BASIC BIOMECHANICAL RELATIONSHIPS AT PUSH-OFF FOR HANDSPRING FORWARD VAULTS

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INTRODUCTION: The performance prognosis and the creation of new elements in artistic gymnastics require the knowledge of basic biomechanical relationships. We investigated such relationships at elements with flight phase executing from preceding elements on horizontal bar and uneven bars (Knoll, 2001), but also on floor, beam and rings (Knoll, 1993). The reduction of the angular momentum was typical in the upswing and the take-off to the flight element. The posture in the flight element, stretched or tucked, determined the amount of the reduction. We can classify the movement phases of the vaults analogously: the vault preparing elements are running approach, take-off and first flight phase. The push-off on vaulting horse corresponds to the take-off on floor respectively the upswing on hang apparatuses. At last the second flight phase corresponds to the flight element. The aim of this study was to find out if there are identical functional relationships at push-off on vaulting, for example the reduction of the angular momentum which we found in previous studies for other apparatuses. We also investigated the variation of joint angles and reaction forces in the push-off. Finally, in further investigations we will attempt to answer the question if the new vaulting table requires modifications of the sports technique.

METHODS: Video recordings (50 frames/s) were used in order to collect kinematic data during the 1999 and 2001 World Gymnastics Championships in Tianjin and Gent. In addition, the apparatus reaction force was measured synchronously with a horse vault dynamometer (500 Hz) during the 1998 DTB Cup in Stuttgart. The dynamometer was installed to an original apparatus with support by the Spieth company. The video recordings were analyzed with a 2D photogrammetric procedure. Angular momentum (L) about the transversal axis, flight height and apparatus reaction force were studied. The angular momentum was calculated with the procedure by Hay *et al.* (1977) and related to unified body height and body mass values. The investigations were limited to the handspring vaults and Kasamatsu and Tsukahara vaults of male gymnasts.

RESULTS AND DISCUSSION: Preliminary results indicate that: (1) The angular momentum of the first flight phase (L_1) is greater than the angular momentum of the second flight phase (L_2). Thus the biomechanical mechanism is also valid for vaults. The reduction of the angular momentum of preparing elements found in upswing, take-off and push-off to dismounts and flight elements are also found in vaulting. (2) L_1 in all good vaults is approximately of the same size. (3) L_2 is reduced progressively from handspring forward and salto stretched to handspring forward and double salto tucked to forward handspring, whereas the post-flight height increases in the same vault type order. (4) The push-off technique is of paramount importance for the reduction of the angular momentum L_1. A faster execution of preceding elements (see Prassas, 2001) is of secondary importance. Other parameters that will be investigated are the support angle (angle support point, center of mass, horizontal plane) when touching the horse surface, the shoulder angle and the arm angle.

REFERENCES:

Hay, J., Wilson, B., Dapena, J. & Woodworth, G. (1977). A computation of technique to determine the angular momentum of a human body. *Journal Biomechanics*, **10**, 269-277.
Knoll, K. (1993). Biomechanical mechanism of flight elements executed from preliminary movements and conclusions for sports technique of round-off and flic flac on floor. *Proceedings of the 1. Int. Conf. Biomechanics in Gymnastics, 8.-10.9.1992,* 115-126. *Cologne.*
Knoll, K. (2001). The kinematic dynamic structure of effective giant swings backward prior to difficult dismounts and flight elements on horizontal bar and uneven bars. *Proceedings of the 19th Int. Symp. on Biomechanics in Sports, June 20-26,2001,* 19-22. San Francisco.
Prassas, S. (2001). On Dismounts, Twists, Somersaults, etc, or Why it is Difficult to Do that Double Back Layout Somersault. ISBS Homepage: http://www.sportscoach-sci.com/ CIS.