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THE IMPACT OF THE INRUN POSITION ADJUSTMENT ON THE IMPROVEMENT OF THE SECOND AND THIRD PHASE IN SKI JUMPING

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Abstract: *Ski jumping requires great precision during the execution of each of its four phases, as a result of its complex technical components. The objective of this study consists in the improvement of each athlete's technical skills focused on the first phase, with a view to creating the pre-requisites for the improvement of the second and third phase. To achieve this, we used various specific training tasks consisting of imitative exercises applied continuously by using the proprioceptive method, as well as jumps on the HS 71 and HS 100 hills, with specific tasks for the first phase of the jump for each athlete. The evaluation of the ski jumpers' performances was completed objectively in different positional aspects specific to the first phase for ski jumping. The success in adopting and maintaining the inrun position while passing through R1, under the exerted forces on the jumper-ski system and focusing on the correct distribution of the general mass center, created the possibility of improving the indicators of sports performance in the individualized training process.*

Keywords: *ski jumping, phase I – the inrun and the takeoff, positional aspects of the athlete specific to phase I, jump joints, ankle joint angles*

1. Introduction

The major investment in this sport started in 2007 in our country had among its endpoints the ranking of a Romanian athlete among the top 10 athletes in high profile competitions worldwide. Although a total of 40 athletes, along with nine specialists in this field started enthusiastically to achieve this objective in 2007, we now realize that over 90% of these athletes, who had good results during their sports activities in ski jumping, are no longer active in this sport. There are multiple causes for the dropout from sport. The fact is that only one of them managed to continue after the age of 20. We note that international athletes continue their activity with outstanding results at ages of 30 or more. It can also be noted that many teachers / coaches, with outstanding results in their sport and coaching activity, are no longer members of the current teams or reveal a low professional motivation.

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With the above-mentioned facts as a starting point, this study was conducted on three athletes who dropped a period of several months from elite athlete performance. They practiced systematically and continuously complementary sports during that time, after which they were reintegrated into the process of ski jumping training in 2015. Currently, these athletes are members of the Ski Jumping Department of CSU Braşov, former members of national teams, young valuable athletes and aged 17 to 20.

The primary objective of this study was to improve technical performance for each athlete through interventions on specific actuator in Phase I - inrun.

2. Considerations on the Technical Components in Ski Jumping

The acyclic nature of the technical content in ski jumping is determined by the relation space-time, so that a full implementation of jumping on the hill is divided into four main phases: I. Start and inrun phase, II. Takeoff phase III, Flight phase and IV. Landing phase [1].

The quality attained during Phase I, due to the actions of the athlete who tries to adopt the inrun position, determines the quality of sliding speed (aerodynamics position), a correct distribution of the general mass center (GMC) and maintaining the effectiveness of tension in the jump joints (ankles, knees and hip-femoral joint). All this creates the prerequisites for obtaining a good timing represented by an effective takeoff with maximum force at the edge of the hill table. Therefore, adopting a correct inrun position has a major impact on all the other ski jumping phases.

Adopting and maintaining a position on the inrun are influenced by many factors such as:

-Anthropological particularities of individuals,

- Concentration - tiredness,
- Glancing forward in order to vizualize the inrun track, followed by specific actuator position on the adoption of the inrun position,
- Height of the start platform,
- Various angles of the inclination of the inrun,
- Sliding speed,
- Upward speed on the inrun,
- Resistant factors (skis, snow etc.)
- Maintaining tension in the jump joints when passing through the transition curve R1, where the influences of centrifugal forces, centripetal, gravity, as well as air resistance and strength are passed on technical performance,
- BMI index, influenced by ongoing hours of training and competitions in relation to the hours of nutrition of the jumping athletes, as well as their diet outside their sports performance etc.

All these factors will have a significant impact on the adoption of an effective position on the inrun. As for the timing at the moment of takeoff, the following aspects must be considered: "encoding the information and taking the decision will take longer than receiving the information and initiating the response, but all four activities are executed prior to the real movement. So the reaction time does not include the movement. It represents the time from the stimulus momentum to the beginning of the movement. The motion time represents the period of the completion of the task since its initiation to the end. The response time represents the time from when the stimulus occurs until the task is completed; it represents the sum of reaction time and movement time." [6].

Influences induced by the Phase I of the jump on phases II and III are extremely important. Referring to the ratio of ballistic and aerodynamics, Paul Ganzenhuber, quoting Hochmuth, demonstrates that, since 1976, he has reached the conclusion that "if the center of gravity is 3 ° higher and the flight speed is 23 m / sec, the jumped distance - on a HS71 m hill - lengthens with 9 to 14 m. " [3].

In 1926, Straumann established that maintaining the speed and entering as soon as possible in an optimal flight position represent the most important factors for the takeoff. "A jumper succeeds his best when using a little force at takeoff " [7].

Researches conducted by Janura and others reveal that excessive openness of the trunk during takeoff determines the general mass center to move backward. [4].

Referring to the identification of a general model in adopting the position on the inrun, Vaverka points out, based on the studies that were carried out, that it is not possible to define a general model, each coach being responsible for applying a personalized model. [10].

Other studies that were performed on the force plate confirmed that the vertical acceleration at takeoff is given too much importance. Tveit and Pedersen believe it is much more important to determine how you can move faster from the aerodynamic position before takeoff to the aerodynamic position after takeoff with minimal resistance from the air [9]. By using the video analysis technique, it was shown that less than 20% of the changes in the jumped distances can be explained on the basis of the changes in the takeoff parameters. In the same context, he considered that a higher speed when performing the takeoff from the hill table influences the length of the jumps [2]. According to Troxler and Ruegg, the force of momentum and the time parameters are important indicators for a good jump [8].

A jumper can accelerate his horizontal speed obtained on the hill table, with the purpose of an ideal takeoff using theoretical models. This requires a compromise between optimum ballistics and aerodynamics, since ballistics is very important for achieving high takeoff on the hill table. At the same time, the jumper must constantly optimize his aerodynamic flight position [3].

To get the maximum height, the general mass center of the jumper (GMC) should be placed along the action line of the vertical reaction force to the ground, since the generation of angular momentum requires that GMC should be placed prior to this line. Evidence shows that the high-performance jumps are characterized by higher speeds of the knee extension and at the same time, a faster descending angle when performing the takeoff from the hill table [5].

The above-referenced ideas highlight the complexity of the takeoff mechanism, as well as the fact that a theoretically perfect model for this phase of ski jumping / flying has not been identified yet.

All this laid the groundwork for the present study, which allowed us to develop the following hypothesis.

3. The Hypothesis

Adopting a customized inrun position for each athlete will help maintaining a stable general mass center, as well as angles and tension in jump joints. These elements will create an optimum ratio between ballistic and aerodynamics at the moment of takeoff and will allow to accomplish some longer flights.

4. Methodology of Experimental Activity

4.1. Subjects

The study was performed on the members of the Ski Jumping Department of CSU Brasov (three junior athletes). The research was carried out between 1 to 15 November 2015 at the base of ski jumping complex in Râşnov and the gym in Săcele.

4.2. Used Materials

Ski jumping, takeoff support, takeoff stroller, position keeping flight harnesses, goniometer, digital camera and video camera.

4.3. Methods

As part of the research approach, we used the bibliographic method in order to gain a more in-depth theoretical knowledge related to the ski jumping phases, as well as the case study method.

The research approach also involved the use of imitative exercises to adopt the takeoff position and reach the stereotyped movement, i.e. the automatism at takeoff.

The test method

Test I – the goniometric test – has been tested on the three subjects who were asked to adopt the inrun position, knees apart at shoulder's level, then neared at chest level. Measurements have been carried out of the angle made at the level of the joint of the ankles, as well as of the height of the inrun position in comparison with the position of the knees.

Tests:

Test A. – The adoption of the inrun position with knees apart (the measurement of the angle at the joint of the ankles and of the height of the inrun position), dated 02.11.2015.

Test B. - The adoption of the inrun position with knees close together (the measurement of the angle at the joint of the ankles and of the height of the inrun position), dated 12.11.2015.

Fig. 1. *The evaluation of the angle for the joint of the ankles*
[photographs: Wilhelm Grosz, 2015]

The testing conditions were similar and the time of the testing was 19:00.

Test II consisted in complete executions on the HS 71 m and HS 100m hills. The lengths of the jumps were converted to points according to FIS regulations, namely the value of a meter on the HS 71 m hill is of 2,4 points, and on the HS 100m hill of 2 points.

The set of tests consisted of:

-Test II. 1 and II. 3 Six jumps on the HS 71m hill for each test, on 03.11.2015 and 10.11.2015, three executions with the knees apart and three executions with the knees close together, for the adoption of the inrun position;

-Test II.2 and II.4. Six jumps on the HS 100m hill for each test, on 03.11.2015 and 10.11.2015, three executions with the knees apart and three executions with the knees close together, for the adoption of the inrun position.

The testing conditions used the same position of the start bar, number 12 for HS 71m and number 30 for HS 100m, the weather conditions were identical and the start time was 16:00.

Fig. 2. *The inrun position after passing through R1*
[photograph: Wilhelm Grosz, 2015].

4.4. Statistical Transformations

The data obtained were transformed and interpreted by using Word and Excel programs.

5. Results

After conversion of the collected data from **Test I – The Goniometric Test** and **Test II – Complete executions** into points, they were centralized in tables and they were the basis for drawing up charts.

6. Research Data Interpretation

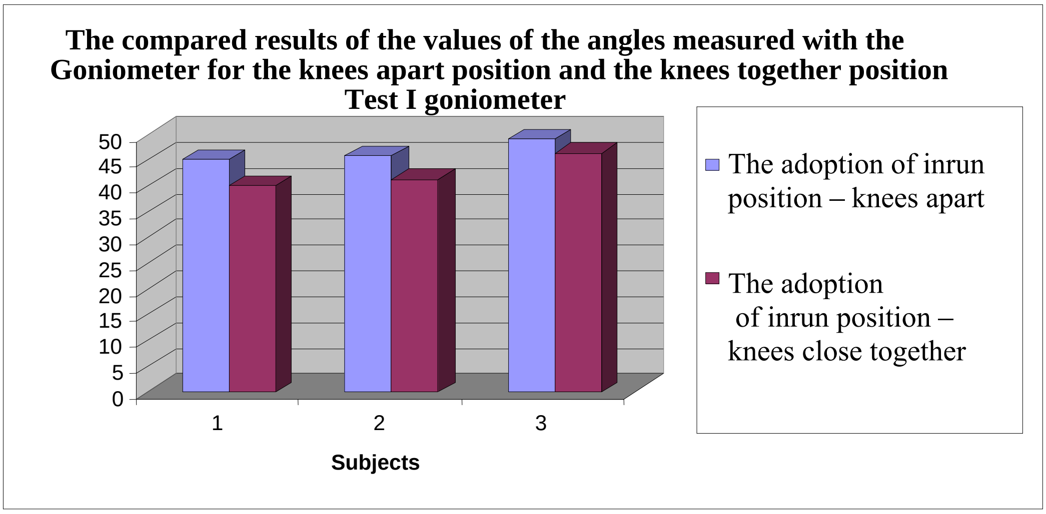

Fig. 3. *The representation of the average angles measured in the joint of the ankles during the two demonstrations – the adoption of the inrun position during imitative exercises on 02.11.2015 and 12.11.2015*

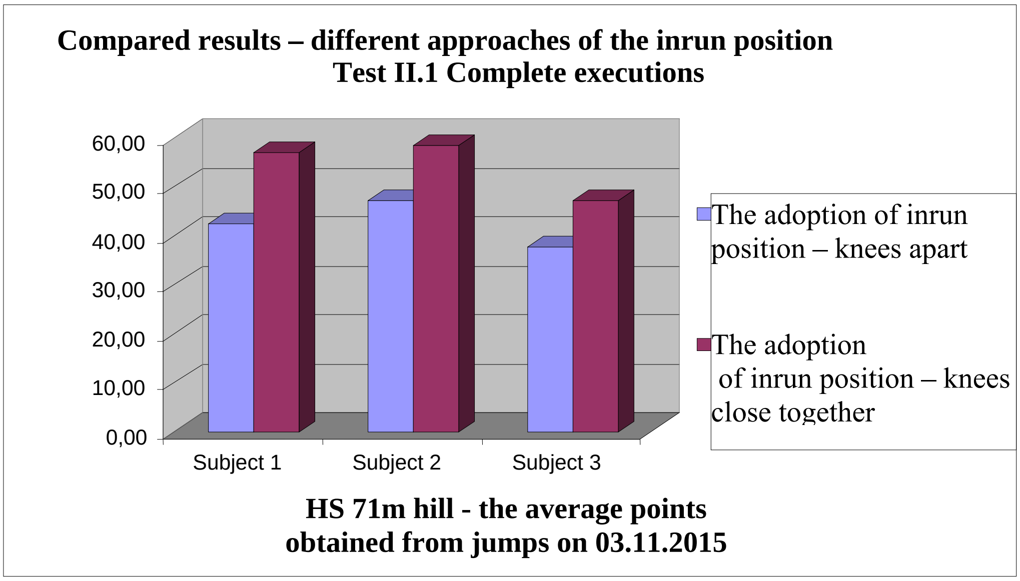

Fig. 4. *The representation of the average points of the length of the jumps during test II on the HS 71m hill obtained by the three subjects – different approaches of the inrun position*

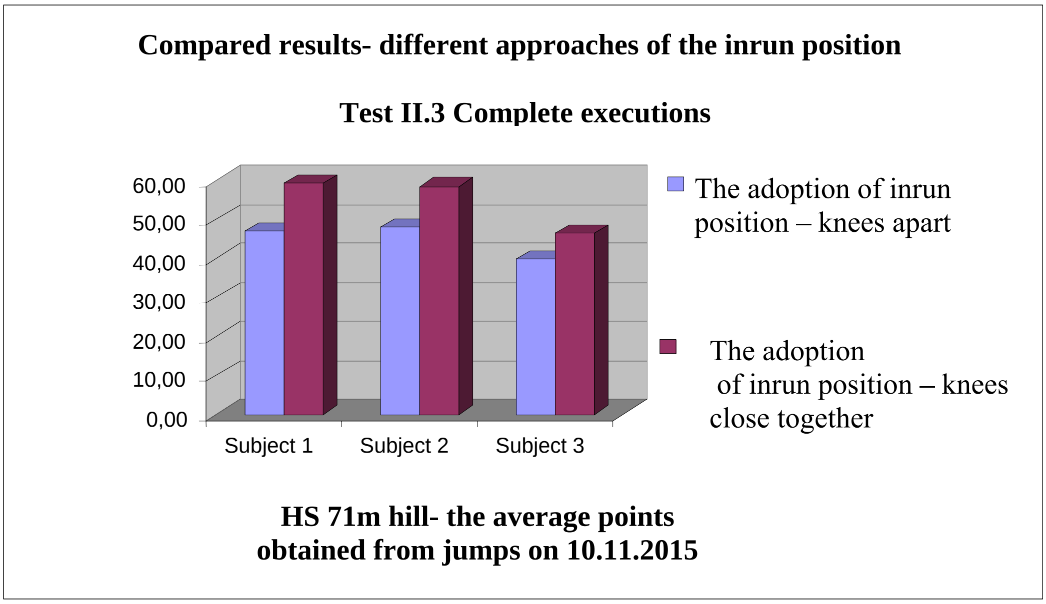

Fig. 5. *The representation of the average points of the length of the jumps during test II.3 on HS 71m hill obtained by the three subjects – different approaches of the inrun position*

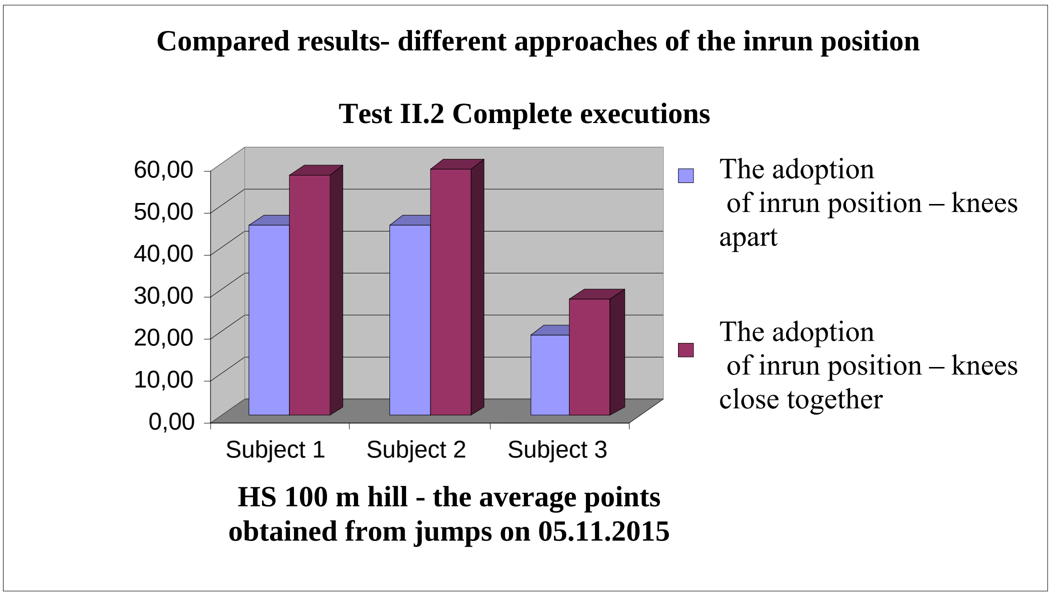

Fig. 6. *The representation of the average points of the length of the jumps during test II.2 on the HS 100m obtained by the three subjects – different approaches of the inrun position*

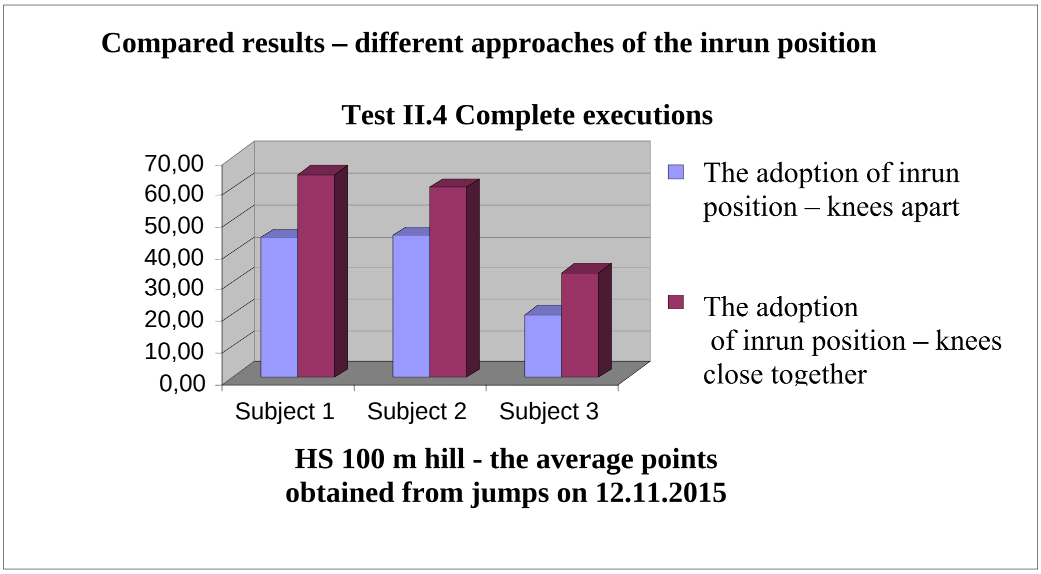

Fig. 7. *The representation of the average points of the length of the jumps during test II.4 on HS 100m hill obtained by the three subjects – different adoptions of the inrun position*

7. Discussions

1. After the application of **the goniometric test – imitative exercises**, all subjects show improvements of the angles in the joint of the ankles by adopting the inrun position with the knees close together in comparison with the position with the knees apart: **Subject 1 – improvement by 5,10°** and by an average of the inrun position **1,75 cm lower**; **Subject 2 – improvement by 4,65°** and by an average of the inrun position **0,50 cm lower**; **Subject 3 – improvement by 2,70°** and by an average of the inrun position **1cm lower.**

2. As a result of **the test II.1 complete executions HS 71m**, it has been noted **a substantial improvement** of the average points obtained by the three subjects in adopting the inrun position with the knees close together compared to the position with the knees apart: **Subject 1 – 14,40 points**, **Subject 2 – 11,20 points**, **Subject 3 – 9,60 points**. As a result of the assumption of **test II.2**, the same improvements of the average points are registered for the three subjects on the HS 100m hill: **Subject 1 – 12 points**, **Subject 2 – 13,34 points**, **Subject 3 – 8,67 points**.

3. The results of the **test II.3 complete executions** HS 71m underline a significant increase of the average points obtained by the three subjects when adopting the inrun position with the knees close together compared to the position with the knees apart: **Subject 1 – 12,40 points**, **Subject 2 – 10,40 points**, **Subject 3 – 6,80 points**. The **Test II.4** reflects the same improvements of the average points for the three subjects on the HS 100m hill: **Subject 1 – 20 points**, **Subject 2 – 15,34 points**, **Subject 3 -13,34 points.**

8. Conclusions

1. The personalized use of the imitative exercises, after the transition phase and the end of the anatomical adaptation period, creates an essential foundation in the transfer of the physical preparation compounds in the technical mechanism.

This consists of **the improvements of the angles** at the level of the ankles and knees, the decrease of the GMC, the **timing** optimization and the improvement of the **speed** and the **takeoff force** indicators.

2. The introduction on a continuous basis of the imitative exercises in the athletes' training ensures the accomplishment of **a large number of executions with a low level of risk** and, in the same time, it leads to **the increase of the self-perception level** of each athlete, as well as **the accurate separation of the actions** made by the athletes, connected to Phase I, II and III of the jumps.

3. As a result of the undergone study, we can state that the adoption of the inrun position demands **a high degree of individualization** because there are significant differences as compared to the general – basic – model related to Phase I of sky jumping.

4. When applying the principle of individualization in Phase I of sky jumping, **a major role is played by the professional level of the trainer** that continuously identifies and corrects the specific actions according to the individual's particularities.

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