EFFECT OF THE VELOCITY OF THE CENTER OF MASS IN PERFORMING THE BASKET WITH HALF TURN TO HANDSTAND ON PARALLEL BARS

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KEYWORDS: gymnastics, parallel bars, basket, turn.

INTRODUCTION: The basket with half turn to handstand on parallel bars (Fig. 1) is an important skill in men's artistic gymnastics. Techniques of the turn in performing this skill are classified into two types: early turn and late turn. With the early turn, the gymnast can improve the difficulty value by increasing the angle of the turn. Peak forward velocity of the center of mass in the early turn has been shown to be greater than in the late turn during forward swing, but peak upward velocity differs little between the two types of turn (Yamada et al., 2009). Those results spawned two hypotheses concerning the limit to which kinetic energy can be increased during the early turn. (1) Intrinsic characteristics of the technique restrict how much kinetic energy can be incorporated into the early turn. (2) The gymnast's muscular ability to generate shoulder flexion torque and hip extension torque limits how much kinetic energy can be produced in the early turn. To explore these hypotheses, it might be useful to compare the basket with half turn to one without a half turn in arriving at handstand. The purpose of this study was to compare the effect of velocity of the center of mass on turn technique in a basket with half turn to handstand versus a basket without turn to handstand.

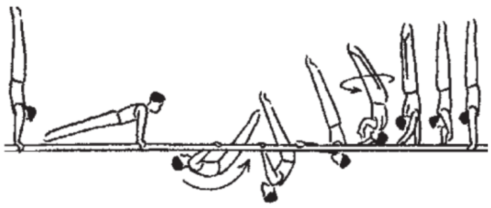

Figure 1. The basket with half turn to handstand (from FIG, 2009).

METHOD: Four senior male gymnasts competing nationally were asked to perform the basket to handstand and the basket with half turn to handstand. The gymnasts repeated these maneuvers until they, along with a coach with a license to judge, agreed that performance was satisfactory. All of these performances were videotaped using two digital video cameras (60 Hz)(Sony, DCR-VX1000 and DCR-TRV900), one from a lateral view and the other from a diagonal view in front. Twenty-two body landmarks (right and left third MPs, wrists, elbows, shoulders, great toes, heels, ankles, knees, and hips, and in the midline the vertex, midpoint between tragions, suprasternale, and lower end of the thorax) were digitized (DKH, Frame-DIAS IV). Three dimensional coordinates were synchronized and reconstructed using the method of Yeadon and King (1999). The coordinates were smoothed with a fourth order Butterworth digital filter with cut-off frequencies ranging from 3.4 to 5.4 Hz, and the center of mass of each segment and of the whole body were estimated using the body segment inertia parameters of a Japanese athlete model (Ae, 1996).

RESULTS: Two subjects were classified as using the early turn and the remaining two subjects the late turn, according to observations by the coach. Table 1 shows peak horizontal (forward) and vertical (upward) velocities of the center of mass in the basket to handstand and the basket with half turn to handstand. Peak horizontal velocity of the center of mass appears at around the lowest point of the swing and then vertical velocity reaches peak value. Peak horizontal velocity of the center of mass was similar between using and not using the turn, whether early or late. Whereas in the subjects using the early turn peak vertical velocity in the basket was greater in the performance without the turn than with the

Table 1. Peak horizontal (forward) and vertical (upward) velocities of the center of mass in performing basket without and with half turn to handstand.

Subject	Type of Turn	Peak Horizontal Velocity		Peak Vertical Velocity	
		Without Turn (m/s)	With Turn (m/s)	Without Turn (m/s)	With Turn (m/s)
1	Early	3.37	3.52	3.73	3.61
2	Early	3.33	3.38	3.94	3.72
3	Late	3.17	3.10	3.56	3.65
4	Late	3.19	3.29	3.83	3.92

turn, in the subjects using the late turn peak vertical velocity in the basket was a little greater with the turn than without the turn.

DISCUSSION: Horizontal and vertical velocities in the late turn were not systematically influenced by presence or absence of the turn itself. The late turn consisted of a basket to handstand on one rail and a half turn backward in a handstand. The belatedness of the turn appears to have made its effect on what happened during the upward phase of the swing relatively small. In the early turn, on the other hand, vertical velocity was smaller in the basket with half turn to handstand than without that turn, possibly because shoulder flexion and hip extension during the upward phase of the swing might have been impeded by the turning movement, given its start from within the basket swing itself. Vertical velocity at bar release is important for performing the basket to handstand mount (Takei and Dunn, 1996). Vertical velocity at bar release is considered to be important, whether or not a turn intervenes in arrival to the handstand. In the early turn, peak vertical velocity could not be increased with the turning movement, so the gymnast appears to have had to compensate for the limitation in vertical velocity by augmenting horizontal velocity. The results here suggest that large horizontal velocity through the downward swing from the handstand position was important to achieve in the technique of the early turn.

CONCLUSION: The turn techniques were classified into early and late types. In the subjects using the early turn peak vertical velocity in the basket was greater in the performance without the turn than with the turn, so the hypothesis that intrinsic characteristics of the technique limit kinetic energy appears more plausible than the hypothesis about the gymnast’s muscular ability. Horizontal velocity was shown to be important for executing the early turn technique because shoulder flexion and hip extension were rendered difficult by the turning movement. If a gymnast uses a large horizontal velocity in the basket to handstand, the early turn would be the recommended technique, whereas if horizontal velocity is not so great, either the late turn should be adopted or the gymnast should improve movement during the downward swing to augment horizontal velocity.

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FIG (2009). Code of points. Lausanne, Switzerland: FIG.

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