Development of an *ex vivo* model to study the response of skeletal muscle to transverse mechanical loading

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Introduction

The soft tissues in our body, particularly skeletal muscles, commonly experience physical stress. In most cases, the muscles can maintain the balance between damage and regeneration. However, this balance might be disturbed in certain populations that are subject to extreme cases of overload or repeated impact, like individuals spinal cord injury [3] or transtibial prosthetic users [2].
To characterise critical loading scenarios, experimental models of skeletal muscle under mechanical loading are necessary [4, 5]. A controllable environment as well as the reproduction of the highly hierarchical structure of skeletal muscle are thereby desirable. We therefore developed an *ex vivo* model to study the response of skeletal muscle to transverse mechanical loading.

Methods

Soleus and extensor digitorum longus muscles of male Sprague Dawley rats were dissected and transversely compressed (2mm indenter, 9-32kPa) (Fig. 1). Control tissues were held under the same conditions for the same time without loading. Subsequently, tissue viability and morphology were assessed through standard histological procedures using Procion Yellow MX4R and Live-or-Dye™ for fluorescent dead cell staining as well as H&E. Additionally, biochemical changes of cell and tissue damaged were visualised with multiphoton Raman microscopy of unstained samples.

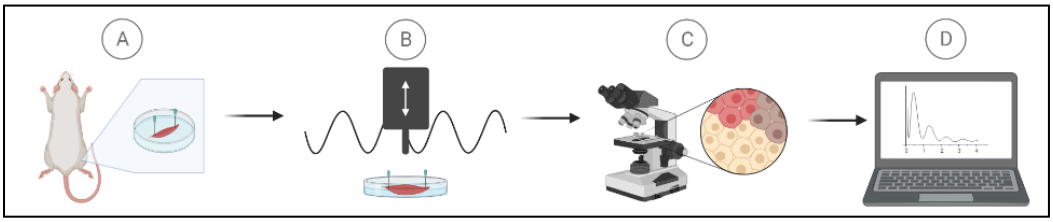

Figure 1: Schematic of ex vivo model. A: Skeletal muscle dissection; B: Mechanical loading; C: Image analysis for cell damage; D: Data analysis to establish the relationship between loading conditions and cell damage.

Results & Discussion

Whilst control samples showed only minor loss in cell viability throughout the experimental time frame (max. 3h), mechanical damage in loaded tissues was readily distinguishable. Imaging revealed a partial loss of cross-striations, disorganised and disrupted muscle fibres, increased interstitial space, and loss of cell viability. With careful control of the experimental setup, detailed imaging of local cellular damage in response to loading conditions could be obtained.

Conclusion

Our *ex vivo* model of skeletal muscle for transverse mechanical loading is suitable for quantifying cellular damage. Looking at this microscale will provide important insights into the adaptive capabilities of skeletal muscle. This can provide the basis for further research into the role of soft tissue deformation in limb pain and ulcer formation and could inform future directions for socket design and fit.

References

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