volunteer (n=3, Age 24.6±3.7) to obtain agreement by approval of ethical committee and agreement. The imaging part was assumed to be lower thigh skeletal muscle (Tibialis Anterior muscle: TA). As a target for comparison, we used one's own homolytic agarose phantom. We could not pinpoint the direction of the vibration for the vibration from several points, complicated boundary condition, vibration decrement and hypothesized that it was disorderly and analyzed it. We put imaging section (Axial, Sagittal, Coronal) and sensitized direction (AP, RL, SI) together than this and we analyzed the oscillation wave by each course, a coefficient of elasticity and evaluated anisotropy.

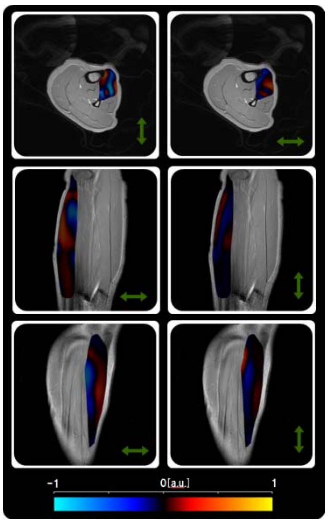

Fig.1 MRE Wave Image
The image of axial, sagittal and coronal from order. Green arrow is motion sensitized direction.

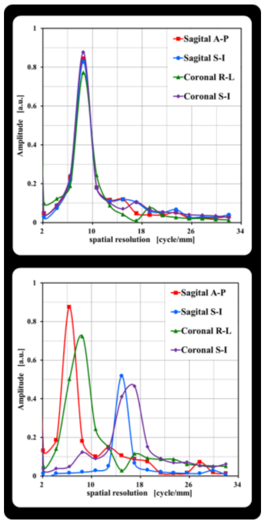

Fig.2 Fourier Analysis
The above it is phantom and below is the skeletal muscle.

Results and Discussion We chose ROI among Fig.1 and drew Profile Curve at Fig.2. It was a relatively equal oscillation wave in results, the phantom, but presented with a complicated oscillation wave in the skeletal muscle. Also, as a result of Fourier analysis, all the wavelengths were similar in the phantom. The wavelength that was different from a major axis in a minor axis was calculated for muscular fiber in the skeletal muscle. Next, we obtained Fig.4 from Fig.3 according to statistics. The phantom became the high value in Axial, and the others showed a similar value. In the skeletal muscle, a significantly different value was calculated in a short axis and a long axis for muscular fiber. As a result, a difference appeared between a short and a long axis of the muscular fiber. This can say that the spread of the elastic wave includes direction dependence. Thus, elasticity anisotropy is thought to be present in lower leg skeletal muscle. We were able to confirm that not only the isotropy but also the anisotropy was present in a coefficient of elasticity of the biotissue than this. We consider density and the course of the tissue fiber for fixed-quantity analysis in MRE.

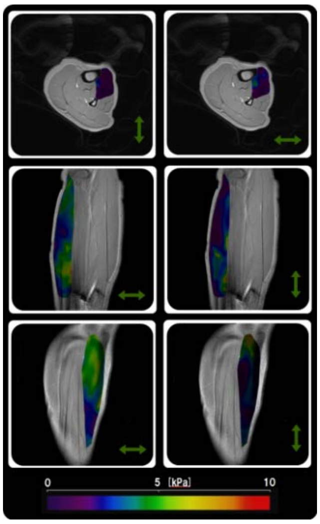

Fig.3 MRE Stiffness image
The image array is the same as Fig.1. Green arrow is MSD.

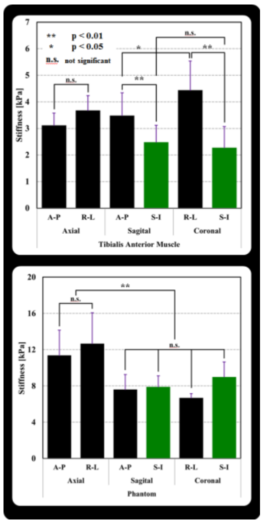

Fig.4 ROI analysis
Each stiffness by combination of section and encode.

Conclusion We analyzed coefficient of elasticity anisotropy of the tissue. It was suggested that MRE established one idea of the technique with the presentation, and the structural analysis with the anisotropy had to consider it.