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CHARACTERISTICS OF JOINT TORQUES IN PERFORMING THE BASKET TO HANDSTAND ON PARALLEL BARS

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The purpose of this study was to investigate characteristics of joint torques in performing the basket to handstand on parallel bars. Twenty-six male elite gymnasts were videotaped in the national championships. Two-dimensional motion analysis technique and inverse dynamics approach were used for calculating the kinematic and kinetic parameters. The shoulder and hip joint torques did not relate to the upward velocity, but significantly related to the downward and forward velocities in performing the basket to handstand. Development of the shoulder flexion torque should be as small as possible for the execution to use the greater swing velocity.

KEY WORDS: gymnastics, parallel bars, basket.

INTRODUCTION: The basket to handstand type elements are important skills in men’s artistic gymnastics. Takei and Dunn (1996) reported that vertical velocity at bar release was important for performing the basket to handstand mount. Two ways of becoming great vertical velocity at bar release are suggested, (1) to utilize downward and forward swing velocities depend on exchange from potential energy at handstand to kinetic energy, (2) to develop mechanical work done by the joint torque during the forward and upward swing (Yamada et al., 2009, Yamada et al., 2010). Most of researches focused on the developing mechanical work (ex. Hiley et al., 2009), while few work was to investigate about the motion from handstand to under the bar. The purpose of this study was to investigate characteristics of joint torques in performing the basket to handstand on parallel bars

METHODS: The basket to handstand type elements performed by twenty-six male elite gymnasts were videotaped (60 Hz) in the sixty-fourth National Championships in Yamaguchi, Japan in 2010. Twenty-two body landmarks (right and left hands, wrists, elbows, shoulders, toes, heels, ankles, knees, and hips, and vertex, tragion, suprasternale, and lower end of thorax) were digitized. The coordinates of the body landmarks were filtered with a forth order Butterworth digital filter with cut-off frequencies ranging from 3.0 to 4.2 Hz which were determined automatically by the technique of Winter (1990). The center of mass was estimated using the body segment inertia parameters of a Japanese athlete model after Ae (1996). The joint torques of the shoulder and hip were calculated using an inverse dynamics approach. The joint torques were normalized by the body mass of the subject.

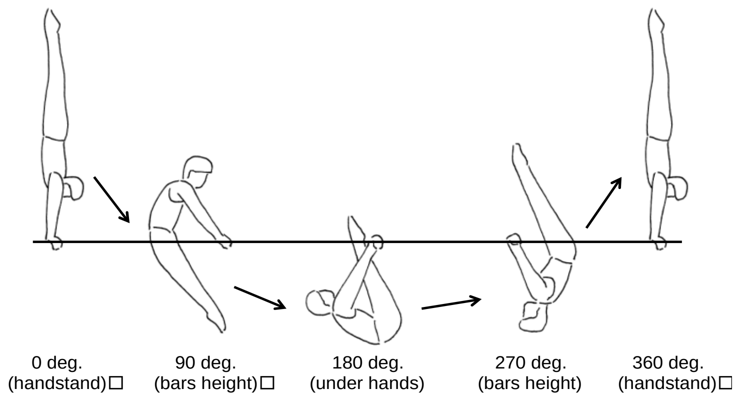

Figure 1: The basket from handstand to handstand.

Five specific events (0 deg., 90 deg., 180 deg., 270 deg., and 360 deg.) were decided based on a rotation angle of the center of mass around the hand for this investigate (Figure 1).

Correlation coefficient was performed for a test of relationships between the velocity of the center of mass and the joint torque. The level of significance was set less than 0.05.

RESULTS: Table 1 showed horizontal and vertical velocities of the center of mass at the 90, 180, and 270 deg. positions. All the gymnasts had the great downward and slightly backward velocities at 90 deg., great forward and slightly upward velocities at 180 deg., and great upward and slightly backward velocities at 270 deg.. Figure 2 showed shoulder and hip joint torques developed by typical gymnast in performing the basket to handstand. The shoulder

Table 1: Horizontal and vertical velocities of CoM at 90, 180 270 deg

joint torque had flexion and extension peaks, whereas the hip joint torque had two flexion and two extension peaks. Figure 3 showed relationships between the peak flexion torque of the

□	□	90 deg.	180 deg.	270 deg.
Horizontal Velocity	(m/s)	-0.56	3.21	-0.28
S.D.		0.19	0.37	0.30
Vertical Velocity		-2.28	0.59	3.43

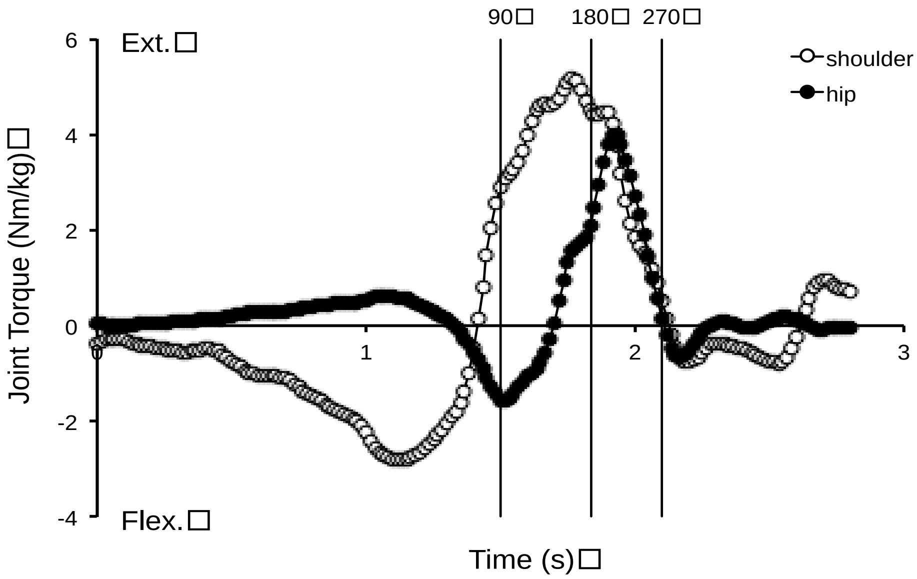

Figure 2: Shoulder and hip joint torques in performing the basket to handstand (typical data).

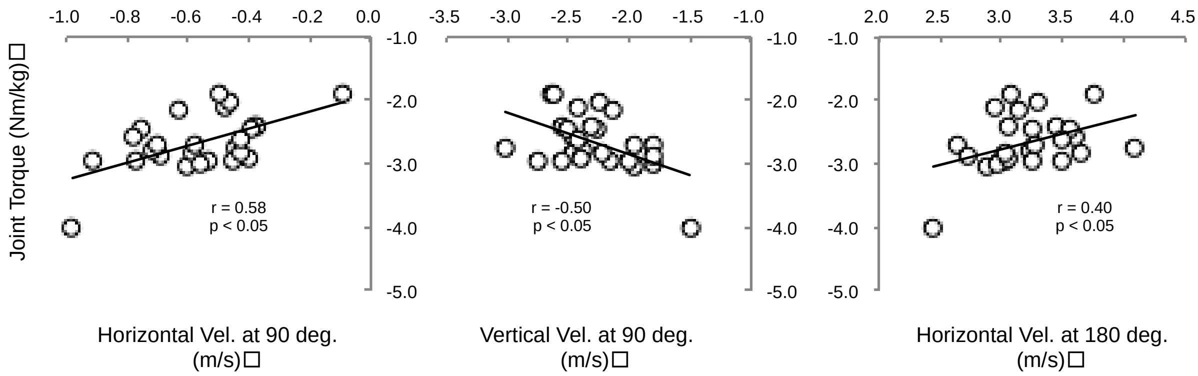

Figure 3: Relationships between the peak flexion torque of the shoulder and the horizontal and vertical velocities at 90 deg. and horizontal velocity at 180 deg..

shoulder and the horizontal and vertical velocities at 90 deg. and horizontal velocity at 180 deg.. The peak flexion torque of the shoulder significantly related to the horizontal and vertical velocities at 90 deg. and horizontal velocity at 180 deg., but did not relate to the vertical velocity at 180 deg. and horizontal and vertical velocities at 270 deg.. Figure 4 showed relationships between the peak extension torque of the hip and the vertical velocity at 90 deg. and horizontal velocity at 180..The peak extension torque of the hip significantly related to the vertical velocity at 90 deg. and horizontal velocity at 180 deg., but did not relate to the horizontal velocity at 90 deg., vertical velocity at 180 deg., and horizontal and vertical velocities at 270 deg.. The peak extension torque of the shoulder and flexion torque of the hip had no significantly relation to each velocity.

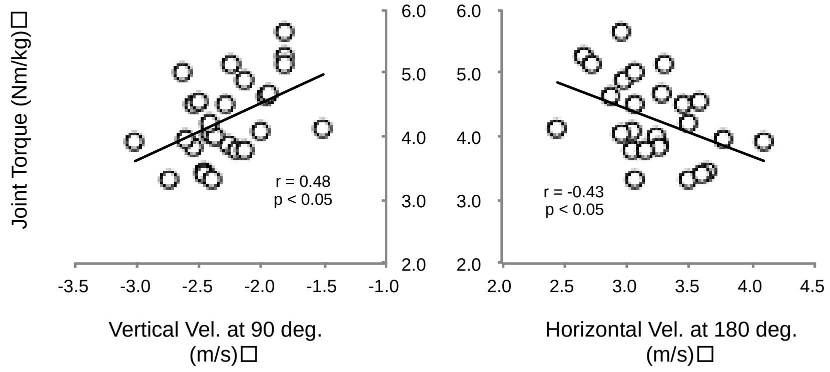

Figure 4: Relationships between the peak extension torque of the hip and the vertical velocities at 90 deg. and horizontal velocity at 180 deg

DISCUSSION: All the peak torques were not relation to the upward velocity at 270 deg., because all the gymnasts needed similar upward velocity at 270 deg. for execution the basket to handstand. A gymnast with great downward velocity at 90 deg. and forward velocity at 180. developed small hip extension torque during the forward swing. This result might indicate that the gymnast with greater velocity did not need to increase the velocity for execute the basket, although it was difficult to exert large torque for faster movement. The execution of the basket with half or full turn had difficulty of exertion of large joint torque, therefore it was thought that the gymnast with great velocity was suitable for execution of a more difficult elements of the basket type.

The peak flexion torque of the shoulder significantly related to the downward and forward velocities. The development of the shoulder flexion torque during a downward movement might act on a brake to decrease the downward velocity. Gymnasts who want great downward and forward velocities should be going to prevent developing the shoulder flexion torque for the downward movement.

CONCLUSION: The shoulder and hip joint torques did not relate to the upward velocity at 270., but significantly related to the downward and forward velocities. For the execution to use the greater swing velocity, development of the shoulder flexion torque should be as small as possible. The other hand, the execution with the small forward velocity was needed to develop the large hip extension torque for successful performing the basket to handstand. The development of the large hip extension torque might interfere with performing twisting elements.

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