KINEMATIC ANALYSIS OF UNEVEN BAR DISMOUNTS IN THE 1994 WORLD GYMNASTICS CHAMPIONSHIP

Spiros Prassas

Department of Exercise and Sport Science, Colorado State University, Fort Collins, USA

INTRODUCTION

The uneven bars (UB) is one of the most spectacular events in women's gymnastics competition. Gymnasts, in order to win, are expected to perform flawless and difficult routines culminating in a dismount. The dismount, being the skill last seen by the judges, greatly influences the scores awarded. Minor mistakes made earlier in the routine can be compensated for by a difficult and perfectly executed dismount. On the other hand, a perfect routine can be jeopardized by a faulty dismount. There is a number of research studies in dismounts in gymnastics, but they have been largely concentrated on the horizontal bar (HB) (Bruggemann, Cheetham, Alp & Arampatzis, 1994; Park & Prassas, 1994; Kerwin, Yeadon & Harwood, 1993; Takei, Nohara & Kamimura,1992). Although similarities between HB and UB dismounts may exist, differences should also be expected due to (among other things) differences in the physical characteristics, design and construction of the apparatuses. The purpose of this study was to kinematically analyze dismounts from the UB and, when appropriate, to compare the results with existing data from HB dismounts.

METHODS

Eight dismounts (six double layout (DL) and two double piked (DP) somersaults), recorded during the 1994 World Gymnastics Championships with 2 Panasonic video cameras operating at 50 Hz, were analyzed utilizing the Ariel Performance Analysis System (APAS). Three-dimensional coordinates of 8 (ankles, hips, shoulders and wrists) to 10 (the above, plus knees and/or elbows) body points were calculated by combining the video images of the two cameras utilizing the direct linear transformation (DLT) method (Abdel-Aziz & Karara, 1971). The raw data was digitally smoothed with a cut-off frequency of 5 Hz before being submitted to further analysis. Dempster's (1955) data as presented by Plagenhoef (1971) was utilized to predict the segmental and total body anthropometric parameters necessary to solve the mechanical equations.

RESULTS

Linear kinematic and temporal results are presented in Table 1. Radius of gyration (RG) for the UB dismounts was shorter than RG reported by Gervais and Talley (1993) for various release-regrasp horizontal bar skills. RG comparisons, however, would be more meaningfull if data were normalized, which was not done in either the present (gymnasts' anthropometric parameters were not available), or in Gervais and Talley's studies. CM horizontal release velocity for UB dismounts was similar to the corresponding velocities for various types of HB dismounts reported

Table 1
Linear Kinematic and Temporal Results (M, SD)

Variable	Double Layout (n = 6)		Double Piked (n = 2)		Combined (n = 8)	
RG (m)	0.730	0.079	0.725	0.016	0.729	0.067
CMVX (m/s)	1.386	0.726	1.153	0.066	1.328	0.624
CMVY (m/s)	3.005	0.491	3.234	0.139	3.063	0.431
CMMXH (m)	0.224	0.076	0.456	0.004	0.282	0.125
TAIR (sec)	0.975	0.057	0.990	0.028	0.979	0.050
TMXH (%)	31.80	4.031	33.35	2.333	32.188	3.592

RG: radius of gyration; CM: center of mass; V: velocity; X, Y: horizontal, vertical
TAIR: time in air; TMXH: time to maximum height (% of TAIR)

previously by Bruggemann et al. (1994), Park and Prassas (1994), Kerwin et al. (1993) and Takei et al. (1992). CM vertical release velocity for UB dismounts (3.063 m/s) was substantially smaller than vertical velocities reported by Bruggemann et al. (1994), Park and Prassas (1994) and Takei et al. (1992) for various types of HB dismounts (4.04 to 5.98 m/s). The smaller (UB) vertical release velocity resulted in smaller CM maximum height above the bar (CMMH) and smaller flight time (TAIR) for

Table 2
Angular Kinematic Results (M, SD)

Variable	Double Layout (n = 6)		Double Piked (n = 2)		Combined (n = 8)	
SLJA (deg)	144.83	4.792	144.00	5.657	144.38	4.658
HJA (deg)	154.67	26.174	131.00	4.243	148.75	24.737
CMA (deg)[1]	-14.27	8.624	-6.920	3.479	-12.43	8.196
CMAV (deg/sec)	263.96	60.493	270.55	16.44	265.60	51.591
TRRMXH (%)	31.750	2.462	20.650	1.485	28.975	5.572
TRAV (deg/sec)	459.67	87.24	282.50	27.577	415.375	110.78

SLJ: shoulder joint; HJ: hip joint; A: angle; AV: angular velocity
TRRMXH: trunk rotation to maximum height ((TRRMXH/630)X100)
[1]: negative angle denotes release below bar level

the UB dismounts as compared to reported CMMH and TAIR for HB dismounts. Possible differences in the beat action through the bottom of the swing, differences in the physical characteristics, design and construction of the apparatuses and anthropometric differences between male and female gymnasts may explain some of the velocity and related parameter differences between the two apparatuses.

Table 2 presents angular kinematic results. The data revealed that all gymnasts released the bar when their CM was below bar level, which is in agreement with results obtained by Kerwin et al. (1993). The results showed that gymnasts release the bar earlier in DL (-14.27 deg) than in DP (-6.92 deg), which is similar to results by Park and Prassas (1994) for HB double layout (-14.58 deg) and triple somersault (-6.44 deg) dismounts. Comparison between release trunk (459.67 deg/sec) and CM (263.96 deg/sec) angular velocities for DL reveals that gymnasts do not rotate rigidly about the bar at release, but that multiple axes of rotation (shoulder and possibly hip joints) exist.

CONCLUSION

The results of the study reveal that although the general movement pattern of uneven bar dismounts may be similar to the one employed in horizontal bar dismounts, differences in physical characteristics, design and construction of the apparatuses, anthropometric differences and possible differences in the beat action through the bottom of the swing result in smaller vertical release velocity and related maximum height above the bar and time in the air. It would be, therefore, advantageous to give instructions "tailored" to each apparatus to athletes.

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