Kinematic Parameters Differences between Horizontal Bar Dismounts Double Stretched Backward Somersault with One, Two and Three Longitudinal Axis Rotations

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1 OBJECTIVES

Determination of variables that differ horizontal bar dismount double stretched somersault backward with one, two and three longitudinal axis twist was main objective of this research, as a part of author's doctoral dissertation (Moznik, 2018).

Horizontal bar is one of six men`s artistic gymnastics apparatus where gymnasts perform complex, virtuoso and demanding elements. Dismounts are a group of elements which gymnasts use to finish their routine and which therefore affect the final score and the competition rank. Today FIG Code of Points has a total of 32 dismounts (FIG Code of Points, 2017). A lot of different horizontal bar dismounts were investigated (Bauer, 1983; Brügemann et al., 1994; Hiley and Yeadon 2003a; Hiley and Yeadon, 2003b; Hiley and Yeadon, 2005; Kerwin, Yeadon and Harwood, 1993; Kerwin, Yeadon and Lee, 1990; Yeadon, 1997; Yeadon and Hiley, 2000). However, only 2 studies about dismount with 3 longitudinal axis twists were conducted so far (Yang et al., 1995; Knoll, 2001), each with sample of one gymnast. These dismount has a name Fedorchenko, by the Kazahstan gymnast who performed it for the first time in 1995 World Championships.

Although there are two different techniques of giant swing which precedes the dismount from horizontal bar, for complex dismounts gymnasts mostly use modern technique. In modern technique gymnast after passing vertical line under the bar performs strong hyperextension and opens his shoulder angle. After long period of hyperextension in the hips, gymnast swings the shortest way with the legs and by doing that he cuts the handstand position. If compared with traditional, in modern giant swing technique period of hyperextension in the hips and body position in the bow shape lasts a lot longer (Karácsony and Cuk, 2015).

Hypothesis of this research was that different amount of rotation around the longitudinal axis are characterized by a specific relationship between biomechanical variables and parameters defining the trajectory of the flight and initiating and controlling the rotation around the transverse and longitudinal axis. It should be investigated how dismounts classified according to the number of turns around the longitudinal axis differ according to the parameters within certain variables.

2 METHODS

Data collection took place during the 2016 FIG World Challenge Cup tournament in Osijek, Croatia.

A sample was a total of 12 elite gymnasts (18-29 y.o., 159-183 cm, 55-80 kg), representatives of the national team from 10 different countries. Few gymnasts from the sample were Olympic and World champions.

For the purpose of kinematic analysis, 15 different dismounts were selected, divided into three groups by five dismounts, according to the rotations around the longitudinal axis (360°, 720°, 1080°). Dismount with 1/1 and 2/1 turn performed five different gymnasts and dismount with 3/1 turn performed two gymnasts.

Dismounts were filmed with two mini DV cameras (Sony HDR-HC9E), with frequency of 50 Hz. Shutter speed was set on 1/1000. Data processing was performed according to the APAS procedures (Ariel Performance Analysis System).

Five positions (table 1; figure 1) were defined in which a total of 128 variables were analysed by the SPSS (Statistical Package for the Social Sciences) program package.

Table 1: Positions for the kinematic analysis.

	PHASE	MOMENT OF POSITION DETERMINATION
P1	Giant swing	Center of gravity of a body in a vertical line above the bar (*x* axis)
P2	Giant swing	Center of gravity of a body in a horizontal line behind the bar (*y* axis)
P3	Giant swing	Center of gravity of a body in a vertical line under the bar (*x* axis)
P4	Bar release	The left and right wrists 10 cm away from the bar (according to *x* axis)
P5	Foot and the mat first contact	Foot stoped their way down (by *y* axis)

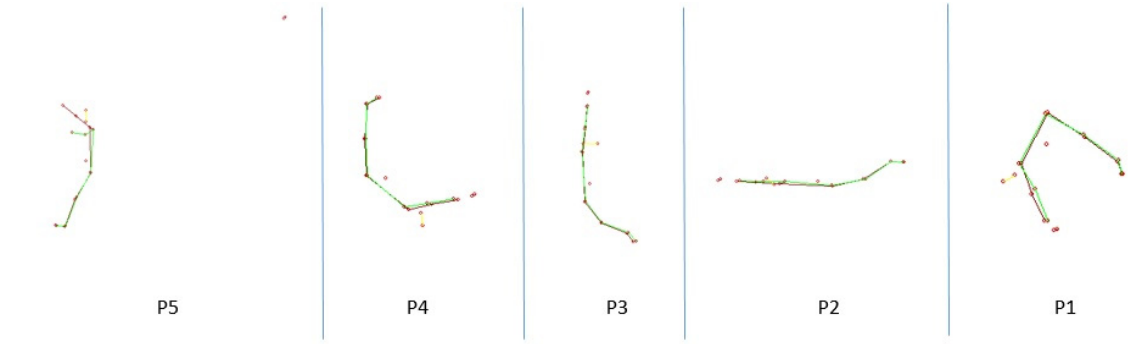

Figure 1: Positions for the kinematic analysis.

3 RESULTS

Statistical data processing has shown that in certain positions there are differences in parameters within certain variables and the differences between dismount groups in a total of 74 variables. In five specific positions of the body, variables have differed dismounts with 1/1 and 2/1 turn in total of 14 times, with 2/1 and 3/1 turn 60 times and with 1/1 and 3/1 turn 84 times.

Center of gravity of a body at the moment of releasing the bar was above the bar and (vertical and horizontal) speed increased exponentially for dismounts with 3/1 turn in regards to dismounts with 2/1 and 1/1 turn (table 2).

Flight time (figure 2) and maximum height of the center of gravity of a body (figure 3) showed the highest values for the dismounts with 3/1 turn in regards to dismounts with 2/1 and 1/1 turn.

Position P1 (figure 4, 5) and P4 (figure 6, 7) showed the most significant differences between dismounts with 2/1 and 3/1 turn.

Table 2: Position and speed of a center of gravity of a body in a dismounts with 1/1, 2/1 and 3/1 turn.

	Distance from the bar by *y* axis (cm)	**Distance from the bar by *x* axis (cm)**	**Speed by *y* axis (m/s)**	**Speed by *x* axis (m/s)**
1	5,33±9,69	91,41±5,59	4,40±0,26	1,24±0,52
2	3,00±9,95	87,30±6,84	4,28±0,20	1,08±0,26
3	2,56±2,00	84,78±1,40	4,95±0,30	1,55±0,29

Figure 2: Flight time.

Figure 3: Max height of the center of gravity of a body.

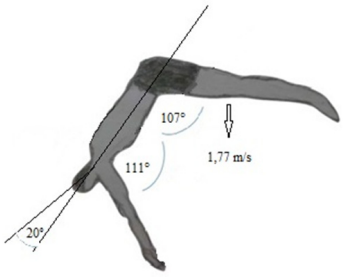

Figure 4: P1 in dismount with 2/1 turns.

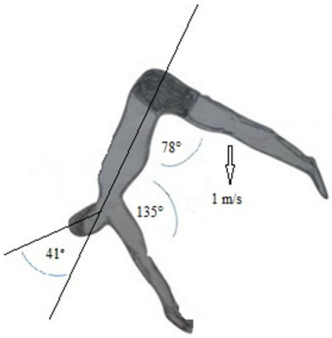

Figure 5: P1 in dismount with 3/1 turns.

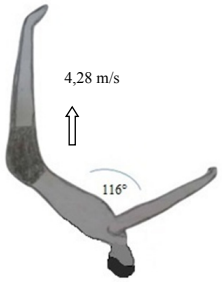

Figure 6: P4 in dismount with 2/1 turns.

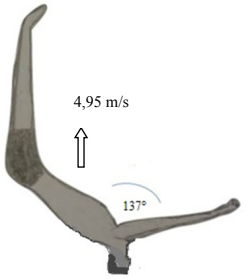

Figure 7: P5 in dismount with 3/1 turns.

4 DISCUSSION

The results showed that for performance of double stretched somersault backward dismounts with three turns around the longitudinal axis it`s necessary to significantly increase the values of parameters of multiple biomechanical variables that condition a safe and successful execution with respect to dismounts with one or two turns that interact with each other and with respect to dismounts with three turns in a smaller number of variables and in a smaller ratio.

The information from this research suggests the need to achieve certain biomechanical parameters while learning the dismount double stretched somersault backward in order to pre-prepare the conditions for a successful upgrading of a double stretched somersault backward dismount by adding one, two, and then three turns around the longitudinal axis.

In addition to help in the training process, the results indicated the need to consider assigning a higher difficulty value to the dismount *Fedorchenko* in the FIG Code of Points.

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