TECHNIQUE ANALYSIS OF THE 1992 COMPULSORY DISMOUNT FROM THE PARALLEL BARS

SPIROS G. PRASSAS
Department of Exercise and Sport Science, Colorado State University,
Fort Collins, CO 80523, USA

Introduction

The 1992 compulsory dismount from the parallel bars (BSD) can be described as a backward somersault from a handstand position with the body in a layout-piked-layout position. Although the current compulsory dismount involves a forward somersault, mastering of the 1992 dismount is still a must for most gymnasts since the great majority of them perform backward somersault(s) dismounts as part of their optional routines. It would be beneficial for gymnasts and coaches to recognize the variables for which judges are looking, as well as technique differences between skillfully and poorly executed BSDs. The purpose of this study was, therefore, to: 1) identify the skill variables best correlating with the scores given to the BSDs by qualifying judges, and 2) to identify the differences in technique between the most and least skillful BSDs.

Methods

Eighteen BSDs, recorded during the 1990 United States Gymnastics Federation Championships with a NAC 400 HSV camera operating at 200 Hz, were analyzed utilizing the Ariel Performance Analysis System (APAS). Two dimensional position data of 6 body points were digitally smoothed with a cut-off frequency of 6 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. The analyzed BSDs were rated by two internationally qualified judges on a scale from 1 (worst) to 10 (best). To determine the best predictors of a good score, product moment correlations between lunematic variables and the judges' averaged scores were computed. To examine the differences between kinematic variables of the best (n=8; average score: 8.438) and worst (n=10; average score: 5.15) BSDs, paired t-tests were used.

Results and Discussion

Table 1 presents the means and standard deviations of the computed kinematic variable and the correlations and (Bonferoni) probabilities between these variables and the judges' averaged scores. According to the data and in order of importance, the best predictors of a good BSD are: 1) the maximum height of the center of mass (CM) above bars, 2) the total time in the air, 3) the vertical velocity of the

Table 1 (N=18)
Correlations Between Mechanical Variables and Judges' Scores

Variable	Mean	SD	r	P
CMXRL (meters)	-0.064	0.176	0.435	1.000
CMYRL (meters)	35.336	4.213	0.598	1.000
CMTHRL (deg)	92.072	8.925	-0.652	0.639
CMYVRL (met/sec)	2.125	0.579	0.890	0.000
CMAVRL (radsec)	3.522	0.88	0.703	0.215
SJRL (deg)	59.167	19.319	0.766	0.040
HJRL (deg)	143.5	50.956	0.834	0.003
KJRL (deg)	176.667	4.229	0.024	1.000
LRL (normalized)	0.133	0.023	-0.414	1.000
CMAB (% of height)	49.363	10.095	0.965	0.000
SHJAB (deg)	71.222	17.427	-0.629	0.984
SKJAB (deg)	172.556	7.816	0.451	1.000
CMYLD (% of height)	49.168	2.776	0.470	1.000
CMTHLD (deg)	80.264	3.559	0.373	1.000
CMAVLD (radsec)	5.093	0.099	0.351	1.000
TTAIR (sec)	0.792	0.083	0.903	0.000
TMXH (sec)	0.193	0.055	0.767	0.039
HJROMAIR (deg)	75.056	67.587	0.795	0.016

CMXFU: CM horizontal distance from hands at push off.
CMYFU: CM vertical distance from hands at push off.
CMTHRL: Angle of hands to CM line (from bars) at push off.
CMYVRL: CM vertical velocity at push off.
CMAVRL: Angular velocity of hands to CM line at push off (from v = or).
SJRL: Shoulder joint angle (hyperextention) at push off.
HJRL: Hip joint angle at push off.
KJRL: (Posterior) knee joint angle at release.
LFU: (Normalized) angular momentum at push off (Hinrichs et al., 1983).
CMAB: Height of CM above bars.
SHJAIR: Minimum (anterior) hip joint angle in the air.
SKJAIR: Minimum (anterior) knee joint angle in the air.
CMYLD: CM vertical distance from the ground at landing.
CMTHLD: Angle of feet to CM line (from the ground) at landing.
CMAVLD: Angular velocity of feet to CM line at landing (from v = or).
TTAIR: Time from push off to landing.
TMXH: Time from push off to maximum height.
HJROMAIR. Hip joint range of motion during the airborne phase.

CM at release, 4) the hip joint angle at push off, 5) the hip joint range of motion during the airborne phase, 6) the time from release to maximum height, and 7) shoulder joint angle at push off.

Table 2 presents the t-test scores between computed kinematic variables of the groups of the BSDs receiving high (mean score = 8.438) and low (mean = 5.150) scores. According to the data, the height of the CM above bars is the most significant difference between high and low scored BSDs. Additional significant

Table 2
Comparison Between Mechanical Variables (M and SD) of High (N=8) and Low (N=10) Scored Dismounts

Variable	High Scored		Low Scored		t	P
CMXRL (m)	0.003	0.063	-0.119	0.219	1.056	0.327
CMYRL (m)	37.213	5.190	33.834	2.635	1.260	0.248
CMTHRL (deg)	87.525	5.094	95.710	9.859	-1.537	0.168
CMYVRL (m)	2.639	0.303	1.714	0.374	6.057	0.001
CMAVRL (deg/sec)	4.175	0.681	3.000	0.648	3.063	0.018
SJRL (deg)	75.250	13.424	46.300	12.284	4.585	0.003
HJRL (deg)	190.625	17.631	105.80	33.309	6.707	0.000
KJRL (deg)	175.625	4.406	177.50	4.116	-1.150	0.288
LRL (normalized)	0.118	0.024	0.146	0.012	-3.895	0.006
CMAB (% of height)	58.866	5.593	41.761	4.867	7.922	0.000
SHJAB (deg)	57.750	12.021	82.000	13.072	-4.729	0.002
SKJAB (deg)	176.00	3.854	169.80	9.211	1.283	0.240
CMYLD (m)	50.275	2.316	48.283	2.903	1.662	0.140
CMTHLD (deg)	81.829	3.702	79.012	3.057	1.944	0.093
CMAVLD (deg/sec)	5.376	0.695	4.866	1.175	0.722	0.494
TTAIR (sec)	0.866	0.030	0.733	0.059	7.548	0.000
TMXH (sec)	0.235	0.030	0.159	0.048	-3.780	0.007
HJROMAIR (deg)	135.125	25.222	27.000	48.582	4.636	0.002

factors differentiating high and low scored BSDs are: 1) the total time that the gymnasts are airborne; 2) the hip joint angle at push off (the joint should be hyperextended); 3) the vertical velocity of the CM at push off (which should be high and relates, of course, to the CMAB, the TTAIR and the TMXH); 4) the hip joint action in the air (gymnasts should perform a vigorous flexion-extension during the dismount); 5) the shoulder joint angle at push off (gymnasts should hyperextend); and 6) the angular velocity and angular momentum at push off.

Examination of the individual data of the BSDs receiviing the highest (9.5) and lowest (3.5) scores provides additional support for the suggestions made in the previous paragraph referring to the data in Table 2. For example, the gymnast receiving the highest score had the highest vertical velocity at push off (resulting in the largest height above bars and most time in the air), had the second largest hip joint range of motion in the air, and the second most hyperextended hip and shoulder joints at push off. In contrast, the gymnast receiving the lowest score had the smallest vertical velocity at push off (resulting in the least height above bars, the least time to maximum height and second smallest time in the air), was at a dip hip joint flexion and the least hyperextended at the shoulder joint at push off, and did not exhibit any hip joint action when airborne.

As with most correlational results, caution should be exercised when the data in Table 1 are considered. Preliminary regression analysis revealed that, with the exception of the CM height above the bars, none of the significant variables in the Table are good predictors of a judge's score. In fact, this preliminary analysis reveals that the second best predictor of a judge's score is the horizontal distance of the CM from the hands at push off (the regression equation is: Score = -1.629 + 1.44CMXRL + 0.169CMAB, explaining 94.8 per cent of the judges' scores variation).

Conclusion

The results indicate that the best predictors of a good BSD are the height of the CM above bars and the vertical velocity at push off and associated time in the air. Additionally, the shoulder and hip joint angles and actions at push off and/or in the air are also good predictors of a good BSD. In lieu of preliminary regression analysis, these predictors should be viewed with caution. The height of the CM above bars, the total time that the gymnasts are airborne, the hip joint angle at push off, the vertical velocity of the CM at push off, the hip joint action in the air, the shoulder joint angle at push off, the time to maximum height and the angular velocity and angular momentum at push off are the most significant factors differentiating high and low scored BSDs.

References

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