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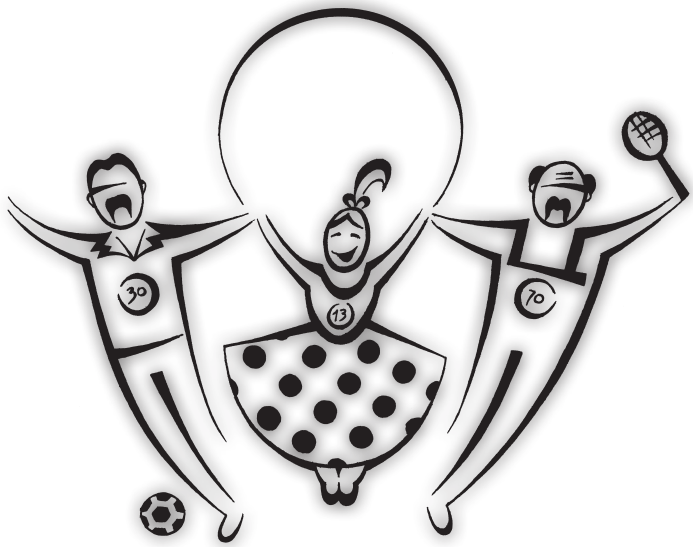

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MOTION ANALYSIS OF THE SKILL INVERTED GIANT SWING (ALDER) ON HIGH BAR

Keywords: *motion analysis, gymnasts, high bar*

Introduction

Skills in gymnastics characterized by high speed and installation as well as connect them to form the kinetic chains on various gymnastics equipment [1]. As a result, a great number of skills have been developed on each piece of apparatus over the years; more are expected in the future. Although most of these skills are unique to each apparatus, some broad classifications can be made.

Generally, gymnastic skills are of the 'swinging, balance, strength, or tumbling' type. Or they can be classified as 'primary' and 'secondary'. Primary skills are skills that constitute the core of each individual routine such as giant swings, somersaults, handstands, etc. Secondary are skills connecting the "primary ones within a routine, such as the round-off, handsprings, various leaps and the stoop-in pike through to inverted giants" [2]. And all that makes it affected aspects biomechanics dramatically [1].

Strength, balance, flexibility, speed, proper timing, and stamina have long been considered a necessity for the sport of gymnastics. However, the explosive worldwide development of the sport the last decade established another factor the mastering of swinging to be of paramount importance for gymnasts desiring to succeed in competition [3].

The stoop circle rearward forward, also called "Adler" (German word for eagle) is an old element in artistic gymnastics. It is performed mostly by men on high bar,

but also by women on the uneven bars. In the last years this element becomes more important because of the possibility to combine it with another element, especially with flight elements. This combination is important to earn combination points to get a higher difficulty value of the routine [4].

As the our specialty in the field of training for gymnastics, the field experience in the training work made us recognize more and more on training requirements in the modern artistic gymnastics, where the perfect performance of the technical skills and the sentences is the ultimate goal that seeks to it both coach and athlete in this area this is achieved only from during adjusts all the physical and mechanical properties characteristic of the movement.

Based on all this, we has been decided to do study kinematics to one of the kinetic chain requirements on horizontal bar apparatus for the purpose of application and method of improving performance when gymnasts and perhaps this contributes to facilitate the sports training process when those interested in this field.

Research problem

For the stoop circle rearward forward there are no judge's rules for the start position. The Code of points (Federation Internationale de Gymnastique, 2009) and other regulations from the gymnastics Federation [5] specify only the last position (handstand) of the element. If the gymnast did not reach the handstand position and there is a difference of more than 15° the execution judges deduct 0.1, 0.3 or 0.5 points. Additionally the level of difficulty will be downgraded by the difficulty judges (e.g. from C-value to B-value or no value).

Research questions

1. Which technique enables better progression to more advanced skills?
2. Which technique is better to reach the perfect final position (handstand)?
3. Which requirements are important for the different techniques?

Aims of the research are finding biomechanical differences between the two techniques and deducing requirements for gymnasts.

Material and Methods

One male gymnast from Qatar national team (age 21 years, mass 70.2 kg, height 1.70 m) and one male gymnast from Kingdom of Saudi Arabia national team (age 22 years, mass 75.6 kg, height 1.76 m).

The filming took place at Gulf competition (qualification), was selected as the best performance of this skill.

Videography was employed for the biomechanical kinematics analysis of Alder on high bar. The camera that was used for this study was a standard Sony. The video camera was mounted on the tripod stand at the height of 2.80 m from the floor arena. The video camera was placed perpendicularly at center in the line of inner bar and parallel to the sagittal plane at a distance of 10 meters. The frequency of the camera was 60 frames/second with HD quality of video. The subject performed the skill three times and the best trail was used for the analysis.

Data were gathered in the standard testing procedure under the controlled condition. All testing was carried out in the standard gymnasium of Qatar and Kingdom of Saudi Arabia. Ideography technique was employed in order to register the performance of Alder for the study. The digitization of the photographic sequence of selected phases was done with the help of Kinovea and Dratfish software. The center of gravity of required phases was located by using segmentation method (Hey, 1993). Curves angular velocity by the Statistical Package Minitab 16.

Results and Discussion

If we compare the movement time[s] for the two techniques for the quadrant the high technique has longer for Qatar gymnast than KSA gymnast (Table 1).

Table 1.

Temporal Results [s]

quadrant	Qatar gymnast	KSA gymnast
1	0.44	0.52
2	0.68	0.80
3	0.92	1.04
4	1.36	1.32

Source: authors' research.

Table 2.

Angle velocities [°/s]

quadrant	Qatar gymnast		KSA gymnast	
	shoulder	hip	shoulder	hip
1	406.773	316.463	354.346	515.342
2	325.384	440.932	476.254	265.286
3	421.359	261.347	326.370	724.712
4	104.029	129.727	215.780	47.045

Source: authors' research.

Table 3.

Shoulder and hip angle [°]

quadrant	Qatar gymnast		KSA gymnast	
	shoulder	hip	shoulder	hip
1	84	23	56	29
2	78	37	46	33
3	16	31	10	98
4	138	108	128	91

Source: authors' research.

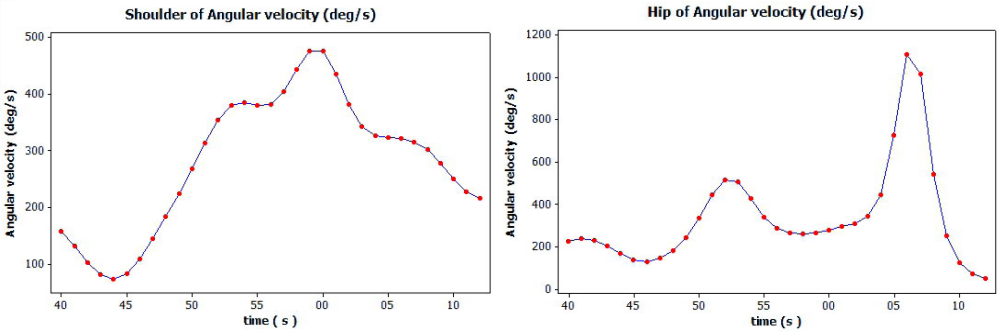

Figure 1. Shoulder and hip of Angular velocity (deg/s) KAS gymnast

Source: authors' research.

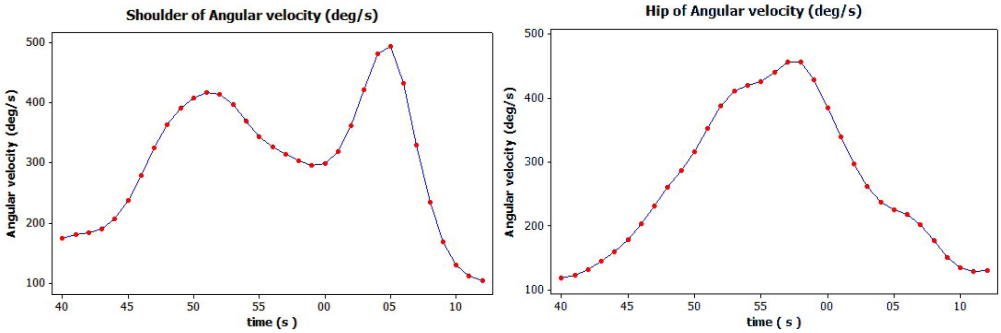

Figure 2. Shoulder and hip of Angular velocity (deg/s) Qatar gymnast

Source: authors' research.

Although no substantial differences among subjects and techniques can be found regarding total times, other differences can be detected. For example, in the late drop technique the gymnast is required to brake the drop in the first quadrant in order to facilitate hip joint flexion, by maintaining a relatively wide shoulder joint angle and inhibiting consciously the forward rotation [2]. It is shown in the table 1

that Subjects KSA gymnast (the late droppers) consumed proportionally more time in the first quadrant than the early droppers did. Selected kinematic data for two subjects is presented in table 2 the relationship between the shoulder, hip joint angles and the shoulder and hip joint angular velocities is found in table 3.

Besides the obvious and most pronounced difference regarding the knee joint angle which however is subject and not technique related, there are no profound or surprising differences in this set of kinematics. Notice, however, the steeper decrease in the hip joint angle of Subject one and the braking action at this shoulder joint, which is manifested through a relatively steeper decrease in the joint's angular velocity.

Qatar gymnast prefers the high technique with the late stoop in. But our findings show this technique make higher demands on the gymnasts. They must bend their hip and shoulder faster than with the low technique. Our first results give us no answer why gymnasts use the high technique with greater demands. One assumption of the coaches was that body mass and height of the gymnasts is one reason for choosing high or low technique. Using official information from the gymnastics federation with height and mass of the gymnast [4]. We could not find differences between the gymnasts using high or low technique.

Maybe the question is not only answerable with biomechanical data. It could be also a question of which movement has the greater effect on judges and spectators. This is a question of aesthetics. Maybe it is more impressively to have a slow start of the stoop circles and than a faster movement (high technique) compared to the slower movement with an early start (low technique).

Both techniques of the stoop circle rearward forward were performed successful by gymnasts. But our analysis with kinematic data shows different requirements in hip and shoulder angle for these techniques. Using the high technique higher angular velocities must be performed in hip and shoulder angles. Coaches and gymnasts should consider this in their training especially in strength training for hip and shoulder angle. Further research should include the calculation of energy and joint torques. Applying these data to a simulation model could be used for movement optimization [4].

Conclusion

The analysis revealed that of the subjects utilized similar mechanical patterns, but the second, at times, deviated substantially. It was found that, in general, execution of the inverted giant swing involves large changes in body configuration as a result of large hip and shoulder movement ranges. However, the timing factor, relative to when these joint movements occurred, was not consistent among the tow gymnasts, which resulted in differing techniques. Although the velocity

angle generally increased during the descending portion of the movement and decreased in the ascending portion, the increments/decrements were not consistent among subjects. Surprisingly, these increments/decrements were not always directly and proportionally related to respectively increments/decrements in the subjects' radius of gyration.

Although a case can be made that all the recorded performances were aesthetically pleasing, the technique of subject Qatar resulted in a smaller loss in velocity angle in the ascending phase of the swing, Consequently, the technique of subject Qatar is the recommended model to follow.

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Summary

Keywords: *motion analysis, gymnasts, high bar*

Aims of the research are finding biomechanical differences between the two techniques and deducing requirements for gymnasts. 2D-video analysis from high bar routines of the gulf Championships 2016 was used one male gymnast from Qatar national team and one male gymnast from Kingdom of Saudi Arabia national team. There are more gymnasts performing the high technique. We find differences in movement time and maximum angular velocities for hip and shoulder angles. These differences should be considered by

coaches and gymnasts. None of the analyzed performances were ideal. The performance of Subject one was, overall, the most skillful. It was characterized by a "braking" action in the beginning of the descending phase to facilitate the (quick and tight) hip joint flexion and a relatively large shoulder joint angle at the highest point of the upswing. Additional analysis, including more skilled performances, is needed in order to identify the variables that contribute most to successful execution of the skill.