KINEMATIC ANALYSIS OF THE GAYLORD I ON UNEVEN BARS PERFORMED BY MO HUILAN (CHINA)

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The female gymnasts have been able to include many of the skills initiated on the men's horizontal bar in their uneven bars routines. The Gaylord I was until now one of the skills that the female gymnast had not performed on the uneven bars. The release-regrasp skills on uneven bars had not required the gymnast to travel over the high bar, as the inherent danger in missing the regrasp and hitting the low bar was sufficient deterrent. The Gaylord I is a tucked forward one and a half salto over the high bar to regrasp in forward swing. Mo Huilan (China) performed this skill on the uneven bars for the first time at the World Gymnastics Championships in Brisbane, 1994. At the instant of release, Mo had a vertical velocity of the centre of mass (CM) of 2.29m/s, and a horizontal velocity of the CM of 0.7m/s. In comparison to studies completed on the men's horizontal bar these release values were quite low. Mo's small stature (1.3m tall) and her semi-tucked position allowed her to release the bar with a small moment of inertia, and complete the saltos very quickly. Her size also diminished the chances of her hitting the low bar if regrasp was unsuccessful. Mo was able to set a new standard in the technical difficulty of a release-regrasp movement on the uneven bars.

INTRODUCTION

For the first time at a major world championships, Mo Huilan of China, performed the Gaylord I on the uneven bars. The Gaylord I involves the athlete performing a one and a half forward tucked salto over the bar to regrasp in a forward swinging hang position. On the horizontal bar, the consequences of failure to regrasp usually means that the athlete lands safely on the mat. However, on the uneven bar, this skill is performed such that the athlete is faced with the prospect of hitting the low bar if the execution is not successful. Subsequently, Mo Huilan is the only athlete to have performed this skill on this apparatus at this time.

The preparatory movements for the Gaylord I consist of two forward giant swings. In a case study of a Slovenian gymnast, (Cuk 1992) breaks the movement down into four distinct phases - preparation, release, flight and regrasp. At the moment of release Cuk reports the need to have appropriate linear velocity of the centre of mass. In Cuk's case study analysis, the gymnast in question records centre of mass linear velocities at release of 4.2m/s in the vertical direction and 1.74m/s in the horizontal direction. Cuk also reports that at release the gymnasts arms, body and legs are in an almost linear position.

During the flight phase, Cuk recommends that the gymnast should get into a completely tucked position without losing speed of rotation. This is important for the athlete to complete the saltos successfully. The path of the centre of mass is parabolic during the movement, and Cuk believes that the maximal height of the centre of mass should be

attained directly over the bar when viewing the movement from side on. The data reported in Cuk's study shows that the gymnast achieves a maximal height of the centre of mass of 3.96m some 0.13m to the right of the bar. Flight time, which was calculated from instant of release to instant of regrasp, was reported as 0.8s.

In a paper on the men's high bar at the 1992 Olympics, Brueggemann, Cheetham, Alp and Arampatzis (1994) analysed the performance of seven Gaylord I's. Brueggemann et al. were most interested in the release characteristics of the athletes and thus their analysis was limited to this phase of the skill. The mean release values reported show that the CM horizontal velocity was -1.36m/s and vertical velocity was 4.22m/s. These values are quite similar to those reported by Cuk (1992), especially in terms of the vertical velocity at release. The different signs attributed to the horizontal velocity are indicative of the different methods employed to allocate positive and negative directions of movement. Brueggemann et al. also report a value of the centre of mass angle to the horizontal at release of 392".

There is a general lack of information available on this skill as evidenced by the two papers reported here. In terms of release properties, it is assumed that there will be a substantial difference in the linear velocities between these athletes and Mo Huilan. In terms of true comparison, the release angle of the centre of mass to the horizontal is probably the most relevant.

METHODS AND EQUIPMENT

Subject

In this case study analysis, the athlete involved was Mo Huilan from China. Mo performed this skill during the qualifying round for individual apparatus competition. She successfully completed the Gaylord I but unfortunately fell on a later release movement in her routine. Mo was 1.3m tall and weighed 29kg at the time of competition.

Equipment and data capture

The qualifying rounds of the uneven bars at the 1994 World Gymnastics Championships were filmed using two Panasonic PAL F-15 cameras positioned in the catwalks above the competition floor. The competition area was lit by high power television lighting. The cameras were gen locked and time synchronised using an Event Synchronisation Unit and EBU time code generators. The EBU time code was recorded on the audio track of the videotapes (channel 2).

In order to reconstruct the gymnasts position in three dimensional space from two 2-D camera views, the PEAK system calibration frame consisting of 24 spheres of known co-ordinates was filmed to obtain a calibration and scaling factor. This gives an approximate calibrated space of 2.05m x 2.05m x 1.3m. The long horizontal axis of the calibration frame was approximately aligned with the direction of movement of the gymnast.

Data analysis

Analysis of the Gaylord I was completed using the PEAK Technologies Motion Analysis System V5. The 2-D co-ordinates of a 21 point body model were manually digitised (effective half-pixel resolution 1024 x 1024). The raw co-ordinates were filtered using a Butterworth low pass digital filter with an optimal cut-off frequency determined by the Jackson 'knee' method (1973). Total body centre of mass position was determined based on the anthropometric data of Dempster (1955). The differential process employed provided the kinematic data (Miller and Nelson, 1973).

RESULTS AND DISCUSSION

Mo's physical characteristics gave her a distinct advantage over her competitors when performing saltos as her moment of inertia was comparatively small. In terms of the Gaylord I then, she was more likely to be able to complete the movement successfully, and it is even possible that she would not hit the low bar if the regrasp was unsuccessful.

At the rnoment of release Mo's CM vertical velocity was 2.29m/s with CM horizontal velocity of 0.7m/s. Mo's centre of mass to horizontal angle at release was 380". This was at a point closer to the horizontal than that reported by Brueggemann et al. (1994). At the release position, Mo was in a slightly tucked position with the knees flexed to 65" and a small amount of flexion at the hips (15') (Figure 1). This was in contrast to the linear (straight) body position that Cuk (1992) advocated. This semi-tucked position allowed Mo to get into a completely tucked position early in the flight phase. Maximum height of the centre of gravity was compromised.

Mo's CM reached a maximal height of 2.83m, with this maximum occurring 0.06m from the bar on the low bar side. The data shows that Mo did not attain a great amount of height during the movement as her CM vertical velocity at release was quite small, and the gymnasts size and small moment of inertia throughout the flight phase allowed her to complete the saltos relatively close to the bar. Therefore, in comparison to the value reported by Cuk (1992) the flight phase was comparatively short at 0.64s. From the point of release, Mo's CM height had gone from 2.45m to 2.83m at the top of the flight, back to 2.31m at regrasp. By comparison to rnale gymnasts performing the Gaylord I, Mo performed what might best be described as an abbreviated version of the skill.

Figure 1: Diagram showing Mo's body position at release

CONCLUSION

Mo Huilan has set a new level of difficulty on the uneven bars. Unfortunately at these championships, she fell when performing a simpler movement later in her routine, so the impact of this skill on her performance could not be judged. Certainly Mo's physical characteristics made her unique even among her fellow gymnasts. Whether more female gymnasts will take up the challenge of this skill is something that will be decided over time.

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