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Commentary



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# Comment on "The late swing and early stance of sprinting are most hazardous for hamstring injuries" by Liu et al.

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We have carefully read the description of the proposed mechanisms of hamstring muscle strain injury by Liu et al.<sup>1</sup> and noticed that they suggest that hamstring strain injuries may be associated with extensive muscle force and occur during the early stance phase of sprinting when the hamstrings are thought to work concentrically. We did not find any evidence in our extensive literature review to support this particular view. Liu et al.<sup>1</sup> did not provide any literature showing a muscle injury mechanism with high concentric muscle contractions.

The literature is full of examples demonstrating that muscle strain injuries are caused by muscle strain, instead of muscle force, that occurs in eccentrically contracting muscles. Garrett et al.<sup>2</sup> demonstrated that muscle strain injury occurred at similar strains in eccentric contraction, independent of muscle forces. Similarly, Lieber and Friden<sup>3</sup> found that muscle strain, not force, was the primary factor producing muscle damage due to repetitive eccentric contractions. We did not find evidence that muscle strain could occur in concentric contractions.

Mann and Sprague<sup>4</sup> investigated lower extremity kinetics during overground sprinting and calculated the resultant torques of the lower limb joints. They found that knee flexion and hip extension torques peaked in early stance.<sup>4</sup> Although the variations in knee flexion and hip extension torque can be approximated as indications of the variation in hamstring muscle force, Mann and Sprague<sup>4</sup> did not present muscle strain values. Therefore, it was impossible for them to establish an association between muscle force and strain. Their suggestion that hamstring muscles might be at risk for strain injury during early stance was a guess lacking scientific rigor and was made in the absence of studies on the mechanism of muscle strain injury. It has been found that hamstring muscle force and strain are not associated in sprinting. Mann and Sprague<sup>4</sup> showed that the peak knee flexion and hip extension torque occurred in the early stance phase in overground sprinting. However, Thelen et al.<sup>5</sup> found that the hamstring muscles were in eccentric contraction and reached maximal muscle-tendon unit length in the late swing phase in treadmill sprinting. They also found that the hamstring muscles were contracting concentrically in the early stance phase of sprinting.<sup>4</sup> Yu et al.<sup>6</sup> showed similar results in overground sprinting. These results taken together clearly indicate that hamstring muscle force and strain are not associated in a linear fashion in sprinting and specifically that peak torques and hamstring forces do not occur at peak hamstring lengths.

The idea that hamstring muscle strain injury may be caused by muscle force is mainly based on a recent study by Sun et al.<sup>7</sup> However, there is little information on the possible mechanisms of hamstring muscle strain injury in sprinting in that study. Sun et al.<sup>7</sup> decomposed the contributions to the resultant joint torques into 5 components using a sophisticated biomechanical model. However, they did not establish a convincing correlation between any of the components and hamstring muscle length or strain. Therefore, no direct evidence was shown supporting an association among hamstring injury, muscle force, and muscle strain to support their proposal.

Liu et al.<sup>1</sup> cited Uchiyama et al.<sup>8</sup> in support of their view that muscle strain injury can occur during concentric contraction. We would argue that the study by Uchiyama et al.<sup>8</sup> provides little support to their proposal. Uchiyama et al.<sup>8</sup> added strain in concentric contractions to create strain injuries in rat muscles. Therefore, the muscle strain injuries actually occurred in an eccentric part of the contraction,<sup>8</sup> which is different from the hamstrings' continuous concentric contraction in the early stance phase of sprinting.

In summary, the current literature provides overwhelming evidence that muscle strain injuries occur in eccentric contractions, or when muscles are stretched without activation, and that

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hamstring muscles are at risk for strain injury during the late swing phase of sprinting in which hamstring muscles have peak strains in eccentric contraction. In an extensive literature review, we failed to find any theoretical or direct experimental evidence supporting the association between hamstring strain injury and concentric contraction during the early stance phase of sprinting.

# Authors' contributions

BY drafted the manuscript; HL performed literature searches and helped to draft and revise the manuscript; WEG helped to perform literature searches and draft and revise the manuscript. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

## **Competing interests**

The authors declare that they have no competing interests.

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