Kinematic Analysis of Kolman acrobatics in the High Bar Exercise

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INTRODUCTION

The high bar exercise is one of the six events in men's artistic gymnastics. Kolman, which is an element with super E difficulty, is categorized into the flight-acrobatic element group in the high bar exercise (Figure 1) [1]. The well execution of the flight-acrobatics witch is difficult to perform is critical for getting a high score in a competition.

In this study, we used Kwon 3D analysis software to analyze the kinematical parameters of the images of Kolman acrobatics performed by an outstanding Taiwanese gymnast. The present results could provide some critical information to gymnasts to safely and perfectly perform Kolman.

METHODS

We used two high speed cameras (Redlake) with 125Hz recording frequency and 1/625 sec shutter speed were used to synchronously record the 3D images of the Kolman acrobatics. Digitalization of the recorded images and analysis of the kinematical parameters of the gymnast's body segments were carried out by Kwon3D 3.1 Performance System [2]. The values of the parameters were analyzed with the Mann-Whitney test to reveal the kinematical characteristics of Kolman and the important factors which determine the successful execution of this acrobatics.

RESULTS AND DISCUSSION

In the period of gymnast swinging down from handstand, no parameter had significantly different values in the successful and failed Kolman. When the center-of-mass (COM) of gymnast's body arrived at the lowest position, the projected position of the COM in the failed Kolman was significantly farer away the projected position of the bar on the X-axis in the coordinate (0.24±0.02 m, P=0.034), comparing to that in the successful Kolman (0.17±0.05m). The value of the horizontal acceleration of the COM in the failed Kolman (-2.68±0.77m/s^2) was significantly smaller than that in the successful Kolman (1.19±1.56m/s^2) (P=0.034). The results indicated that the gymnast may plucked the bar too early and then had an excessive component of force along the horizontal direction of body movement while he failed to perform Kolamn (Table 1).

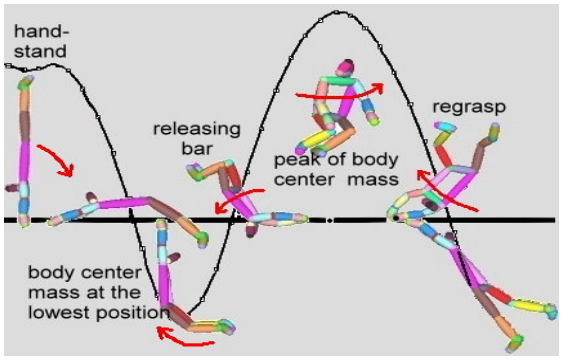

Figure 1: The schematic process of completing Kolman. The change of the position of the gymnast's body center mass was illustrated by the curve.

The gymnast plucked the bar twice at different time points before released from the bar. The first pluck occurred when the gymnast's COM arrived at the lowest position; the second one occurred after the COM passed the lowest position. After the second pluck, the value of the horizontal acceleration of the COM in the failed Kolman (36.03±2.05m/s^2) was significantly higher than that in the successful one (30.42±2.28m/s^2) (P=0.034). That probably caused an excessive force to overfly the bar and then leaded to a drawback in regrasping the bar.

CONCLUSIONS

The timing to pluck the bar and the horizontal component of the bar-plucking force are likely to be the important tipping points to affect the performance of the gymnast who carries out the Kolman. We suggested that gymnasts and coaches should pay attention to the timing and the skills with which to pluck the bar for getting an adequate force to complete the whole acrobatics successfully.

REFERENCES

1. International Gymnastics Federation Men's Technical Committee. *Code of points for men's artistic gymnastics competitions,* 3-22, 113-132, 2001.
2. Kwon, Y. H. *The effects of body segment parameter estimation on the experimental simulation of a complex airborne movement*, Doctoral dissertation, Pennsylvania State University, 1993.

Table 1: Two kinematical parameters of the center-of-mass of gymnast's body when the center-of-mass arrived at the lowest position.

	Parameters	
Kolman	Projected position on the X-axis (m)	Horizontal acceleration (m/s^2)
Successful	0.17±0.05	1.19±1.56
Failed	0.24±0.02	-2.68±0.77
P value	0.034	0.034