Assessment Using MRI shows that Inter-synergistic as well as Inter-antagonistic Epimuscular Myofascial Force Transmission has Sizable Effects within the Entire Human Lower Leg, in vivo

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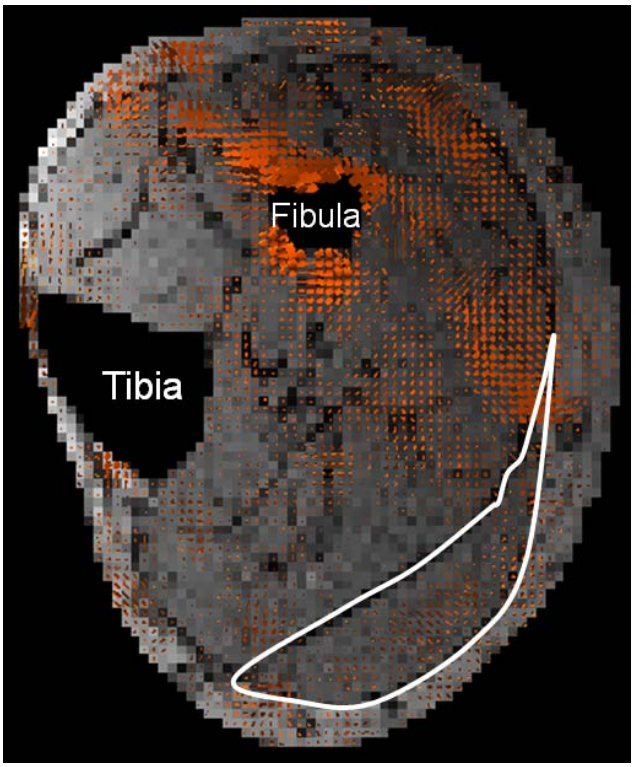
INTRODUCTION: In addition to myotendinous pathways, important pathways for transmission of muscle force are comprised by connective tissue structures providing mechanical linkage between muscles and neighboring muscular and nonmuscular tissues [e.g., 1]. With experiments, in situ and using finite element modeling, such epimuscular myofascial force transmission (EMFT) has been shown to affect muscular mechanics substantially in the rat, leading to proximo-distal force differences and major sarcomere length heterogeneity. The goal of this work was to show using MRI that EMFT has major effects also in human, in vivo.

METHODS: The ankle angle of a male (30 years old, height=175 cm and weight=70 kg) was fixed (at 90°). The effects of passively changing the knee angle on local deformation within the lower leg were assessed: Deformations of muscles not crossing the knee (which remain isometric due to an unchanged ankle angle) were considered as indicators of the effects of EMFT. Intensity based non-rigid B-spline semilocal registration [2] was used to obtain displacement fields for a knee angle=160° (reference state) and a knee angle=130° (deformed state). Principle values of Green-Lagrange strains were calculated for each voxel (size=0.8x0.8x0.8 mm).



Strain field of an axial slice of the lower leg. The white line delimits m. gastrocnemius length of which was altered by changing knee angles. For the remainder of mono-articular muscles, no length changes were imposed hence any strain is ascribable to EMFT.

RESULTS: Our results showed that changing knee angle causes sizable strains not only in m. gastrocnemius, but also in synergistic m. soleus (maximal local lengthening and shortening equals 35% and 50%, respectively) and even in antagonistic muscles not crossing the knee (e.g., similar to m. soleus, for peronei muscles maximal local lengthening and shortening equals 36% and 50%, respectively). We conclude that EMFT has major effects within the entire human lower leg, in vivo.

REFERENCES

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