FORCES DURING GIANT SWING TECHNIQUES ON THE HORIZONTAL BAR

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INTRODUCTION

Giant swings as a basic element in men's artistic gymanstics on the high bar are used either as linking elements or to generate the rotation that the gymnast needs to perform the release-regrasp and dismount skills [1,2].
The aim of this study was to measure the force $F(t)$ acting on the horizontal bar and on the athlete during giant swings.

METHODS

Series of linked giant swings (GS) and giant swings before dismounting (GSD) were performed by an elite athlete (Austrian champion 2008). Weight: 65.4 kg; stature: 1.70 m. Anthropometric dimensions according to [3] were measured for determination of segmental properties [4].

A Vicon V612 motion capturing system (with eight M2 near-infrared cameras) operated at 100 Hz was used to measure 3D coordinates of markers placed on both the athlete and the horizontal bar. The calibrated construction volume covered 3 m in x-direction (axis through bar), 5.5 m in z-direction (height), and 6 m in length (y-direction).

The bar itself (FIG conform apparatus [5]) was used as the dynamometer: the force-dependent bar displacement was calibrated by means of weights in y- and z-directions. For the calibration process 45 markers were attached to the bar and another 8 markers registered the movement and bending of the support stands.

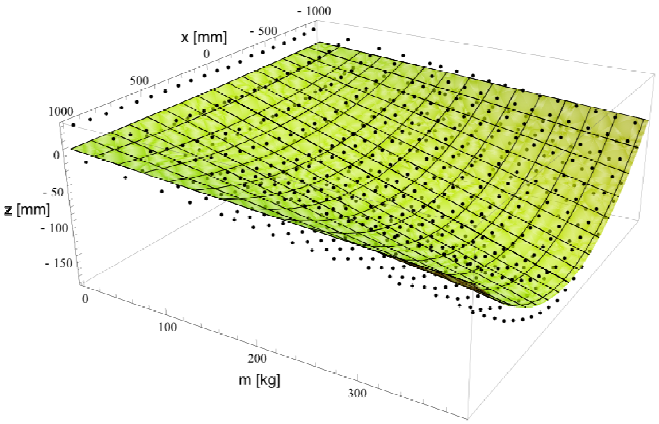

Figure 1: Force-dependent displacement of the high bar for calibration in z-direction. 23 markers were evenly distributed on top of the bar, 22 on the bar's lower side. The displacement, e.g., at a load of 345.9 kg was 116.0 mm.

RESULTS AND DISCUSSION

The polar diagram of the forces acting on the bar is shown in Figure 2. Evidently, the force characteristics of the two giant swing techniques differ substantially; the dashed trace (standard GS) exhibits a force maximum of 3281.5 N at an angle φ = 152.7°, the solid trace (GSD) shows two maxima with 3781.1 N at φ = 110.7° and 4256.6 N at φ = 200.1°, respectively. The peak forces are found to occur shortly after the maximum total moment of inertia [4]. The entire GS lasted 1.7 s while the full GSD was completed after 1.4 s.

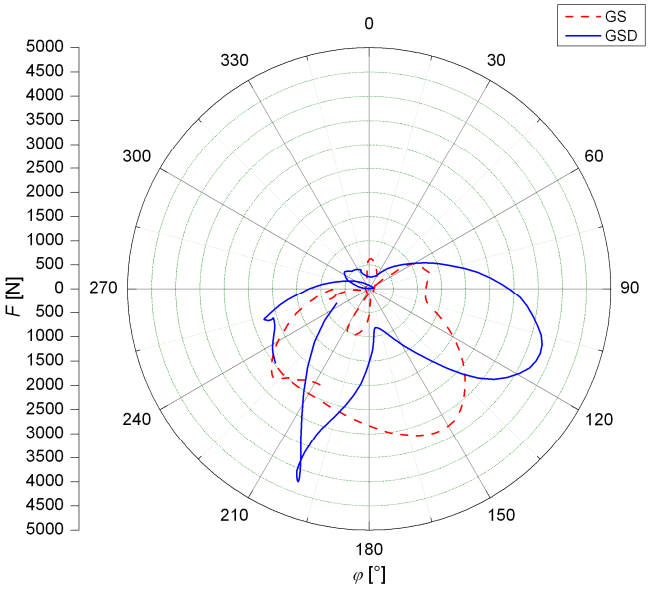

Figure 2: Forces acting on the bar during backward GS (dashed line) and GSD (solid line); movement in clockwise direction, φ = 0° is the handstand position.

Even a basic element like a GS results in very high loads on the athlete (5.1 g). The accelerating movement of the GSD is associated with peaks of 5.9 g and 6.6 g separated by 380 ms with an intermittent force minimum corresponding to 1.3 g.

CONCLUSIONS

The bar itself can be used as a precise and accurate device for force measurements during high bar performances. This force measurement technique can also be applied analogously to other apparatus like the parallel or uneven bars.
The herein introduced technique results in force data and timing patterns which are fingerprints of the performed movements. This can be applied to study techniques in gymnastics and to compare individual styles and presentations.

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