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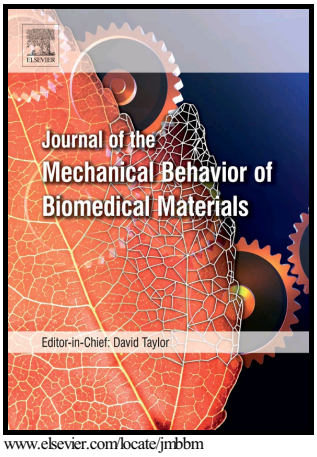

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Collagen fibril organization in chicken and porcine skeletal muscle perimysium under applied tension and compression

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Abstract

The tension/compression asymmetry observed in the stress-stretch response of skeletal muscle is not well understood. The collagen network in the extracellular matrix (ECM) almost certainly plays a major role, but the details are unknown. This paper reports qualitatively and quantitatively on skeletal muscle ECM reorganization during applied deformation using confocal imaging of collagen through use of a fluorescently-tagged specific collagen binding protein (CNA35-EGFP) of porcine and chicken muscle samples under tensile and compressive deformation in both the fibre and cross-fibre directions. This reveals the overall three-dimensional structure of collagen in perimysium in planes perpendicular and parallel to the muscle fibres in both species. Furthermore, there is clear evidence of the reorganization of these structures under compression and tension applied in both the muscle fibre and cross-fibre directions. These observations improve our understanding of perimysium structure and response to three-dimensional deformations and are an important basis for constitutive models of passive skeletal muscle. Although overall behaviour was similar, some differences in perimysium structure were observed between chicken and porcine muscle tissue. Further work is required to better understand which structures are responsible for the tension and compression stress-strain asymmetry previously observed in the mechanical response of passive skeletal muscle.

Keywords

Perimysium, CNA35, collagen waviness, skeletal muscle, microstructure, tension/compression asymmetry.

1. Introduction

In skeletal muscle, the extracellular matrix (ECM) functions as a structure that organises muscle fibres into hierarchal groups and acts as a retaining mechanism during deformation (Rowe, 1974, Huijing, 2009). About 10% of skeletal muscle volume is composed of collagen fibres and collagen is the main protein of the ECM (Williams et al., 1995, Dransfield, 1977). Perimysium collagen is mostly type I, whereas endomysium and epimysium consist of equal amounts of collagen type I and type III (Light and Champion, 1984). The mechanical properties of passive skeletal muscle clearly depend on the size,

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