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USE OF BIOMECHANICAL ANALYSIS IN VAULTING RIDING

Vavacek Martin [1]*,
Zvonar Martin [2],
Zhanel Jiri [3],
Balint Gheorghe [4],
Duvac Igor [5],
Psalman Vladimir [6]

[1,2,3,5,6] *Masaryk University, Brno, Czech Republic*
[4] *"Vasile Alecsandri" University of Bacau, Str. Marasesti No 157, Bacau, Romania*

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Abstract

Our work focuses on comparing kinematic indices of an exercise figure – a swing, being applied as an introductory exercise in the training of compulsory set of exercises in vaulting. We compared selected kinematic indices, their performance on a horse and on a barrel simulator. Via ex post facto research with the help of substantially logical methods and computer technique we tried to find differences and connections in kinematic indices. Exercises were carried out on a barrel simulator and thereafter on a horse. The follow-up file was formed by 9 top riders from various clubs in the Czech and Slovak Republic. During the research we managed to support more significant dependence between the indices – angular dimension between vertical axis and lower limbs in maximum upper position, in hand stand and distance between hips and a wrist on a horse in motion – where r = 0,833 ($p<0,01$).

1. Introduction

Problems and plenty of publications pursuing scientific research in riding sports are not extensive and mainly in vaulting very rare, though despite it the importance of scientific research starts to be underlined as necessity for the sake of more accurate and better understanding the nodal points of optimal technique when performing exercise figures or training certain motion stereotypes. More detailed was analysed the technique of exercise figures at compulsory set of exercises in the graduation thesis of Klouda (2010) who explored impact of premature tipping of upper body upon performance quality of introductory exercise – a swing. The research was executed with the help of biomechanical motion analysis using video analyser of SIMI MOTION software. The author ascertained that according to actual experience and in comparison with acquired data, a fault in the timing technique of exercise figures, s. c. premature „*lying down*," is the prime cause of unsuccessful attempt, in case of slight fault – less successful attempt. It is namely the matter of deviation from

* *E-mail*: vavacek@fsps.muni.cz, zvonar@fsps.muni.cz , zhanel@fsps.muni.cz,

optimal technique and exercise performance, which further influences the whole exercise figure and can have fatal consequences upon exercise performance itself. The author claims at the same time that it expressly results from acquired facts that the main factor in the researched issue is primarily the correspondence of a rider with horse motion along with proper motion timing of particular physical segments, and not just maximal fixation and speed of lower limbs. On the other hand we can say that without sufficient accelerating of lower limbs the hand stand from sitting position cannot be reached. Acceleration value seems to be individual according to acquired information and undoubtedly dependent on constitutive properties of a sportsman body.

2. Material and methods

Work aim. The aim of our work was to monitor and compare selected biomechanical parameters of introductory exercise technique – a swing, which is an inevitable prerequisite to master compulsory set of exercises by using 3D biomechanical analysis of motion in a group of top vaulting sportsmen. Concurrently we wanted to pursue dependent relation between kinematic indices when exercises are performed on a horse and on a barrel simulator and to compare each other.

Work hypothesis **H1:** Quality of exercise figure - the hand stand, expressed by angular dimension (an angle between vertical axis and lower limbs), as a final position of exercise figure – a swing, shall more significantly depend on distance between sportsman´s hips and wrist in initial phase of an exercise figure riding on a horseback than on a barrel simulator.

Team characteristics The team of experimentees was formed by 9 gymnasts of the jockey clubs: Jockey Club Nitra Kynek, Secondary Vocational School of Agriculture Šaľa, National Stud-farm Toľčianky, University of Veterinary Medicine Košice, Lucky Drásov (Czech Republic), Tlumačov (Czech Republic). The experimentees were at the age from 20 to 30, who actively devote themselves to vaulting and represent their countries at the greatest vaulting events in Europe and worldwide.

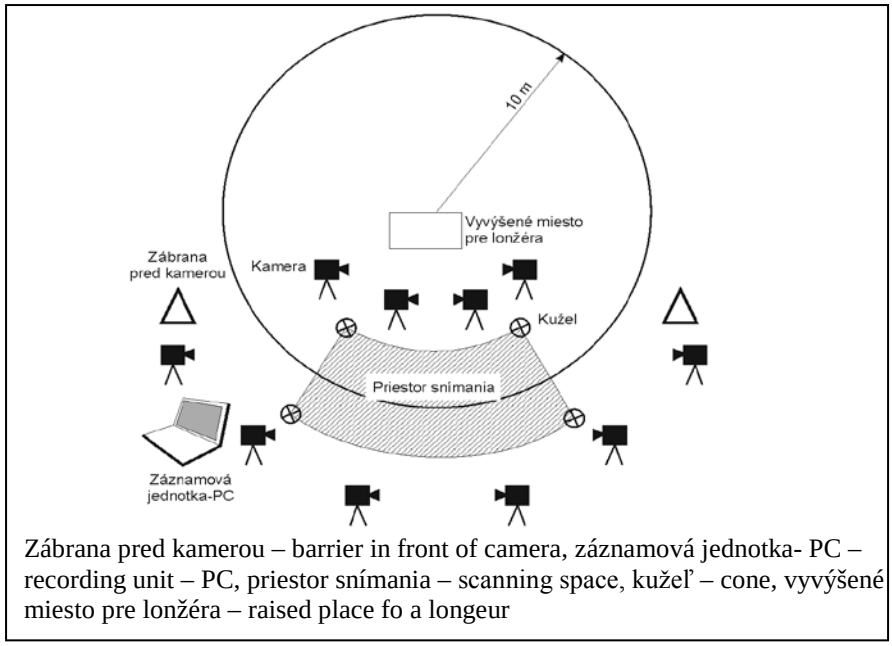
Table 1: *Basic characteristics of follow-up file*

No.	Age	Sport age	BM [kg]	BH [cm]	BMI (I)
1	16	9	54	163	20.32
2	27	17	85	175	27.75
3	26	17	76	178	23.98
4	31	17	75	180	23.14
5	28	17	66	185	19.28
6	30	20	60	168	21.25
7	22	12	70	183	20.90
8	26	14	66	178	20.83
9	23	9	78	178	24.61

Methods of empirical data acquisition and processing

To acquire kinematic indices of motion activity we used video recording enabling to use 3-dimensial analysis of kinograms.

Taking into account that specific exercise is performed on a horse moving in a circle, it is to a great extent problematic to reach upright position of scanning devices. Therefore we decided for a fixed position of cameras in assured distance from exactly set zone on a circle, in which exercises will be performed.



Zábrana pred kamerou – barrier in front of camera, záznamová jednotka- PC – recording unit – PC, priestor snímania – scanning space, kužeľ – cone, vyvýšené miesto pre lonžéra – raised place fo a longeur

Figure 1*: Sketch diagram of cameras layout and of other material equipment*

Herewith we minimize inaccuracy caused by track bending of horse motion (Soumar, 2009). Performing this experiment we applied optoelectronic analyser of Swedish company Qualisys, using high frequency cameras with coincidental usage of passive and active markers for monitoring motion of a measured object.

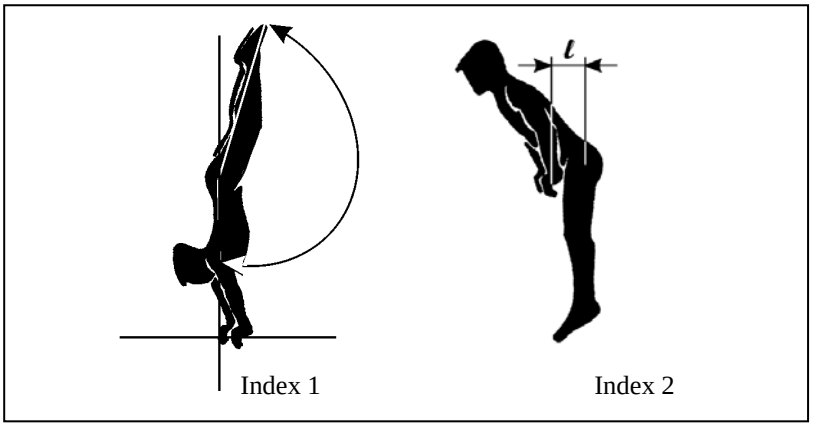


Figure 2

The acquired empirical data were exposed to be processed by mathematic statistics using computer programme Excel and programme software at the Faculty *of Physical Education and Sport, Comenius* University in Bratislava. Particularly monitored indices

were characterized by a median (M), maximum value (x_{max}), minimal value (x_{min}) and extent of variation (Vr). Beside analysis of mathematic statistics we used also following non-parametric assessment methods: *Spearman's* Rank Correlation *Coefficient to express dependent relations among indices.* Statistical significance of relations was assessed at 1%, 5% a 10% significance level.

3. Results and Discussions

Our hypothesis was supported, since angular dimension between vertical axis and lower limbs in maximum upper position, in hand stand – as a final position of exercise figure - a swing, depended more significantly on distance between hips and a wrist of a gymnast in initial phase of exercise figure when riding on a horseback than on a barrel simulator. More significant dependent relation between these indices was recorded in the case of exercise on a horseback, where r=0,833 (p<0,01). More significant dependent relation was not recorded on a barrel simulator. (p=n.s.) We interpret this fact so, that the static barrel simulator is not able to positively or negatively influence motion of a gymnast in the course of exercise in contrast to exercise performance in motion on a horseback. We deem that when a gymnast retracts pelvis from the wrists (from grasp) in motion on a horseback it comes to counterproductive motion actuated by horse gallop, which negatively influences motions of a gymnast in the course of exercise performance.

4. Conclusions

Following our results we recommend trainers and gymnasts to concentrate on eliminating the faults, which are caused by premature retraction of pelvis of a gymnast to tail part of the horse, mainly upon conditions in motion on a horseback. The reasons are those that we recorded non-significant statistic dependent relation between the quality of exercise figure – hand stand, expressed by angular dimension (angle between vertical axis and lower limbs), as a final position of exercise figure – a swing and distance between hips and a wrist of a gymnast in initial phase of exercise figure on a barrel simulator.

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