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Editors:
Keijo Häkkinen
Kari L. Keskinen
Paavo V. Komi
Antti Mero

Congress host:
Department of Biology of Physical Activity
University of Jyväskylä
Finland

ANGULAR MOMENTUM IN THE FREE HIP CIRCLE TO HANDSTAND ON THE UNEVEN BARS.

Mark D. Ricard[1] and George A. Stylianides[2]

[1]Brigham Young University, Provo, UT, USA, [2]University of Toledo, Toledo, OH, USA

INTRODUCTION

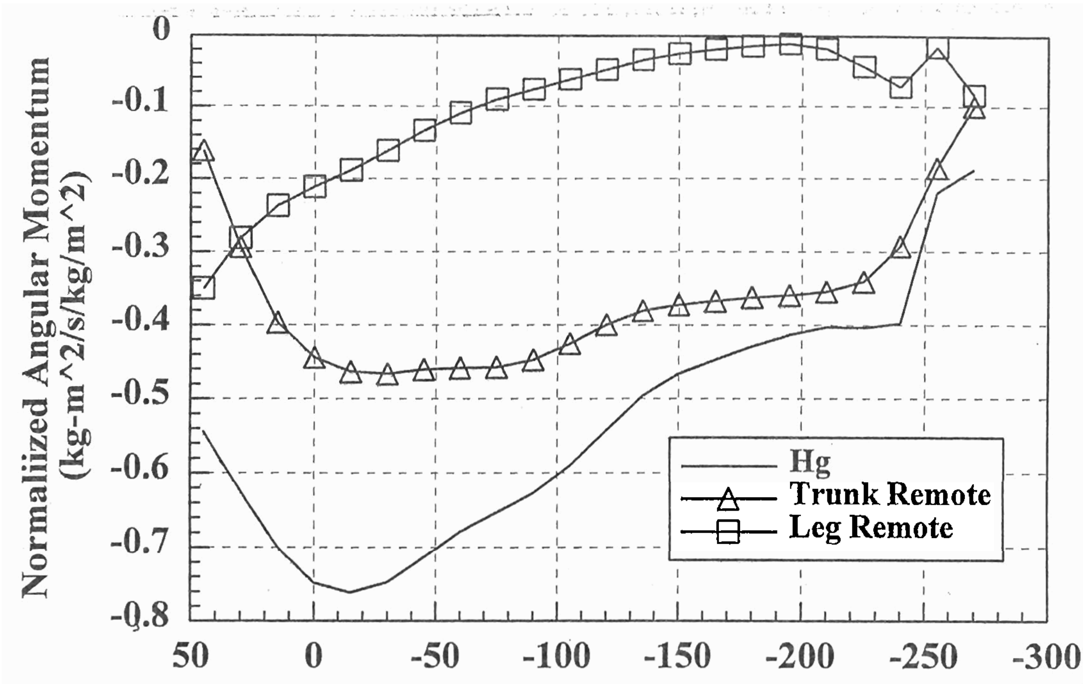
The level of performance in women's gymnastics has improved markedly in recent years. Advances in training, and recent increases in bar widths in uneven parallel bars has resulted in gymnasts performing routines with increasingly more difficult swing and release-regrasp skills. The free hip circle to handstand serves as a lead-in skill to both release and swing movements on the uneven bars. In order to execute the free hip circle to handstand with correct technique and form the gymnast must generate sufficient angular momentum about the bar on the downswing to compensate for losses in momentum due to friction and air resistance. Evans (1988) found that better performances of the free hip circle were highly correlated with work and power performed as the gymnast ascended to the handstand. The purpose of this study was to describe the angular momentum patterns in the free hip circle to handstand on the women's uneven bars.

METHODS

Seven collegiate female gymnasts were filmed with a Locam camera at 60 fps, while they each performed ten free hip circles to handstand on the uneven parallel bars. The gymnasts began in a handstand position and executed a free hip circle to handstand. All ten trials per subject were analyzed with the exception of subject 7 who was only able to complete 7 trials. Eleven body landmarks were digitized using a Numonics digitizer. The coordinates were digitally filtered using a fourth-order Butterworth lowpass filter with a 6 Hz cutoff. Joint linear and angular kinematics were computed using finite differentiation. Body segment parameters were calculated using regression equations (Zatsiorsky and Seluyanov, 1985). Angular momentum about a transverse axis passing through the bar was calculated for each trial (Hay, Wilson, Dapena & Woodworth, 1977). Angular momentum was normalized by dividing by subjects mass in kg and squared standing height in m. Time normalization was achieved by using a cubic spline function to fit angular momentum to the angle of the gymnast's COG to the bar. After time and magnitude normalization, all 76 trials were averaged to generate an ensemble average of angular momentum as a function of the gymnast's position about the bar.

RESULTS AND DISCUSSION

The free hip circle was performed from handstand to handstand. Due to variability in obtaining the initial handstand, time normalization of the data with the spline function began at a COG to bar angle of 45 d above the right horizontal. After obtaining the initial handstand, the gymnast's flex the hip and extend the shoulder on the downswing of the movement. Peak hip flexion velocity of -244.6 d/s occurred at a COG to bar angle of 30 degrees above the horizontal. Peak shoulder extension velocity of -108.3 d/s occurred at a COG to bar angle of 45 d. On the upward swing, the gymnast's flex the shoulder and extend the hip joint to obtain the handstand position. Peak shoulder flexion velocity of 92.2 d/s occurred at a COG to bar angle of -210 d and peak hip extension velocity of 288.7 d/s occurred at an angle of -195 d. Polar coordinates were used to describe the rate of change in COG to bar distance (dr) and rate of change in position (dθ). On the downswing, peak dr was -1.43 m/s at a COG to bar angle of 45



COG to Bar Angle (d)

Figure 1. Mean angular momentum about a transverse axis passing through the bar as a function of the COG to bar angle to the right horizontal.

d and peak dθ was -456.7 d/s at an angle of -15 d. On the upward swing, peak dr was 1.77 m/s at a COG to bar angle of -225 d and peak dθ was -527.2 d at an angle of -180 d.

Mean angular momentum in the free hip circle to handstand about a transverse axis passing through the bar as a function of the COG to bar angle is shown in Figure 1. Peak angular momentum of -.761±.101 kg•m^2/s/kg/ m^2 occurred at a COG to bar angle of 30 degrees below the right horizontal. The total body angular momentum in the free hip circle to handstand can be attributed primarily to the remote components of angular momentum for the trunk and leg segments. Since the gymnasts begin the skill in the handstand position, the angular momentum developed at the outset is due to the momentum of the legs. After the COG to bar angle becomes less than 15 degrees above the right horizontal, the trunk remote component is the primary contributor of angular momentum.

Angular momentum about the bar was found to peak at an angle of 30 degrees below the right horizontal. In better performances, characterized by greater angular speed and amplitude, subjects: developed more angular momentum on the down swing, had less hip flexion on both the down and upward swing, and began shoulder flexion earlier on the upward swing.

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