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Original scientific paper

THE CENTER OF GYMNAST'S BODY GRAVITY DURING THE PERFORMANCE OF THE SALTO FORWARD TUCKED

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Abstract

Salto forward tucked is one of the most spectacular elements of acrobatics. During her performance, gymnast manifests her technical skills by coordinating every movement of her body parts with maximum precision. With the system for kinematic analysis - APAS (Ariel Performance Analysis System), was analyzed the performance of salto forward tucked by a quality gymnast. The results of the body position and the trajectory of her movement show greater displacement of the body's gravity center in the anteroposterior direction - forward (208 cm), then in the vertical-high (60 cm) direction, while in the mediolateral direction - the displacement value is symbolic (3 cm), which shows the high precision of performing salto forward tucked. The highest point of the center of gravity of the body from the carpet during the flight phase is 154cm and is reached for 2.16 seconds of the fly-off phase that represents 55% of the flight phase time (3.92 seconds).At the top of the center of gravity trajectory, the angles in the angles are: knees-64 °, thigh-75 °, arms-20 ° and elbows-139 °.These values confirm correct performance, while the kinematic analysis of the salto forward tucked gives a very useful insight into the technique of performing, finding errors and improving them during the training process.

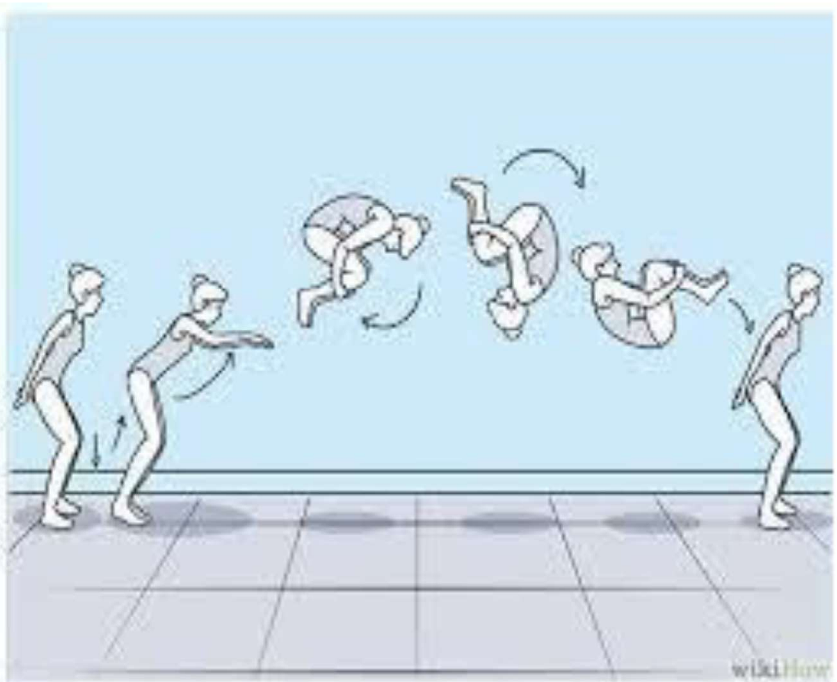
*Keywords: A*crobatics, salto forward tucked, kinematic analysis, trajectory.

Introduction

Salto forward tucked is one of the most spectacular elements of acrobatics. It is an important element that is included in the curriculum for students of the Faculty of Physical Culture. Also, it is part in all combinations of exercises Gymnastic higher categories on the floor. During the performance, gymnasts manifest her technical skills by coordinating every movement of her body parts with maximum precision (Banerjee A., S. Ghosh, S. Bhowmick., 2014; Bruggemann, G. P., 1987).

A Salto Forward Tucked is usually performed after a modest run. The last step of the run should be the hurdle. During the hurdle, the arms should be doing a circle sideways, from downward to upward. The arms should finish over the shoulders. The head should be in a neutral position with the body extended, slightly arched, with the hips forward. The gymnast should jump from their toes, with their feet together. During the flight (until vertical), the gymnast should regroup their body. The legs should be bent and moving backward, at the same time the upper body and the arms should be following the legs. The gymnast may hold their legs, but this is optional. From the vertical position (at the highest point in the flip), the body should begin extending and preparing for the landing. The head should be in a neutral position. At the landing, the arms should be bent in front of the chest (Gym Drill Pro, 2019). In order to improve the element, firstly, we need to know Forward Roll, Dive Roll, as well as the learning methodology of Salto Forward Tucked.

Figure 1. Salto Forward Tucked



Methods of work

Conditions of performance of the Salto Forward Tucked and recording methods

The purpose of this study is to analyze the position of the gymnast at the highest point of the trajectory of the center of gravity of the body during the performance of Salto Forward Tucked.

The technique was performed by a high quality gymnast from the Prishtina Gymnastics Club, (Rep. of Kosovo) with five years of experience (D.K.). Body height 168 cm and body weight 54 kg.

The technique is demonstrated during training in a gymnastic hall with optimal environment conditions. The engagement of the gymnast has been maximal and technically fair so that the filmed images can be used for further analysis.

The filmed material is processed according to the process of the APAS System modules. APAS is a 3D motion analysis system based on video footage that accurately quantifies and provides objective data so professionals can use it to evaluate and improve further treatment.
Analysis System - APAS, integrates computer hardware and video processing with specialized software modules that perform data collection, analysis and presentation. The objective measurable material is for 2-dimensional and 3-dimensional analysis. Specific points of interest to the researcher can be digitized by user intervention or automatically using different markers

(Ariel Dynamics, 1994). The performing of technique (Salto Forward Tucked) in this study is filmed with three digital cameras (60Hz / s), positioned at an angle of about 120 degrees from each other. The distance of the cameras from the performance technique is 5-6 meters. After the cameras are fixed to the place where the technique was to be performed, dimensions calibration frame (200cmx200cmx200cm) was filmed. Then the calibration framework is removed and the same technique field starts performing the techniques.

The first analytical step after recording is transferring the video image to the computer hard disk for digitalization. Capture module is a windows-based program for recording and saving these images for analysis using the Ariel Performance Analysis System (APAS). For successful performance, the film is cut from the beginning of the push up to the land. For the above mentioned technique, after cutting the film, is created a model of the gymnast's body lever system formed by 18 points of her body. After digitalization, the transformation of the model takes place from the figures2D to 3D. Then, takes place the filtering of the signal (movement curve) for each analyzed point. Finally, we read the data obtained from the curves for the displacements, angles in the joints, velocities and duration of the realisation of technique.

After synchronized images are cut for all three cameras, begins digitization. The Digitize module is a windows-based program for digitizing images to be analyzed using the Ariel Performance Analysis System (APAS).

In this study was performed manual digitization under the control of a computer operator for previously synchronized video images for all cameras. This operator is equipped with a consistent digitization model compatible with the anatomical dimensions of the persons analyzed and can rapidly produce high quality digitized images. ARIEL TRANSFORMATION software is a Windows based program in order to finish this conversion process. Transformation is the process of converting two or more two-dimensional images digitized into a three-dimensional image sequence. Option Transform is also available to convert a single, two-dimensional digitized view into a two-dimensional image sequence. In each case, the process involves transforming the corresponding digitized coordinates for each point into each frame of the image space. Although, some of the transformation features may seem complex, they are relatively easy to master because this process is entirely computer-based. The transformation phase begins after all camera images have been digitized. The purpose of this phase is to calculate three-dimensional space images of the coordinate system of the subject's body joints from the two-dimensional coordinates digitized for each camera view.

Filtering is used to remove small random errors or "noise" of digitization from the transformed image sequence. The digitization process involves measuring the location of each part of the body. This module can improve digitized shared sites by minimizing the effect of errors made during the analysis process. Except the displacement curve, filtering can also be used for other curves, velocity and acceleration for each component. APAS/View has been developed to dynamically view and analyze images created as segment and points, numerical data, force platform vectors (if reactive force measurement system is used) and AVI videos. With APAS/View it is possible to upload all data to the computer, display and evaluate multiple datasets in some windows. The data window can display almost any type of numerical data collected over time. For example, velocity, acceleration and higher center of gravity.

Analysis and results

The results of the body position and the trajectory of her movement show greater displacement of the body's gravity center in the anteroposterior direction - forward (208 cm), then in the vertical-high (60 cm) direction, while in the mediolateral direction - the displacement value is symbolic (3 cm), which shows the high precision of performing salto forward tucked.
At the top of the center of gravity trajectory, the angles in the joints are: knees-64 °, thigh-75 °, arms-20 ° and elbows-139 ° (Table 1).

These values confirm correct performance, while the kinematic analysis of the salto forward tucked gives a very useful insight into the technique of performing, finding errors and improving them during the training process.

Table 1. Results of gymnast (D.K.) body position during saltos performance: Body height: 168 cm; Mass: 54 kg.

Athlete (D.K.)	Maximum displacement Anteroposterior (cm)	Maximum Vertical Displacement (cm)	Maximum displacement mediolaterale (cm)	Knee angle at the maximum point(º)	Thighs angle at the maximum point(º)	Arms angle at the maximum point(º)	Elbows angle at the maximum point(º)
Center of gravity	208	60	3				
Feet during the flight moment		154 (55% of the Phases)					
The angles at the maximum vertical point				64º	75º	20º	139

Conclusion

During the learning of the gymnastic technique Salto Forward Tucked, it is important to know correct performing, also special importance is to know methodical and didactic principles as well as to know the most common mistakes in the process of learning (Banerjee, 2016; Mamuti, 2012).
From these values we conclude that during school hours and clubs it is necessary to pay attention on folding legs in order to increase the body's position when performing the salto forward tucked as well as several other technical details.

It is also necessary to enhance the number of gymnastics classes as a regular school subject for students of the Faculty of Physical Culture.

References

[1]. Ariel Performance Analysis System. *Ariel Dynamics* (1994). Handbook. San Diego, CA.

[2]. Banerjee, A. (2016). Kinematic analysis of angular velocity of take-off action between backward Salto in floor exercise and handspring vault in vaulting table in national level gymnasts. *International Journal of Physical Education, Sports and Health*. Vol. 3, Issue 2, Part B.

[3]. Banerjee A., S. Ghosh, S. Bhowmick. (2014). A kinematic study of back tuck somersault takes off following round off on the floor exercise. *Journal of Education and Practice*, ISSN 2222-1735 (Paper), ISSN 2222-288X (online). Vol.5, No,37.

[4]. Bruggemann, G. P. (1987). Kinematics and kinetics of the backward somersault take-off from the floor. In H. Matsui and K Kobayashi (eds.), *Biomechanics VIII-B,* 793-800. Champaign, IL: Human Kinetics.

[5]. Mamuti. F. (2012). *Akrobatika* [Acrobatic. In Albanian]. Tetovë.