The mysteries of eccentric muscle action

Walter Herzog Guest Editor

PII: S2095-2546(18)30047-4
DOI: 10.1016/j.jshs.2018.05.006
Reference: JSHS 460

To appear in: *Journal of Sport and Health Science*

Accepted date: 14 May 2018

Note: This is an invited special issue article.

Editorial

The mysteries of eccentric muscle action

Muscle actions are typically divided into 3 categories: concentric, isometric, and eccentric. An active muscle that is shortening and produces positive mechanical work is said to work concentrically; an active muscle that is not changing its length, and thus does not produce net work, is said to work isometrically; and an active muscle that is elongated by external forces, and thus absorbs work, or produces negative work, is said to work eccentrically [1].

Concentric and isometric muscle actions are well studied and well understood, and they fit well into the way we think about muscle contraction on the molecular level: the sliding filament [2,3] and the cross-bridge theory [4]. In contrast, eccentric muscle actions are not nearly as much studied as concentric and isometric actions, and they do not fit well into the cross-bridge theory thinking (e.g., Herzog [5]). Muscles working eccentrically can produce much greater forces than muscles working concentrically or isometrically [6,7], they remain stronger following the eccentric action (residual force enhancement, e.g., Edman et al. , [8] Herzog and Leonard[,9]), they require less energy per unit of force [10], and eccentric muscle actions are occurring in everyday life all the time [11]. Eccentric muscle actions have also been associated with increased risks for muscle injury (e.g., Brooks et al.,[12,] Armstrong et al. [13]), instability of force production and sarcomere lengths (e.g., Morgan [14]), and inhibition of voluntary activation (e.g., Westing et al.[15]). However, eccentric muscle actions remain understudied, and many of the phenomena associated with eccentric actions have eluded satisfactory explanation. Eccentric muscle actions, the properties associated with them, and the underlying mechanistic explanations remain poorly understood.

In this special issue of the *Journal of Sport and Health Science* (*JSHS*), experts in the field have tackled some of the mysteries surrounding eccentric muscle actions. They have addressed the mechanical properties of eccentric muscle action (force production and residual force enhancement), the neural control and muscle inhibitions associated with eccentric muscle actions, and issues associated with eccentric muscle action and injuries as a tool for rehabilitation.

Herzog discusses why muscles are stronger when they are actively lengthened compared to when they are shortening, using the cross-bridge theory. He then identifies the shortcomings of the cross-bridge theory in explaining eccentric muscle actions and discusses how sarcomere length non-uniformity and passive structural elements have been used to fill the gap left by the cross-bridge theory. He continues by explaining phenomena such as the residual force enhancement and reduced energetic cost in eccentric muscle action using a model that includes the engagement of a structural element in eccentric muscle actions.

Comment [F1]: The full text link would be provided here once this reference is online published, as well as the other 7 articles in the same special issue as mentioned as below.

Nishikawa et al. explore the topic of eccentric action and residual force enhancement further using a historical context, making a strong argument for eccentric muscle work as a tool in rehabilitation settings, specifically for patient populations with compromised oxygen uptake capacities. They also use a comparative approach between mammalian and molluscan skeletal muscles that may explain some of the mysteries surrounding the residual force enhancement property.