

Key elements of sports technique in the phase structure of acrobatic exercise that connects moves performed on a beam

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Abstract:

The paper presents new scientific facts of the efficient biomechanical analysis and assessment of the indices of sports technique key elements in the phase structure of acrobatic exercise connecting moves: round-off – double salto backward tucked performed on the beam and round-off – double salto backward tucked during beam dismount, by the method of motion postural cues. Skilled and highly skilled female gymnasts took part in the study. Their average indices of height, body mass and age ($x \pm \delta$) were as follows: 157.5 ± 2.85 cm; 51 ± 2.25 kg; 20 ± 2.35 years, respectively more than nine years of experience in high performance according to the PFG (Polish Federation of Gymnastics) standards. All gymnasts were informed in written and oral way about the assays that would be carried out in the study. All gymnasts signed the informed consent form. Two sequences with the following elements were analysed: round-off – double salto backward tucked performed on the beam (variant I) and round-off – double salto backward tucked during beam dismount (variant II). The highest differences between the key components describing performance of presented exercises exist for joint angles during multiplication and landing position, and resultant velocities during the launching posture and landing position. In variant I the athlete created prerequisites for gliding double salto backward tucked by means of the body segments motions, whereas in variant II he executes faster motions of the body segments accentuating his actions upon backward rotation of the body. In the end of the movement the velocities of the body biolinks and GCM represent the confirmation of controlled motor actions during landing. They have “bunched up” at 1.04 s and 1.10 s in the I and the II variant, respectively with slight “spread” of the body biolinks resultant velocities at the moment of the foot hitting the support during landing. Indices of sports technique key elements in the phase structure of exercises are subjected to development and improvement based on using suggested training programs to enhance the quality of motion control with account for the level of sports fitness, specificity, and complexity of sports exercises.

Key Words: female athletes - round-off - salto backward - double salto backward - tuck position - biomechanical analysis

Introduction

Balance beam exercises are a type of women's gymnastics all-around, symbolizing the priority of accuracy, the elegance of female gymnast movements, perfect regulation of body posture. Modern balance beam exercises are, actually, floor exercises, transferred to narrow support, and including rather complex acrobatic jumps performed by returning to the support and in dismounts, which now acquire the role of exercise difficulty carriers. Balance beam dismount is an important key element of every composition, which often influences the last impression of sports judges and spectators. According to experts in artistic gymnastics events, the completion of the balance beam exercise (dismount) should be performed in accordance with the difficulty of the entire composition, and the specific requirements of the competition. The analysis of female gymnast performances at competitions shows that most of the technical errors in the process of executing salto elements on the balance beam and during beam dismounts are registered during pushing off and landing of athletes [Boloban 2013, Gavardkovsky 2014, Potop 2013, Sadowski et al. 2012, Smolevsky and Gavardkovsky 1999, Boloban and Potop 2014, Niżnikowski et al. 2011].

We have discovered that the method of motion postural cues plays a positive role in the process of teaching sports exercises, which allows analyzing and evaluating the key elements of sports technique. The key element is a signal point (posture) of motion predetermining optimal motor actions in the phase structure of the

exercise. It has been found that the body postures and positions in the structure of competitive exercises predetermine the biomechanics of preceding and subsequent motions: the preceding element (posture) contains the properties (speed-strength, spatiotemporal, tempo-rhythmic, etc.) of the subsequent one. Their optimal ratio enables an athlete to perform an exercise, a connection of exercises with small motor rearrangements without accumulating technical errors [Boloban 2013, Potop 2013, Sadowski et al. 2012, Boloban et al. 2012, Niżnikowski 2009].

Taking into account the multifunctional purpose of acrobatic exercises performed on a balance beam (execution to a stop, the transition to a connection of exercises, as well as the possible development of vertical difficulty, for instance, a subsequent beam dismount – round-off – triple salto backward tucked), the role of correctly assumed and fixed within the optimal time on the support body positions for effective pushing off, rotation and stable landing tend to increase. The successful solution of the tasks of gymnastic, acrobatic exercise biomechanical analysis and the development of modern programs for their mastering will allow putting into action significant reserves of the educational and training process and competitive activity [Gavardovsky 2014, Sadowski et al. 2012, Smolevsky and Gavardovsky 1999, Niżnikowski et al. 2011, King and Yeadon 2003, Huchez 2016, Mkaouer et al. 2012].

Materials and methods

Participants

Skilled and highly skilled female gymnasts took part in the study. Their average indices of height, body mass and age ($\bar{x} \pm \delta$) were as follows: 157.5 ± 2.85 cm; 51 ± 2.25 kg; 20 ± 2.35 years, respectively more than nine years of experience in high performance according to the PFG (Polish Federation of Gymnastics) standards. All gymnasts were informed in written and oral way about the assays that would be carried out in the study. All gymnasts signed the informed consent form.

Objective

To study the kinematic structure of indices of the key elements of sports technique round-off – salto backward tucked performed on a balance beam and round-off – double salto backward tucked during beam dismount; to outline the key elements of sports technique in the phase structure of exercises.

Tasks

1. To perform biomechanical measurements of exercises executed in connections: round-off – salto backward tucked on a balance beam and round-off – double salto backward tucked during beam dismount.
2. To study the kinematic structure of indices of the key elements of sports technique of exercises: round-off – salto backward tucked performed on a balance beam and round-off – double salto backward tucked during beam dismount.

Methods of study

1. Video recording of a connection of exercises round-off – salto backward tucked performed on a balance beam (variant I) and round-off – double salto backward tucked during beam dismount (variant II) with two digital video cameras JVS 6R-DVL 9800 NTSC. The video recording frame rate constituted 240 frames per second. The measurement error constituted 3% [Boloban 2013, Sadowski et al. 2012, Boloban et al. 2012, Sadowski et al. 2013]. The study involved skilled and highly skilled female gymnasts ($n = 16$). Average indices of height, body mass, and age ($\bar{x} \pm \delta$) constituted 157.5 ± 2.85 cm; 51 ± 2.25 kg; 20 ± 2.35 years, respectively.
2. The use of the APAS 2000 computer program (Ariel Dynamice Inc.) to analyze the articular angles of the athlete's movements while performing round-off – salto backward tucked on a balance beam, and round-off – double salto backward tucked during beam dismount with the task of stable landing; the velocities and accelerations of the ankle, knee, hip, shoulder, elbow, wrist joints, and the body GCM; as well as analysis of the body postures and positions on support and in support-free space; the time of the exercise phase execution; the movements of the extremities should be symmetrical during salto performance.

Results

Key elements of sports technique in the phase structure of exercise connecting moves

During the biomechanical analysis of the connections of the exercises, round-off – salto backward tucked performed on a balance beam and round-off – double salto backward tucked during beam dismount, the phase structure of motions was revealed and studied; key elements of sports technique were identified as the motion signal points (postures). The phase structure of motions in the studied connecting moves of exercises was considered as structural and functional integrity, cause-and-effect causality. Fig. 1 illustrates the kinematic structure and displacement trajectory of the body general center of mass (GCM) while performing round-off – salto backward tucked on a balance beam (upper part of the figure, variant I) and round-off – double salto backward tucked during beam dismount (lower part of the figure, variant II). Both connections of exercises ended with a stable landing.

Biomechanical analysis of exercise connecting moves has allowed identifying in the structure of the round-off the key element of sports technique – the launching posture (LP) of the body – biomechanically stable vertical position of the gymnast's body at the end of the round-off in the coordinate system on the support, which

creates efficient conditions for pushing off and directed upward – backward flying up to the main phase of motor actions; whereas in the phase of main motor actions – the key element of sports technique is the multiplication of "tuck" posture (MP) of the athlete's body. Multiplication of "tuck" body posture is a process of sequential alternation of a tucked body position to create a dynamic integral motor action determining and characterizing the composition of the exercise; in the final phase – the key element of sports technique is the concluding posture (CP) of the body – landing, which is consistent with the studies [Boloban 2013, Potop 2013, Sadowski et al. 2012, Boloban and Potop 2014, Niżnikowski 2009, Sadowski et al. 2009].

Skilled and highly skilled female gymnasts took part in the study. Their average indices of height, body mass and age ($x \pm \delta$) were as follows: 157.5 ± 2.85 cm; 51 ± 2.25 kg; 20 ± 2.35 years, respectively more than nine years of experience in high performance according to the PFG (Polish Federation of Gymnastics) standards. All gymnasts were informed in written and oral way about the assays that would be carried out in the study. All gymnasts signed the informed consent form.

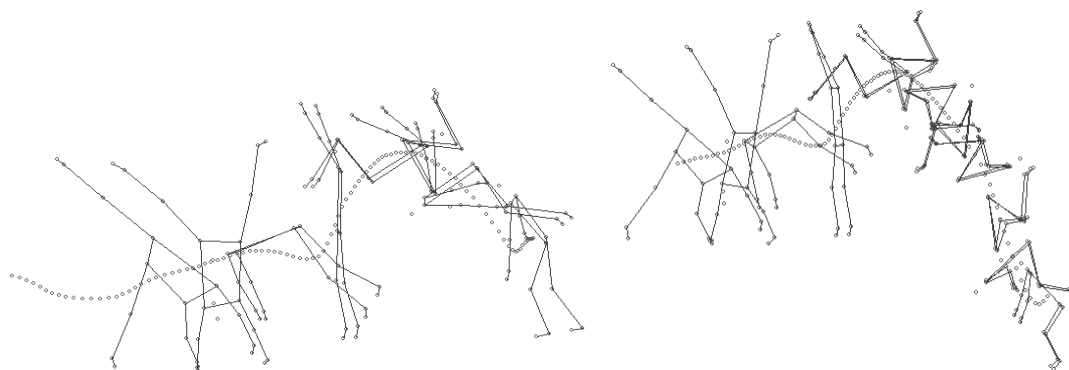


Fig. 1. Kinematic structure and displacement trajectory of the general center of mass (GCM) of female athlete body while performing the connection of exercises round-off – salto backward tucked on a balance beam (upper part of the figure, variant I) and round-off – double salto backward tucked during beam dismount (lower part of the figure, variant II). Both connections of exercises ended with a stable landing.

The phase of preparatory motor actions

A biomechanical analysis of the indices that characterize the LP as a key element of the final motor actions of the round-off preceding salto backward tucked on a balance beam (upper part of the figure, variant I, time 0.08 s) was performed. The body LP was registered in front of the vertical (thigh-trunk angle in variant I – 171.67° – with arms raised forward-upward, on tiptoe in a narrow stand with feet astride, one leg in front of the other. The body launching posture during the final motor actions of the round-off preceding a double salto backward tucked while dismounting from a balance beam (lower part of the figure, variant II, time 0.08 s) is characterized by a slightly closed body position (thigh-trunk angle in variant II – 168.93°) on tiptoe on a support, in a narrow stand with feet astride, one leg in front of the other, in front of the vertical, arms forward-upward. The indices of biomechanical analysis of the performed exercise connecting moves indicate both the identity of the body launching postures and their difference (Fig. 2).

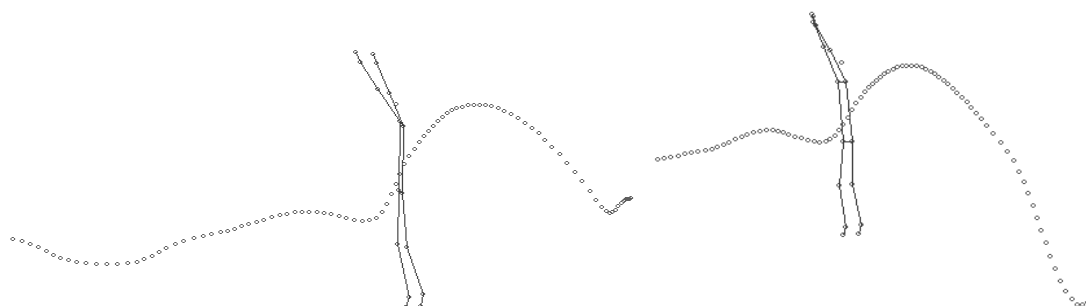


Fig. 2. The phase of preparatory actions – the key element of sports technique – the body launching posture at the phase of the round-off final actions in connections of exercises round-off – salto backward tucked on a balance beam (upper part of the figure, variant I, time 0,08 s) and round-off – double salto backward tucked during beam dismount (lower part of the figure, variant II, time 0,08 s).

In the upper part of Fig. 3, variant I (time 0,08 s) illustrating the performance of the connecting move of exercises round-off – salto backward tucked on a balance beam, the flying up to salto is preceded by the final phase of the round-off, which is characterized by a high speed of the body biolinks motions: the speed of ankle

joint motion at 0,08s was equal to 3,09 m/s, that of knee joint – 3,00 m/s, that of hip joint – 2,99 m/s, that of shoulder joint – 3,75 m/s, that of elbow joint – 5.99 m/s, and that of wrist joint – 8,49 m/s, which resulted in insufficiently coordinated curves of the velocities (resultant) of athlete body biolinks during short-term LP fixation on support before pushing off due to foot placement on support with increasing motion speed in the courbette part of the round-off, leading to some “spread in curves” of the body biolinks velocities.

The lower part of the Fig. 3, variant II (time 0.08 s) shows the trajectories of the resultant velocities of the body biolinks displacement and that of the body GCM during short-term fixation of the LP in the final phase of the round-off while performing a connection of exercises round-off – double salto backward tucked during beam dismount. The feet-support interaction is of elastorigid character.

Short-term maintenance of the LP on the support during a round-off execution in a connection of exercises round-off – double salto is typical and indicates positive coordination of the body vertical position on the support. It is demonstrated in Fig. 3 by “bunching up” the curves of the resultant velocities of the body biolinks, which allows the athlete to perform a technically accurate entry into the main phase of the acrobatic connection of exercises through pushing off. As far as the performers were highly skilled female gymnasts, we attributed the revealed peculiarities of their launching body posture execution to the individual style of sports technique and considered them as an opportunity to further improve the motor skill of performing this key element of sports technique – the body launching posture.

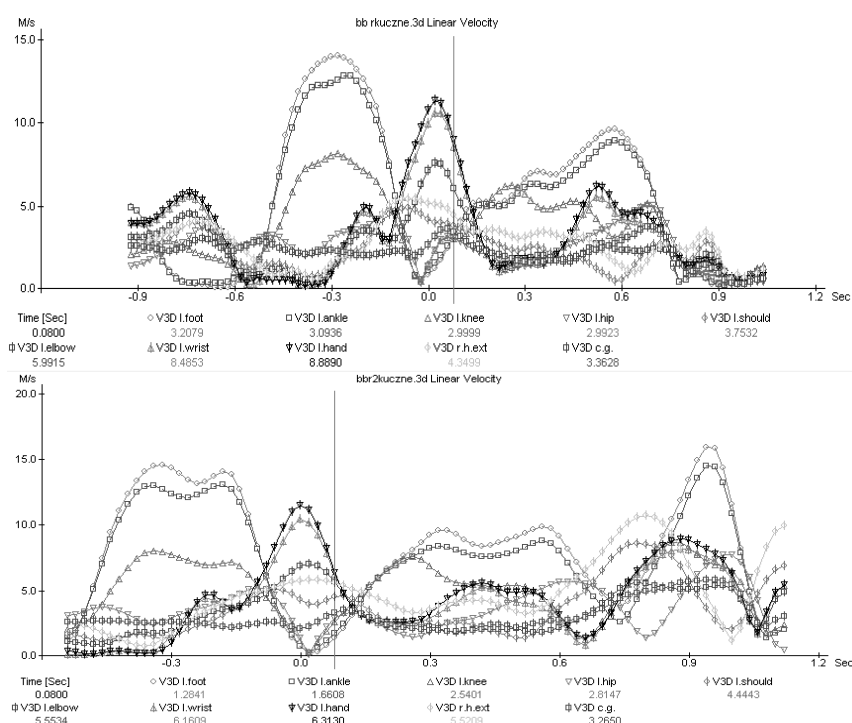


Fig. 3. Trajectories of the resultant velocities of displacing the ankle, knee, hip, shoulder, elbow, and wrist joints as well as the athlete body GCM during short-term fixation of the LP in the final phase of the round-off (phase of preparatory motor actions) while performing a connection of exercises: round-off – double salto backward tucked during beam dismount (upper part of the figure, variant I); round-off – double salto backward tucked during beam dismount (lower part of the figure, variant II). Legend: ankle – ankle joint, knee – knee joint, hip – hip joint, shoulder – shoulder joint, elbow – elbow joint, wrist – wrist joint, c.g. – the general center of mass (GCM) of the body.

The resultant velocities of the vertical and horizontal constituents of the body biolinks and GCM (Fig. 3) while performing the connecting moves of exercises round-off – salto backward tucked on a balance beam (upper part of the figure, variant I) and round-off – double salto backward tucked during beam dismount (lower part of the figure, variant II) and assuming the body LP are differentiated. In variant I, the velocity of the ankle joint motion at a time of 0.08 s was 3.09 m/s, that of knee joint – 3.00 m/s, that of hip joint – 2.99 m/s, that of shoulder joint – 3.75 m/s, that of elbow joint – 5.99 m/s, and that of wrist joint – 8.49 m/s, whereas in variant II – 1.66 m/s, 2.54 m/s, 2.81 m/s, 4.44 m/s, 5.55 m/s, and 6.16 m/s, respectively. The body GCM was displaced at a time of 0,08 s at a speed of 3,36 m/s and 3,27 m/s in the I and the II variant, respectively. The reason for such differentiated velocities (especially that of the shoulder joint – variant I – 3.75 m/s, variant II – 4.44 m/s, and the wrist joint – variant I – 8.49 m/s; variant II – 6.16 m/s) is the difference in exercise difficulty. In variant II, the athlete properly positions the body biolinks in terms of biomechanics, with her arms raised forward-upward above the support – LP, trying to ensure that the ballistic wave of the system impulse of force, being in

elastorigid state, and the resistance of the support to the elastically rigid state of the athlete's body coincide. This allows the gymnast to perform a high upward-backward jump and more than 1/2 turn in the first salto on the ascending part of the flight trajectory.

The phase of the main motor actions

The key element of sports technique is the multiplication of the body posture (MP) of salto backward tucked (variant I at a time of 0.28 s) and the multiplication of the body posture (MP) of double salto backward – tucking (variant II at a time of 0.26 s). The hip-trunk angle is equal to 101,03° and 109,23° in the I and the II variant, respectively (Fig. 4).

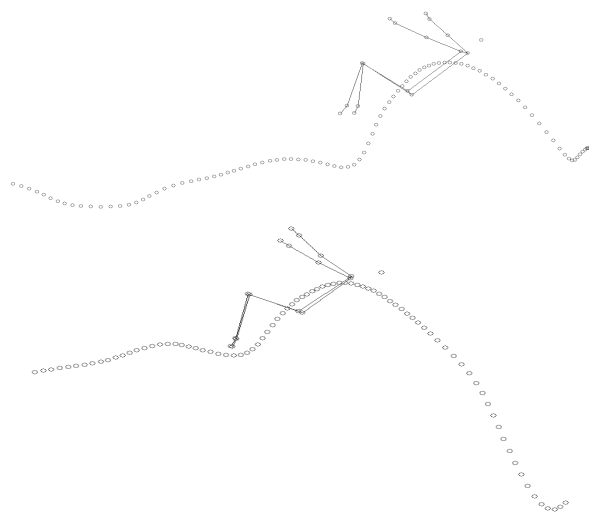


Fig. 4. The phase of the main motor actions. The key element of sports technique – MP of the tucking – in a connection of round-off – salto backward tucked on a balance beam (variant I at a time of 0,28 s) and the body MP of double salto backward tucked in a connection of round-off – double salto backward tucked during beam dismount (variant II at a time of 0,26 s).

Fig. 5 shows the trajectories of the resultant velocities of displacing the ankle, knee, hip, shoulder, elbow, and wrist joints as well as the athlete body GCM in the phase of the main motor actions – MP of tucking while performing a salto in a connection of round-off – salto backward tucked on a balance beam (upper part of the figure, variant I at a time of 0,28 s) and round-off – double salto backward tucked during beam dismount (lower part of the figure, variant II at a time of 0,26 s). They reveal the cause-and-effect dependences of the energy transfer from previous motions (postures) to subsequent ones. Thus, increased velocity of the ankle and knee joint motions on the ascending part of the flight trajectory are recorded, which activate motor actions – rotation around the transverse axis.

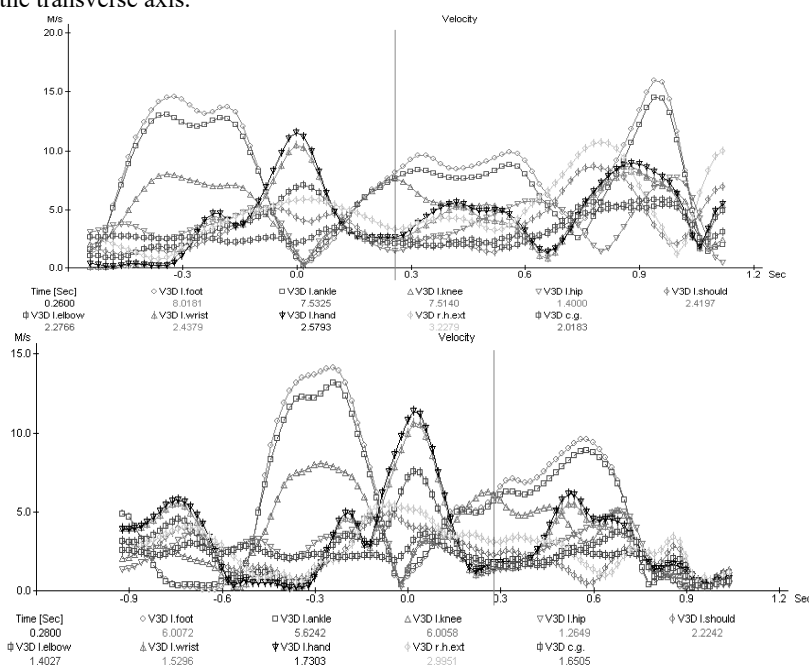


Fig. 5. Trajectories of the resultant velocities of displacing the ankle, knee, hip, shoulder, elbow, and wrist joints as well as the athlete body GCM in the phase of the main motor actions – MP of the body while performing round-off – salto backward tucked on a balance beam (upper part of the figure, variant I at a time of 0,28 s) and round-off – double salto backward tucked during beam dismount (lower part of the figure, variant II at a time of 0,26 s). Legend – see Fig.3.

In variant I, the velocity of motions in the ankle joints increased from 0.08 s to 0.28 s by 5.62 m/s, that in knee joints by 6.01 m/s; that in hip joints by 1.26 m/s, that in shoulder joints by 2.22 m/s; it decreased in the elbow and wrist joints by 1.40 m/s and 1.53 m/s, respectively; in variant II (0.08-0.26 s) the velocity increased in the ankle, knee, and hip joints by 7.53 m/s, 7.51 m/s, and 1.40 m/s, respectively, whereas in the shoulder, elbow and wrist joints it decreased by 2.42 m/s, 2.28 m/s, and 2.44 m/s, respectively. The body GCM is displaced at a speed of 1.65 m/s and 2.02 m/s in the I and the II variant, respectively.

In the further part of the MP of the body (Fig. 6) – the athlete performs the first salto on the ascending segment of the flight trajectory in the structure round-off – salto and round-off – double salto (variant I, time 0.44 s, the thigh – trunk angle constitutes 62.19°; variant II, time 0.46 s, the thigh – trunk angle constitutes 74.01°).

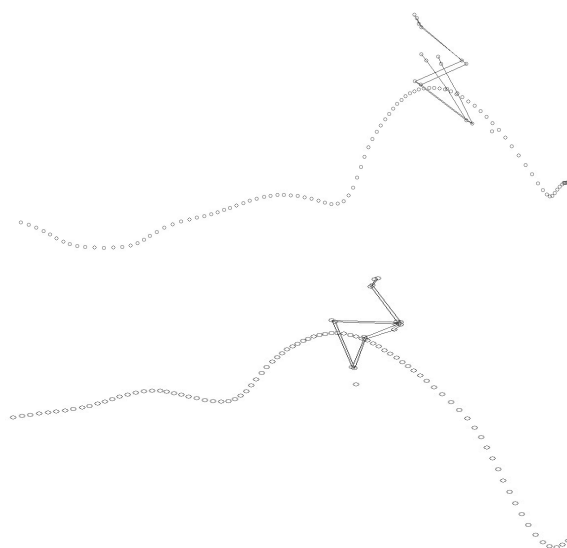
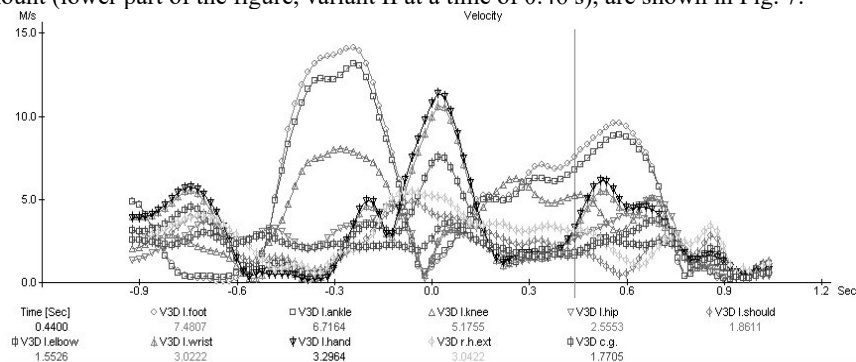


Fig. 6. The phase of the main motor actions. The key element of sports technique – MP tucking – in a connection of exercises round-off – salto backward tucked on a balance beam (variant I at a time of 0,44 s) and MP of the body in a connection of exercises round-off – double salto backward tucked during beam dismount (variant II at a time of 0,46 s).

The gymnasts are tightly tucked in both variants (Fig. 6): to prepare for landing (variant I), and to maintain the speed of rotation, and to prepare for the execution of a non-stop "entry" into the second salto in the structure of a double salto in variant II and landing. The trajectories of the resultant velocities characterizing the displacements of the ankle, knee, hip, shoulder, elbow, wrist joints, as well as the GCM of the body of athletes in the phase of the main motor actions – MP of the body while performing round-off – salto backward tucked on a balance beam (upper part of the figure, variant I time 0.44 s) and round-off – double salto backward tucked during beam dismount (lower part of the figure, variant II at a time of 0.46 s), are shown in Fig. 7.



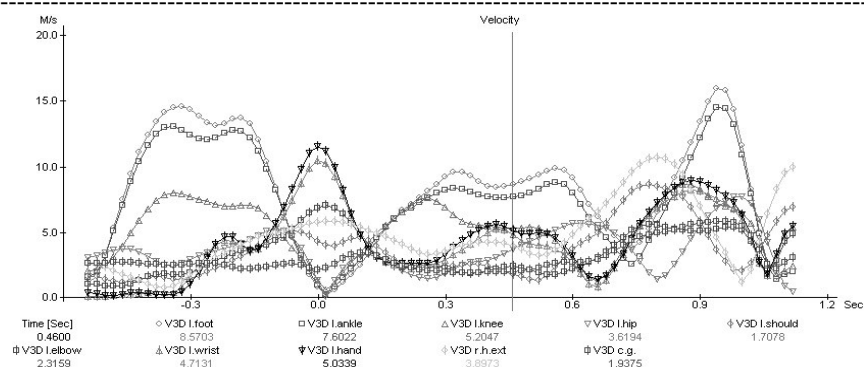


Fig. 7. Trajectories of the resultant velocities of displacing the ankle, knee, hip, shoulder, elbow, and wrist joints as well as the athlete body GCM in the phase of the main motor actions – MP of the body while performing round-off – salto backward tucked on a balance beam (upper part of the figure, variant I at a time of 0,44 s) and round-off – double salto backward tucked during beam dismount (lower part of the figure, variant II at a time of 0,46 s). Legend – see Fig. 3.

As is shown in Fig. 7, in variant I the velocity of motion of ankle, knee, hip, shoulder, elbow, and wrist joints at 0,44 s is equal to 6,72 m/s, 5,18 m/s, 2,56 m/s, 1,86 m/s, 1,55 m/s and 3,02 m/s, respectively, whereas in variant II (0,46 s) – 7,60 m/s, 5,20 m/s, 3,62 m/s, 1,71 m/s, 2,32 m/s and 4,71 m/s, respectively. The velocity of the body GCM in variant I (at 0,44 s) constitutes 1,77 m/s, whereas in variant II (at 0,46 s) – 1,94 m/s.

The phase of final motor actions

Gymnasts are carrying out motor preparation for landing – a key element of sports technique (concluding body posture – CP) in variant I, the upper part of the figure (at 0.62 s), and in variant II, the lower part of the figure (at 1.00 s). Their preparation for landing is characterized by descending flight trajectories, articular angles (in variant I, the thigh-trunk angle constitutes 91.22° , in variant II – 69.86°) (Fig. 8) as well as presented in Fig. 9 trajectories of the resultant velocities of displacing the ankle, knee, hip, shoulder, elbow, wrist joints and the GCM of the body of athletes in the phase of final motor actions while performing the connecting moves of the exercises: round-off – salto backward tucked on a balance beam (upper part of the figure, variant I at 0,62 s) and round-off – double salto backward tucked during beam dismount (lower part of the figure, variant II at 1,00 s).

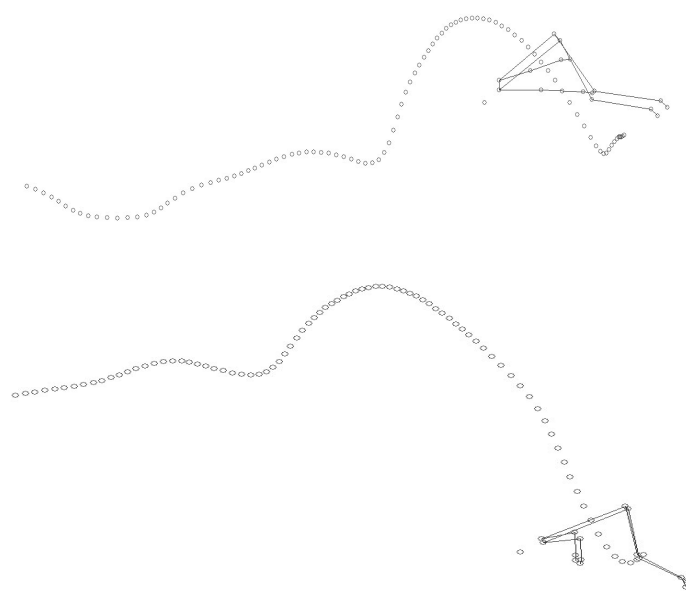


Fig. 8. The phase of final motor actions while performing a connection of exercises round-off – salto backward tucked on a balance beam (upper part of the figure, variant I at 0,62 s) and that of round-off – double salto backward tucked during beam dismount (lower part of the figure, variant II at 1,00 s).

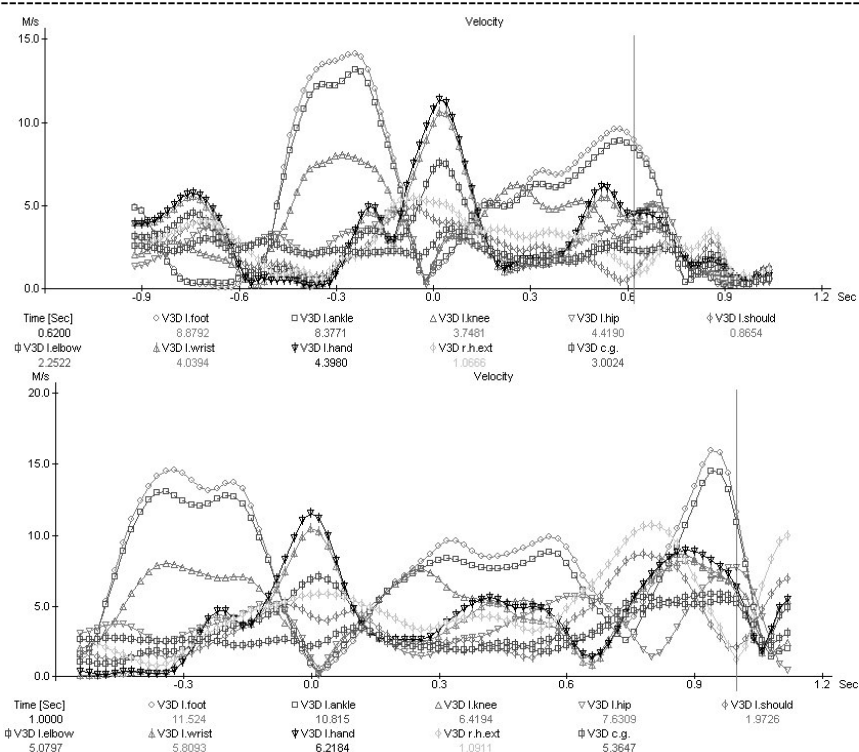


Fig. 9. Trajectories of the resultant velocities of displacing the ankle, knee, hip, shoulder, elbow, and wrist joints as well as the athlete body GCM in the phase of final motor actions – (CP) of the body while performing a connection of exercises round-off – salto backward tucked on a balance beam (upper part of the figure, variant I at 0,62 s) and that of round-off – double salto backward tucked during beam dismount (lower part of the figure, variant II at 1,00 s). Legend – see Fig. 3.

In variant I, the velocity of motion of the ankle, knee, hip, shoulder, elbow, and wrist joints at 0,62 s constitutes 8,38 m/s, 3,75 m/s, 0,87 m/s, 2,25 m/s, and 4,04 m/s, respectively, whereas in variant II (at 1,00 s) 10,82 m/s, 6,42 m/s, 7,63 m/s, 1,97 m/s, 5,08 m/s, and 5,81 m/s. The velocity of the body GCM is equal to 3,00 m/s, and 5,36 m/s in the I and the II variant, respectively (Fig. 9).

Fig. 10 displays CP of the body in the phases of final motor actions – steady landing (upper part of the figure, variant I – 1,04 s, lower part of the figure, variant II – 1,10 s.). The hip-trunk angle is equal to 153,31°, and 117,46° in the I and the II variant, respectively. Video analysis, pedagogical observations enable us to conclude that in variants I and II the gymnasts demonstrate an elastically rigid interaction of the extremities with support, which contributed to assuming the optimal CP – a half-knee bend with forward half bent, arms forward-downward (variant I) and a half-knee bend with forward half bent, arms forward-downward (variant II).

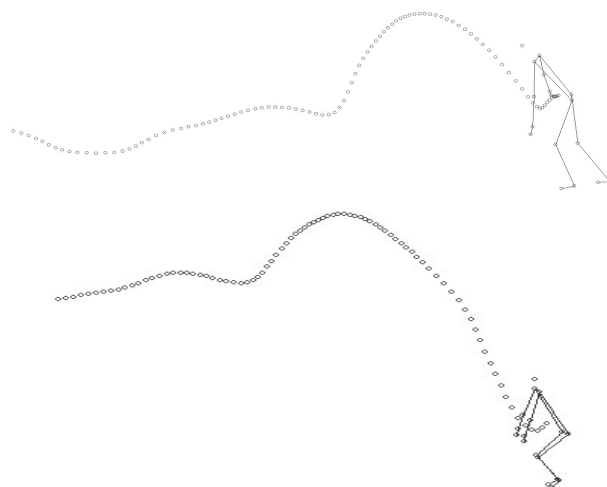


Fig. 10. The phase of final motor actions – landing while performing a connection of exercises round-off – salto backward tucked on a balance beam (upper part of the figure, variant I at 1,04 s) and that of round-off – double salto backward tucked during beam dismount (lower part of the figure, variant II at 1,10 s).

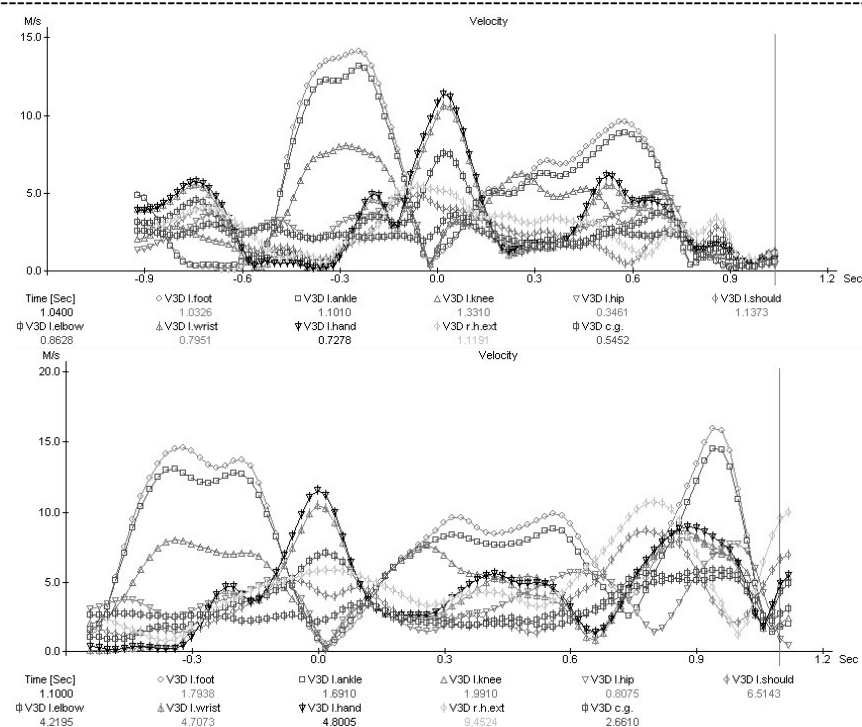


Fig. 11. Trajectories of the resultant velocities of displacing the ankle, knee, hip, shoulder, elbow, and wrist joints as well as the athlete body GCM in the phase of final motor actions – (CP) of the body while performing round-off – salto backward tucked on a balance beam (upper part of the figure, variant I at 1,04 s) and double salto backward tucked on a beam after executed round-off (lower part of the figure, variant II at 1,10 s). Legend – see Fig. 3.

Fig. 11 demonstrates trajectories of the resultant velocities of the body biolinks displacements. In variant I, the velocity of the ankle, knee, hip, shoulder, elbow, and wrist joints at 1,04 s constitutes 1,10 m/s, 1,33 m/s, 0,35 m/s, 1,14 m/s, 0,86 m/s, and 0,8 m/s, respectively, whereas in variant II (1,10 s) 1,69 m/s, 1,99 m/s, 0,81 m/s, 6,51 m/s, 4,22 m/s, and 5,656 m/s, respectively. The GCM displacement occurs at a speed of 5,811 m/s, and 4,71 m/s in the I and the II variant, respectively. The body postures in support position characterize the key element of sports technique – CP, i.e., the posture of landing (half-knee bend with forward half bent) (in variant I the feet in support position are placed one in front of the other, arms forward-downward). The velocities of the body biolinks and GCM represent the confirmation of controlled motor actions during landing. They have “bunched up” at 1,04 s and 1,10 s in the I and the II variant, respectively with slight “spread” of the body biolinks resultant velocities at the moment of the foot hitting the support during landing (Fig. 11, variant II).

Discussion

The analysis of scientific and methodical literature, practical experience indicate the importance of studying the technique of gymnastic, acrobatic exercises, and teaching them with account for the knowledge of the athlete body posture and position. In this regard, V.N. Boloban and E.V. Biryuk suggested using the method of motion postural cues and its key elements to study the technique of exercises in artistic gymnastics events [Boloban 2013]. The method of motion postural cues is a way of biomechanical research of sports exercises through analysis of preceding and subsequent body postures and positions, and their multiplication in the phase structure of the performed exercise, in order to get to know the key elements of sports technique. The findings imply to believe that the conceptual essence of the method of motion postural cues is that each previous body posture in the performed exercise should positively influence the biomechanics of the subsequent one, carry the properties that allow smooth exercise performance without unnecessary motor rearrangements so that to avoid the accumulation of technical errors during the demonstration of the exercises. The key elements of sports technique play a positive role in the process of teaching exercises, as they provide a basis for designing a didactic structure for the formation of motor action skills in the phase structure of a sports exercise [Potop 2013, Sadowski et al. 2012, Boloban et al. 2012, Boloban and Potop 2014, Niżnikowski 2009, Sadowski et al. 2009, Sadowski et al. 2013]. In that respect, the method of motion postural cues underlies the practical methodology of biomechanical – didactic improvement of technical preparation and technical fitness in sports events with a complex coordination structure of movements through the realization of indices of sports technique key elements in the phase structure of exercises (a connection of exercises, transition from one motor action to the subsequent motor action in one exercise, the transition to the next composition element, firm stand – steady landing). Biomechanical studies and pedagogical experiments confirmed the expediency of using the method of motion

postural cues as an efficient way of analyzing and assessing the elements of sports technique and the basis for the elaboration of didactic technologies for teaching sports exercises of various coordination complexity [Boloban 2013, Boloban et al. 2012, Niżnikowski 2009, Sadowski et al. 2009]. Along with the results obtained in gymnastic events, positive results were secured in track and field. For instance, in some studies [Romanov et al. 2011], recommendations are given to use the postural method for teaching the technique of track and field running. The authors single out three postures: the posture of running, that of attack and that of hurdle dismount; in high jumps – the posture of running, that of exit, and that of above the bar; in long jumps: the posture of running (during run-up and flight by the scissor technique), step out posture (during take-off) and landing posture. The authors also emphasize that the subject of training should be the body posture and reproduction of postures.

Conclusions

1. In the phase structure of the connecting moves of exercises: round-off – salto backward tucked performed on a balance beam and round-off – double salto backward tucked during beam dismount, the key elements of sports technique were revealed by the method of motion postural cues. It was found that the key element of sports technique is the motion signal point (posture) predetermining the effective subsequent motor actions in the phase structure of the exercise connecting move. It was proved that signal points (poses) in the examined connecting moves of exercises are: launching posture (LP) of the body (biomechanically rational body posture in support position for efficient flying up to salto), multiplication of the body postures (MP) (sequential alternation of instantaneous fixed postures to create an integral motor action), concluding posture (CP) of the body (firm stand-landing to stop).

2. The biomechanical structure of the key elements of sports technique of exercise acrobatic connecting moves round-off – salto backward tucked performed on a balance beam and round-off – double salto backward tucked during beam dismount, is characterized by individual biomechanical indices of executing the launching body posture, multiplication of the body postures and concluding body posture: articular angles of movements of athletes, velocities of the ankle, knee, hip, shoulder, elbow, wrist joints, and the body GCM; body postures and positions on support and in support-free space; the time of the exercise phase execution.

3. Indices of sports technique key elements in the phase structure of exercises are subjected to development and improvement based on using suggested training programs to enhance the quality of motion control with account for the level of sports fitness, specificity, and complexity of sports exercises.

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