Joint specific mechanical power during the push phase of elite bobsleigh

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Abstract

Introduction

High accelerations in the bobsleigh push phase are crucial for high bob velocities and therefore short final race times.[1,2] For that, leg extensor muscles have to produce high mechanical power at the hip, knee, and ankle to propel the athlete's body and the sled forward. In order to modify training and to enhance performance, the understanding of joint function is essential for coaches and athletes.

Methods

3D kinematics and kinetics of 19 male elite athletes during push phase were measured with 16 IR-Highspeed-Cameras and three force plates. Phases of initial acceleration (step 1 and 2), acceleration at 10 m, and high velocity at 30 m were analyzed. Mechanical power at hip, knee, ankle, and metatarsophalangeal joint was determined with a modified full-body model (Alaska Dynamicus).

Results

The hip joint produced its highest positive power (2.1 to 2.8 ± 0.7 kW) at touch-down and its highest negative power (1.8 to 2.3 ± 1.2 kW) just before toe-off (Fig. 1). In contrast, the ankle generated its maximum negative power (1.3 to 3.9 ± 0.9 kW) immediately after touch-down and its highest positive power (2.5 to 3.7 ± 0.9 kW) just before take-off. After 30 m of acceleration, maximal negative (200%) and positive (48%) ankle power were significantly ($P < 0.01$) increased compared to the beginning of the push phase (contact 1). When hip and ankle function was reduced between 60% and 70% of stance, the knee generated its maximal positive power (1.1 to 1.3 ± 0.4 kW), which was 54% to 65% smaller than at the hip and ankle.

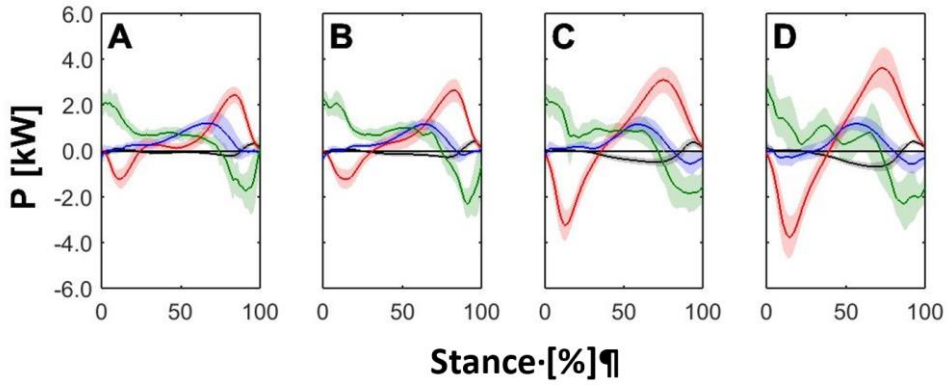

Figure 1: Mechanical power (mean ± SD) at the hip (green), knee (blue), ankle (red) and metatarsophalangeal joint (black) during stance of initial acceleration (A: contact 1; B: contact 2), 10 m (C) and 30 m (D).

Discussion

In the push phase of elite bobsleigh, a reversed interaction between the hip and ankle was observed. The hip extensors mainly contributed to performance in the first half of stance. From 50% to 90% of stance especially the work of the plantar flexors propelled the body forward. As in sprinting, ankle plantar flexors worked more with increasing running distance.[3] Unexpectedly, the knee extensors only made a small contribution to propulsion. Compared to elite sprinting, hip and knee extensors worked completely different during the bobsleigh push phase.[3] In conclusion, push phase training might be focused more on the hip extensors and ankle plantar flexors than on the knee extensors.

References

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