Letter to the Editor

Increasing Role of Hips Supported by Electromyography and Musculoskeletal Modeling

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TO THE EDITOR:

We thank Bryanton and Chiu (4) for their interest in our article (2). We are pleased that they consider our proposal interesting and note their concerns regarding the dangers of simplifying complex biomechanics. Nevertheless, since *Strength and Conditioning Journal* is primarily aimed at practitioners and not academics, simplification of complex terminology is warranted. Moreover, we do not feel our simplifications detract from the proposal as significantly as Bryanton and Chiu (4) suggest. Therefore, we stand by our conclusions and address their points one by one.

First, we consider our definition of joint moment to be correct and consistent with definitions found elsewhere in the literature (8). However, we agree that we should have spent more time covering the concepts of muscle cocontraction and proximal-to-distal sequencing, as well as precisely how the definition of joint moment relates to net joint moment (NJM) calculations.

Second, although we agree that knee extensor effort is underestimated in NJM calculations because of cocontraction, we note that hip extensor effort is also underestimated when accompanied by hip flexor cocontraction. Since the rectus femoris is both hip flexor and knee extensor, this point is particularly relevant during combined hip and knee extension movements. Moreover, the same issue can be found in any NJM calculation, including ankle plantar flexion, knee extension, hip extension, and lumbar extension. Each NJM will be underestimated in dynamic movement because of antagonist cocontraction. Indeed, almost all methods used in biomechanics possess inherent limitations, which is why it is helpful to consider the findings of different techniques. This is illustrated by the next point.

Third, we disagree that "greater hip extensor NJM must be accompanied by greater quadriceps efforts." Electromyography (EMG) investigations have found that muscle activation increases to a greater extent in the hamstrings and gluteus maximus than in the quadriceps with increasing speed during running (3,6) and with increasing load during back squats (1,7). Similarly, musculoskeletal modeling shows that the muscle forces of the hamstrings and gluteus maximus increase to a much greater extent than those of the quadriceps with increasing running speed (5). Thus, both EMG and musculoskeletal modeling studies consistently support our proposal based on NJM data that ratios of hip extensor-to-knee extensor effort are altered with increasing load and speed in favor of the hip extensors.

Fourth, in addition to our point above, we consider the statement "strong quadriceps are required to achieve a large hip extensor NJM" too broad to encompass all movements. Some hip extension movements, including those that involve completely straight legs (e.g., back extensions) or semi-straight legs (e.g., good mornings) will clearly not require as strong cocontractions from the knee extensors as those involving bent legs (e.g., squats).

Fifth, we believe that Bryanton and Chiu (4) are incorrect to infer that the hamstrings contribute 50% of the hip extensor strength during running and jumping on the basis of Waters et al. (11). First, Waters et al. state that "the hamstrings were found to account for about one-third of total hip extensor strength"

(11), which is much less than 50%. Second, this study reported isometric and not dynamic strength. Third, Waters et al. assumed that only a small portion of the adductor magnus was innervated by the sciatic nerve. However, the majority of the adductor magnus is innervated by the sciatic nerve (10) and the entire muscle acts as a hip extensor at >16° of hip flexion (7), implying these calculations may underestimate adductor magnus contribution and overestimate hamstrings contribution. Fourth, the contribution of the hamstrings varied according to hip and knee flexion angles. Fifth, Waters et al. assumed that the moment arms of the hamstring and adductor magnus are similar, but this has since been found to be incorrect (7). It is impossible to ascertain the individual contributions of the hip extensors to hip extension strength as Bryanton and Chiu (4) propose, without establishing other data, including muscle lengths, muscle moment arm lengths, and muscle activation.

In conclusion, we consider the concerns presented by Bryanton and Chiu (4) to be misplaced, and we suggest that other areas of biomechanical research strongly support our proposal rather than undermine it. We maintain that although strengthening the knee extensors is important for enhancing sports performance, developing the hip extensors is paramount.

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