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Biomechanical Analysis of Selected Holding Positions on Parallel Bar in Gymnastic

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Abstract: ***The purpose of the study was to biomechanically analysis the three different holding positions (i.e. Handstand, Straddle L – Hold and L – Hold) on parallel bar in gymnastic. A total of 6 male university level subjects were selected (aged 19.66±1.63) from gymnastic match practice group of Laxshmibai National Institute of Physical Education by using consecutive sampling. The biomechanical and anthropometric variables included were angles at hip joint, stature, weight and BMI. Angles were determined by using dartfish software. Videography method was used to biomechanically analysis the selected moments. For measuring performance in each of the three different holding positions subjective evaluation was used. Descriptive statistics and correlation were used as a statistical technique for the present study. A descriptive profile was made by using EXCEL graphic functionality on selected parameters. In case of correlation, none of the biomechanical and anthropometric variables has exhibited significant relationship with the performance of subjects in any of the selected holding positions on parallel bar.***

Keyword: Handstand, Straddle L – Hold, L – Hold, Kinematic Variable, Anthropometric Variables and Gymnast.

1. Introduction

A biological and mechanical approach to sport is becoming increasingly important in order for athletes to choose the right specialties. Amongst all of the sport activities in which the human engages, track and field, swimming, and gymnastics provide the most pure movements to analyze biomechanically.Gymnastics has become a very popular sport with a concomitant increase in the skill level of gymnasts. Accompanying this increase in skill level is also a greater complexity in the new skills that are developed (Carol Miksch Mooney, 1977).The biomechanical analysis of gymnastics activities must incorporate the human body, with its structure and structural limitations; measuring of different angles, its torque producing mechanism; the muscles; and the apparatus around, over, on, and about which the human body moves in a prescribed manner.

Artistic gymnastics has made outstanding progress, developing in accordance with the tendencies of high performance sport, but it also has its specific particulars, such as: increase of sports mastery, development and rivalry of competitive program complexity, processing of new routines, etc. (Vieru, 1997; Arkaev & Suchilin, 2004).Understanding and utilizing biomechanical principles is an important means by which a gymnast can produce an effective performance. This can be implemented by being acutely aware of how body segments are effectively manipulated during a performance.

It is essential to provide a means by which the gymnast can be more competent while performing on the apparatus. The specific features of each artistic gymnastics event are given by the structure and number of technical elements, by the complexity, originality, spectacular character materialized in the maximum effectiveness reached in competition (Niculescu, 2003). Thus, the technique is represented by a system of specific motor structures rationally and economically built, in order to obtain maximum efficiency in competition (Vladimir Potop, Georgeta Niculescu, Olivia Carmen Timnea, 2013).

Very few research papers have dealt with thekinematic analysis of the parallel bars elements. Linge et al. (2006) dealt with the modeling of the parallel bars in Men's Artistic Gymnastics. Prassas& Ariel (2005); Prassas (1994) dealt with the kinematics of giant swings and back toss on the parallel bars, as well as Tsuchiya et al. (2004) who dealt with the kinetic analysis of the same element. The double back salto dismount from the parallel bars was the research topic of Gervais & Dunn (2003) (SašaVeličkovićet et al, 2011) The purpose of this study was to biomechanically analysis the three different holding positions on parallel bar in gymnastic.

2. Methodology

A total of 6 male university level subjects were selected from gymnastic match practice group of Lakshmibai National Institute of Physical Education by using consecutive sampling. The age of the subjects was ranged from 18 to 28 years and all were regular gymnast with good level of skill. Videography method was used to biomechanically analysis the selected holding positions (i.e. Handstand, Straddle L – hold position and L position) on the parallel bar. A motor driven, Nikon Model EM Camera was used. The subjects were photographed at a distance of 6.85 meters in sagittal plane and the height of the camera was 1.60 meters. Three independent variables such as angle at hip joint, stature, weight BMI (weight / height in meter square) were selected for this study. Dartfish software was used to measure the angle at hip joint. Anthropometric measurement was taken with the help of stadiometer. Weighing machine was used to measure weight. The performance of all the holding positions of each selected subject was taken as the criterion measure for the present study. The performance was recorded on the basis of execution of the skill. The overall score of each holding

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position was divided into five different categories i.e. for handstand, the categories are 1. Initial swing to handstand, 2.Position of head and seat, 3.Position of legs, 4.Duration of hold and 5. Position of arms; for straddle L – hold position, the categories are 1. Position of legs, 2.Downward movement of the body, 3.Position of upper body and head, 4.Duration of the hold 5. Overall impact; for L – hold position, the categories are, 1. Flow of the leg movement 2.Positions of the arms and upper body, 3.Position of head, 4.Duration of hold and 5.Overall flow. All above categories consist of 10 marks each. The total marks given for each holding position is 50 (consist of five categories).The average score of the three judges on each holds were considered as the final points obtained by each gymnast in that particular hold. Descriptive statistics and correlation were used as a statistical technique for the present study.

3. Results

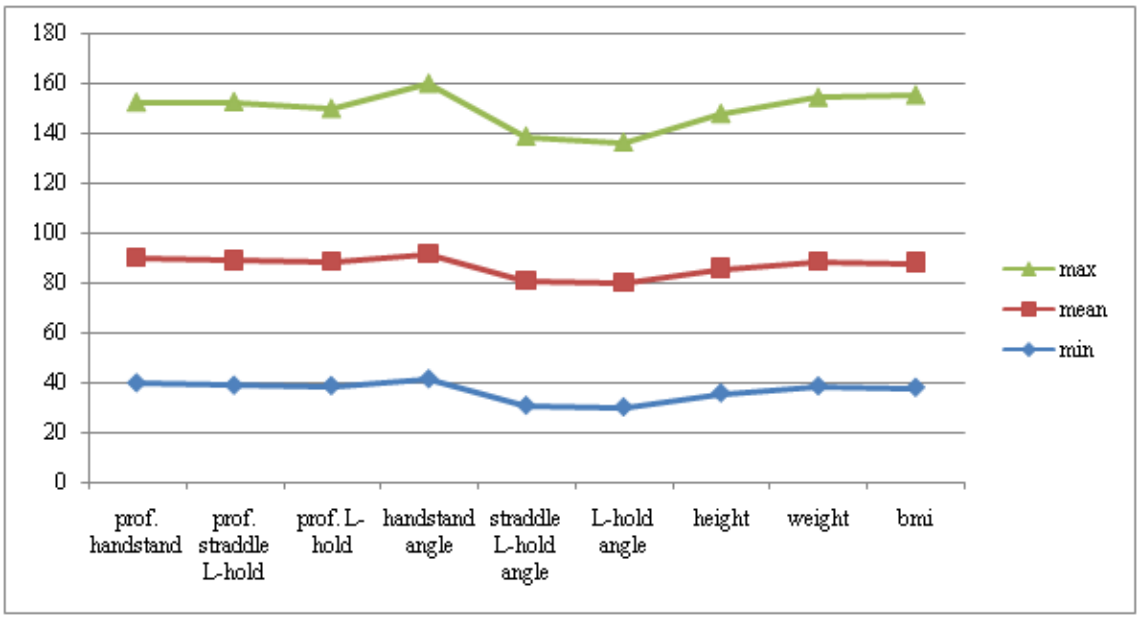
Different interpretation can be made from the results in table 1. However, some of the important findings that can be drawn are as follows.

Except the angles in L – hold and handstand, Mean and median for all the variables are nearly equal. Standard error of mean is the least for performance of L-hold whereas the maximum for the angle of L-hold position. The skewness values more than twice its standard error indicates the departure from symmetry. From table 1, it can be seen that in angle of straddle L-hold and L-hold is negatively skewed as their values are -1.800 and -2.104 which are more than twice their standard error. Thus, it can be interpreted that the angle of the subjects on straddle L-hold and L-hold are more on the upper side.

Other descriptive statistics such as, kurtosis, minimum score, maximum score, range etc. can be seen from the results in table 1.

Table 1: By using the EXCEL graphic functionality for developing line diagram, the profile of university level gymnast in performing three different selected holding positions on parallel bar was prepared by linearly transformed scores.

Descriptive Statistics										
		Performance Handstand	*Performance straddle L hold*	*Performance L hold*	*Angle handstand H.J*	*Angle straddle L hold H.J*	*Angle L hold H.J*	*Height*	*Weight*	*BMI*
N	Valid	6	6	6	6	6	6	6	6	6
	Missing	0	0	0	0	0	0	0	0	0
Mean		39.666	38.666	42.000	177.533	64.650	83.367	169.833	61.083	21.136
Std. Error of Mean		1.085	.9888	.365	3.705	2.558	3.930	1.400	2.563	.6101
Median		39.500	38.000	42.000	175.10	66.550	87.25	170.0	60.25	21.011
Mode		37.00	37.00	41.00[a]	169.90[a]	52.70[a]	64.40[a]	170.00	54.00[a]	19.36[a]
Std. Deviation		2.658	2.422	.894	9.076	6.266	9.627	3.430	6.280	1.494
Variance		7.067	5.867	.800	82.379	39.271	92.683	11.767	39.442	2.234
Skewness		.153	.455	.000	1.556	-1.800	-2.104	-.235	.644	.978
Std. Error of Skewness		.845	.845	.845	.845	.845	.845	.845	.845	.845
Kurtosis		-2.534	-1.794	-1.875	2.503	3.473	4.555	-1.133	-.339	1.524
Std. Error of Kurtosis		1.741	1.741	1.741	1.741	1.741	1.741	1.741	1.741	1.741
Range		6.00	6.00	2.00	24.40	17.00	25.00	9.00	17.00	4.36
Minimum		37.00	36.00	41.00	169.90	52.70	64.40	165.0	54.00	19.36
Maximum		43.00	42.00	43.00	194.30	69.70	89.40	174.0	71.00	23.72
Sum		238.00	232.00	252.00	1065.2	387.90	500.2	1019.0	366.5	126.82
a. Multiple modes exist. The smallest value is shown										



Graph 1

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Relationship of selected biomechanical and anthropometric variables with the performance of the subjects in three different holding positions on parallel bar in gymnastic is presented in table 2.The score of each of the independent variables were correlated with the performance of subjects in handstand, straddle L – hold and L – hold.

Table 2

Correlations						
		performance handstand	Handstand angle	height	weight	BMI
performance handstand	Pearson Correlation	1	.244	.629	.577	.463
	Sig. (2-tailed)		.641	.181	.231	.356
	N	6	6	6	6	6
		performance straddle L hold	straddle L hold angle	height	weight	BMI
performance straddle L hold	Pearson Correlation	1	-.571	.353	-.024	-.234
	Sig. (2-tailed)		.237	.492	.964	.656
	N	6	6	6	6	6
		performance L hold	L hold angle	height	weight	BMI
performance L hold	Pearson Correlation	1	-.553	.326	.374	.340
	Sig. (2-tailed)		.255	.528	.465	.509
	N	6	6	6	6	6
*. Correlation is significant at the 0.05 level (2-tailed).						

4. Discussion and Conclusion

In case of correlation, none of the biomechanical and anthropometric variables has exhibited significant relationship with the performance of subjects in any of the selected holding positions on parallel bar. This might be due to the reason that in hand stand the performance depends upon several factors specially the swinging phase of handstand, shoulder strength, position of center of gravity and the position of the body segment/parts in relation to line of the C.G. (for maintaining balance). Prassas et al. (1986) investigated the relationship between shoulder joint strength, hip joint flexibility, and timing to the straight arms/flexed hipspress handstand on the parallel bars. They concluded that increased levels of shoulder joint strength at the later stages of shoulder joint flexion might be one of the prerequisites for proper execution of the skill, and increase in existing hip joint flexibility could reduce the demands placed upon the shoulder joint musculature. A smooth flow of movement is also require in performing handstand with proper head position during the hold. Asseman and Gahéry (2005) analyzed the influence of the head position on balancing in gymnasts who were asked to perform handstand with different head positions and with eyes open and closed. The professional gymnasts had no problem with balance in a handstand position with their eyes closed. However it was found out that it was much more difficult for them to balance when their neck was in flexion. Similarly in straddle L – hold position and L – hold, abdominal strength, line of C.G. and shoulder strength plays a very vital role in maintaining the position for several seconds.

5. Future Scope

It will give a better understanding of the factors that are really contributing in performing the above holds in parallel bar in gymnastics. It will also help the coaches to focus on the contributing factors, while helping the athlete in correcting the technique and dealing with their technical errors. More research must be done in relation with the above techniques to find out the actual factors that are responsible for a better performance.

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