Assessment of torque production capacity of the hip extensors: concurrent validity and between-session reliability

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Summary

The torque – angular velocity characteristics of the hip extensors are important in many sports such as those including sprint running. However, the assessment of this muscle group on an isokinetic dynamometer is challenging. This study found that the angular velocity of the dynamometer does not reflect the angular velocity of the hip joint as measured by 3-D motion analysis, leading to an overestimation of the observed torque. Importantly, the bias is not systematic between individuals. Accurate assessment of hip extension torque requires the hip joint angle to be considered.

Introduction

Accurate testing of hip extensor strength is essential in many sports. However, the validity and reliability of testing the hip extensors during different concentric contractions are unclear. We hypothesised that the angular velocity of the dynamometer arm would be higher than the hip angular velocity measured by 3-D motion analysis. We expected that the method used to define the range of motion would have a significant effect on the observed torque.

Methods

Fourteen resistance-trained individuals (7 female) were included in this study. A familiarisation session was followed by two main testing sessions, separated by 7 ± 2 days. On the test days, participants lay supine on a dynamometer and performed concentric hip extensions between 70° of flexion and 20° of extension range of motion, as defined by the dynamometer (knee = 40° of flexion). The contractions were performed at four different conditions: 60, 120, 180, and 350°s^{-1}, representing the maximum possible angular velocity of the dynamometer arm that could be achieved. Torque, dynamometer position, and marker displacements were recorded simultaneously. The centre of the hip joint was defined using the Hara regression equation [1,2] and the hip angle was calculated, which was then used to calculate the hip extension velocity. The hip angular velocity was compared with the dynamometer angular velocity over the full range of motion. Torque was then averaged over the largest hip range of motion common to all conditions and participants based on 3-D motion analysis (50° to 20° hip flexion). Torque was then averaged between the 50° and 20° dynamometer positions to compare the effects of the selected method on the observed torque. Intra-class correlation coefficient ($ICC_{2,1}$) and standard error of measurement (SEM) were calculated to assess the reliability between the sessions.

Results and Discussion

The angular velocity of the dynamometer was higher than that of the hip in all conditions, except at the beginning of the range of motion ($p<0.001$). The torque was significantly higher when the range of motion was defined based on the dynamometer in all but the fastest condition ($p < 0.001$, Cohens d = 1.0-1.2). The effect of the method was not consistent between individuals (Figure 1). Up to 180°s^{-1}, good-to-excellent reliability was observed with both methods of defining the range of motion (ICC = 0.73-0.90, SEM = 13-16 Nm). However, at maximum velocity the reliability was comparatively lower (dynamometer-based: ICC = 0.22, SEM = 16 Nm, hip-based: ICC = 0.58, SEM = 13 Nm).

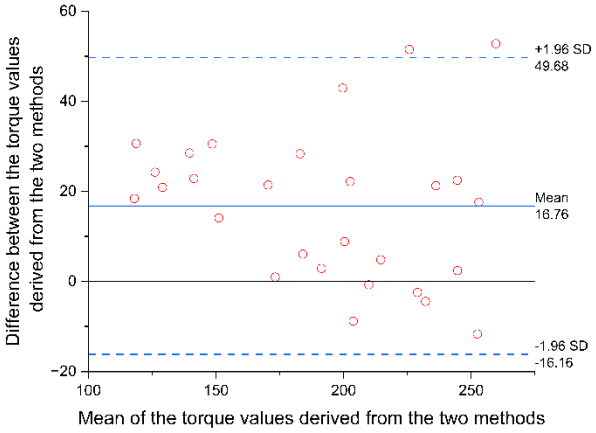

Figure 1: Bland-Altman plots for individual measurements in the condition when the dynamometer arm rotated at 60°s^{-1}.

Conclusions

The angular velocity of the dynamometer does not reflect the angular velocity of the hip joint. Accurate assessment of hip extension torque requires the correction for hip joint angle when defining the range of motion.

Acknowledgments

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References

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