A NEW APPROACH FOR MODEL VALIDATION CONCIDERING AN OPTICAL MEASUREMENT TECHNIQUE

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Introduction

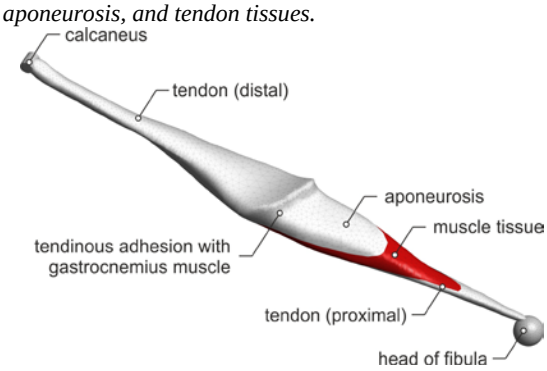
The description of active muscle tissues as well as the determination of their mechanical properties during contraction are of high interest and require complex numerical and experimental techniques. Active muscle experiments are essential to improve previously investigations on activated skeletal muscles [Tang et al., 2007, Böl et al., 2011a] by considering additional to the generated force and length characteristics the three-dimensional deformable muscle shape. In doing so, an optical measurement technique is proposed to obtain a convenient and comprehensive data set for muscle model validation. In the present contribution, an approach is presented, where a recently developed numerical muscle model [Böl et al., 2011b, Ehret et al., 2011] is validated by consideration the locomotive muscle geometry, the fibre alignment, and also the generated force characteristics [Böl et al., 2013].

Methods

An optical measurement method is developed to measure the three-dimensional shape of a muscle during the contraction process. The measurements are carried out *ex situ* on isolated rabbit soleus muscles. In this way an immediate determination of forces and velocities can be ensured as well as the deformation state. The recorded surface is marked by a special coating technology. Thus, the sensors have the ability to detect the various facets and a closed three-dimensional muscle model separated in muscle tissue and tendon/aponeurosis complex can be reconstructed from different recordings, see Figure 1.

In a second step, the transversal isotropic muscle tissue behaviour is described by a hyperelastic constitutive law whereas the activation of the muscle fibres could be inserting by a single parameter, see [Böl et al., 2011b , Ehret et al., 2011].

Figure 1: Exemplary illustration of a typical three-dimensional rabbit soleus muscle consisting of muscle, aponeurosis, and tendon tissues.



Results and Conclusion

The proposed model validation combines, in contrast to previous validation approaches, complex three-dimensional muscle architecture with generated forces during different contraction modes. This allows to a more accurate mechanical description of muscle tissues and further to a better understanding of the interaction between muscles in a whole muscle package. Due to the consideration of biological tissue, results underline the ability of the proposed approach.

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References

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