Regional variations in sarcomere length and number of sarcomeres arranged in series in the human biceps femoris long head

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Summary

This study examined regional variations in sarcomere length and number within biceps femoris long head (BFlh) muscle fibers. The findings suggest that differences in sarcomere length occur within individuals muscle fibers but not between them. Differences in the number of sarcomeres in series were observed between regions, with the proximal region containing the highest number.

Introduction

Understanding the variability in architectural parameters of skeletal muscles is essential to elucidate their functional roles. Sarcomere length and pennation angle at which force is generated, both actively and passively, influence the muscle length-force relationship [1,2]. This study investigated sarcomere length within and between muscle fascicles, as well as the number of sarcomeres arranged in series of different regions within BFlh. The objective of this study was to examine regional structural differences that could help explain the high injury risk associated with this muscle.

Methods

Muscle fascicles were dissected from three regions (proximal, intermediate, distal) of the right leg of the BFlh from two human donors. Five short sections (~1 cm) were cut along the length of each fascicle. These sections were treated with glycerol, rinsed, and immersed in nitric acid to soften connective tissue. From each section, five single fiber segments were isolated. Sarcomere length was measured using a combination of light microscopy and ImageJ grayscale plots and analyzed by a custom-made Matlab script [1]. The total number of sarcomeres in series was calculated by dividing the fascicle length by the mean sarcomere length.

Results and Discussion

Differences in the mean sarcomere length were observed within muscle fascicles (Fig. 1), but not between fascicles from different regions (Table 1). Sarcomeres were shortest in sections closer to the muscle origin within individual fascicles (section 1, proximal) and progressively longer towards the insertion (section 5, distal; Fig. 1). The number of sarcomeres in series was higher in the proximal region compared to the intermediate and distal regions (Table 1). These differences may contribute to an increased injury risk ty in the proximal region due to uneven mechanical loading within the muscle. Due to the limited sample size (n=2), no statistical analysis was performed. Sarcomere length variation within fascicles may be influenced by factors such as rigor mortis, passive tension variability, and structural constraints within the fiber, including connective tissue arrangement and stiffness [3]. However, the number of sarcomeres in series is not affected by these factors, making it a more reliable measure of region-specific differences.

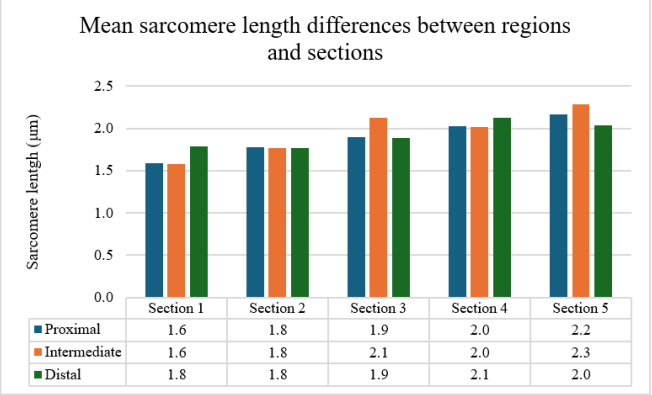

Figure 1: Mean sarcomere number across regions sections. Sections were labeled sequentially from section 1 (most proximal) to section 5 (most distal)

Table 1: Mean fascicle length, sarcomere length and sarcomere number in each region

	Fascicle Length (µm)	Sarcomere Length (µm)	Sarcomere Number
Proximal	**77750**	**1.9**	**43121**
Intermediate	**55000**	**2.0**	**28954**
Distal	**58500**	**1.9**	**31946**

Conclusions

This study highlighted variations in sarcomere length within muscle fascicles and in sarcomere number between different regions of the BFlh. Future research should explore the implications of these variations for 3-dimensional muscle function and injury risk.

Acknowledgments

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