Comparison of maximal joint moments measured by isokinetic dynamometer versus inverse dynamics method

Juha-Pekka Kulmala
Helsinki University Hospital and University of Helsinki
Email: juha-pekka.kulmala@hus.fi

Summary

Isokinetic dynamometers (IKD) and inverse dynamics (ID) are the two gold standard methods used to study joint moments produced by different muscle groups. However, it is not known whether IKD and ID provide comparable joint moment values. Therefore, this research compared the maximum joint moments of antigravity muscle groups measured using IKD and ID methods. A 44% (P=0.002) lower ankle plantarflexor moment was obtained with IKD compared to ID, whereas the opposite was observed at the knee, with a 30% (P=0.029) greater extensor moment measured using IKD. The observation that IKD and ID methods produce significantly different moment outputs for ankle and knee extensor muscles should be considered when interpreting results derived from these two methods.

Introduction

Accurate measurement of joint moments is of great importance for many applications in sports, rehabilitation, and research. Isokinetic dynamometer (IKD) devices and inverse dynamics approach (ID) are both considered as gold standard tools for quantifying joint moments. A vast number of studies using these two methods have provided basis on our understanding of muscle function in various motor tasks among healthy and clinical groups. For decades, IKD and ID are thought to provide equivalent moment values, but this assumption has never been verified. Therefore, this research compared maximal joint moments of antigravity muscle groups measured using IKD and ID methods.

Methods

Maximum isometric moments from nine subjects were measured at matched joint angles for ankle extensors (0°), knee extensors (40°), hip extensors (20°) and hip abductors (0°) using a commercially available IKD (Con-Trex) and a force plate integrated apparatus, which enabled ID computation. In the ID apparatus, participants were in an inclined laying position (30° to the ground horizontal level), with the force plate positioned at a 90° angle relative to the back rest. A custom-built frame was used to fix the foot position when conducting measurement for hip extensors and abductors. Additionally, a wooden block was placed underneath the rearfoot during the knee extensor measurement (multi-joint extension task) to keep the ground reaction force vector close to the ankle joint, preventing plantarflexors from producing opposing moments at the knee joint.

Results and Discussion

A 44% (P=0.002) lower ankle extensor moment was obtained in IKD than ID condition, whereas the opposite – a 30% (P=0.029) greater extensor moment in IKD – was measured at the knee. No significant differences were found between the two methods for hip abductor and hip extensor moments. The discrepancy in the ankle measurement may be due to non-optimal force transmission from the pedal adapter to the rotational axis of the dynamometer. The difference in knee extensor moment may be explained by higher agonist and antagonist (hamstrings) muscle co-contractions during the multi-joint leg extension performed in ID.

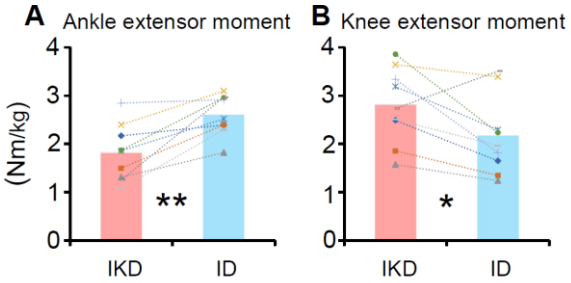

Figure 1: Joint moments measured by IKD (isokinetic dynamometer) and ID (inverse dynamics) for ankle extensors (A), and knee extensors (B).

Conclusions

It is important to consider the differences observed in the ankle and knee extensor moments, when interpreting results derived from IKD and ID measurements.

Table 1: Maximal joint moments (mean ± SD) between IKD (isokinetic dynamometer) and ID (inverse dynamics)

	IKD	ID	P-value (t-test)	Effect Size
Ankle extensors (Nm/kg)	1.81 ± 0.58	2.60 ± 0.42	**.002**	1.55
Knee extensors (Nm/kg)	2.80 ± 0.78	2.16 ± 0.81	**.029**	0.89
Hip extensors (Nm/kg)	2.63 ± 0.81	2.78 ± 0.44	.48	0.25
Hip abductors (Nm/kg)	1.82 ± 0.38	1.86 ± 0.55	.70	0.13