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Original article

PLYOMETRIC EXERCISES TO IMPROVE EXPLOSIVE POWER IN ARTISTIC GYMNASTICS

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Abstract

Problem statement. Preparing gymnasts is more severe due to more frequent change of code points, the major role in preparing athletes taking him coach, he was forced constantly to find the best means of improving working methods. Of all the biomotric training qualities, strength and power are the most critical for many sports. Sports with speed-power dominance is based on developing solid strength and power. Understanding the mechanics and physics of force training and incorporate their principles workout will boost the competitiveness of athletes.

Aim. Pliometric exercises performed at the floor and beam lead the level of explosive power and increase the technical level of artistic jumps.

Methods. Evolution of subjects was accomplished by the Kinovea program, the data being presented in tables and graphs. The means used for research are specific for pliometric training adapted to gymnastics discipline and to the physical characteristics of the individuals targeted. The research was conducted on two groups (experimental and control group) of 8 gymnasts of 9-10 years old.

Results. Explosive power increases the experimental group compared to the control group at all tests ($p<0,005$)

Conclusion. The results lead to the conclusion that plyometric exercise induces an elastic mechanical adjustment in the opposite direction, an increase of muscle tone. Plyometric training interaction causes a change in elasticity-contractility of the muscle by requesting the cycle: stretch – explosive force.

Keywords: maximal force, explosive power, pliometrics, methods, tests.

Introduction

The competition and the high level of the results obtained in most of the sports categories demand an additional effort from the coaches to correct and adjust the variables of the training and competition, by permanently paying attention to the evolution of sport in general or to the evolution of a specific category. (Teodorescu, 2009)

Gymnastics has known a fast progress in the past few years, especially from the moment when new technical demands began to appear. Gymnasts, coaches and researchers, all together have been busy trying to reach the perfection.

Having a deep knowledge regarding the development process of expansion involves a close analysis of the processes of adaptation who can be found in artistic gymnastics training.

Practicing artistic gymnastics according to the style of domain and the actual demands requires great qualities. We can not speak about one single quality, but a combination of many qualities in a system, with a higher level of organization and having a preponderance of them, all of this having a determinant role in establishing the exact performances. (Dungaciu, 1982).

One of the practice methods which enjoys a great success is the training with the help of plyometric exercises. (Bompa 2006).

Plyometric exercices consist of rapid acceleration and deceleration of the muscles which creates a cycle of growth and contraction. The exercices help the muscles, the connective tissue and nervous system to efficiently pass through cycles of elongation and contraction leading to an improvement of the sport performances. Any sportsman needs a rapid deceleration of the body followed by an acceleration in the opposite direction.

The term of plyometric consist in exercises which make the muscle capable of reaching the maximum strength in a very short time. This capability of speed - strength is known as power. (Radcliffe, Farentinos, 1999)

Plyometric exercises help develop rhythm, speed, strength and endurance. The exercices used correctly and for a purpose can be a valuable attribute for a sportsman and for the entire training program as well.

The plyometric training leads to the following:

- rapid mobilization of some increased innervation activities;
- the recruitment of majority or of all motor units and muscle fibers;
- increasing the speed of the pulses to the motor neurons;
- transformation of the muscle power in explosive strength.

Hypothesis of the research

The correct application of some specific methods for the explosive strength in the training will contribute to a significant increase of the expansion indices.

Objectives of the research

- optimization of the methodology regarding the

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development of expansion;
- development of a training program according to the specific needs of the artistic gymnastics and evolution in perspective;
- setting the subjects of the research;
- accomplishment of the tests.

Tasks of the research
- development of expansion through a plyometric exercices program;
- raising the artistic level according to the demands imposed by CP;
- application of the methodology specific for artistic gymanstics;
- statistical processing of the data recorded on the tests applied.

Research protocol

Having as objective experimentalal argumentation of the methodology regarding the development of expansion, the study was carried out on two groups of gymnasts from the same category (experimental group and control group), gymnasts trained by coaches with vast knowledge in domain. Each group had 8 gymnasts between 9 and 10 years old. The study was conducted in the gym of Farul Constanta during 15 september 2012 – 31 may 2013.

To highlight the efficiency of the training, both groups from the study had the same stages and tests.

When we created the methodology of training for the experimental group, we had in mind to solve the following objectives:
- optimization of the methodology regarding the development of expansion;
- development of a training program according to the specific needs of the artistic gymnastics and evolution in perspective;
- setting the subjects of the research;
- accomplishment of the tests.

We also mention that the improvement of this methodology was accomplished by optimizing the volume and the intensity of all the exercises that we used. The intensity of the strength – speed exercices was raised by establishing a specific number of exercices against time, while the volume of work was adjusted for the needs and the age of the two gymnasts.

Methods

PLYOMETRIC PROGRAM

A. Stage I
- Duration: 1 september 2012- 30 november 2012; 1-2 trainings /week; 10 15'/training
- Recovery: minimum 72 hours between trainings; 2-4' break between exercises
- Repetitions: 50 – 80 repetitions / training
- Intensity: low

B. Stage II
- Duration: 1 december 2012 –15 february 2013; 1-2 trainings/week;15-20'/training
- Recovery: minimum 48 hours between trainings; 1-3' break between exercises
- Repetitions: 80 -120 repetitions / training,
- Intensity: low - moderate

C. Stage III
- Duration: 15 february 2013 – 15 april 2013; 2 - 3 trainings/week; 20´/training
- Recovery: 48 hours between trainings; 1 - 2' break between exercises
- Repetitions: 100-150 repetitions/ training
- Intensity: moderate - high

D. Stage IV
- Duration: 15 april 2013 - 31 may 2013; 2-3 trainings/week; 30'/training
- Recovery: minimum 24 hours between trainings; 1-2' break between exercises

Repetitions and intesity: the intesity, frequency and duration of the training are being reduced.

Exercises used for the development of the expansion
- Jumping in place on a leg with ample amortization and immediately detachment, on vertical and raising the knees to the chest; 4 x 20
- Jumping on both legs, with the help of an elastic band, tied on the pelvis and also tied on a bar; 4 x 20
- Successive jumps in place, with detachment from the both legs, turning 180 degrees to the left and to the right; 4 x 30
- 3 – 5 jumps on a leg moving forward and followed by the develope jump; 10x
- 3 – 5 jumps on a leg moving backward and followed by the develope jump; 10x
- Ankle jumps with both legs; 3 x 10
- Ankle jumps with both legs and twisting the hips at the same time; 3 x 10
- Jumping on both legs from the edge of a platform having 45°; 4 x10
- Jumping on a leg from the edge of a platform having 30°; 3 x10
- Back squat from a leg with vertical detachment; 3 x 10

Tasks applied on the research

1. Dynamic tasks
- High jump on place followed by a detachment from the both legs / cm;
- Depth Jump starting from a platform followed by a vertical jump;
- Vertical jump having two steps for upsurge;
- Back squat followed by a vertical jump.

2. Dynamic tasks of artistic jumps
- Calculating the distance (in cm) of the highest moment in the develope artistic jump, made on the ground ;
- Calculating the distance (in cm) of the highest moment in the develope artistic jump, made on the beam.

1. High jump on place. This task was done three times and consisted in a jump on place, in height, starting from the both feet and it's a task where the hand of the gymnasts must touch a wooden support located in the

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lateral plane. The test was calculated in cm and had as purpose highlighting the explosive force of the participants.

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2. Depth Jump starting from a platform. This task was done three times and consisted in a depth jump, from a 45 cm high platform. After the ground landing, the subject jumps on vertical, touching the wall as high as possible. The test was calculated in cm and had as purpose highlighting the explosive force of the participants.

3. Vertical jump having two steps for upsurge. This task was done three times and consisted in taking two steps for upsurge, where in the final step the subject jumped on vertical and had to touch the wall as high as possible, like in the previous task. The test was calculated in cm and had as purpose highlighting the explosive force of the participants.

4. Back squat followed by a vertical jump. This task was done three times and consisted in execution of a backwards squat on one foot. During the execution of this squat the pelvis and the knees get down until the hips will be parallel with the ground. From this position the subject must execute a vertical jump, touching the wall as high as possible.

The test was calculated in cm and had as purpose highlighting the explosive force of the participants.

5. Artistic jumps. Gymnasts have made three developpe jumps both on the ground and on the high beam. The purpose of this test was to highlight the detachment force of every subject, where two international referees rated the executions. Both ground and high beam executions were rated so that every gymnast had one rate for the ground and one rate for the high beam.

For this task we used Kinovea Video, a program that helped us to find out the exact distance in cm when the develope jump reached the climax.

Results

After we finished the initial test, we noticed that there are no big differences between the subjects, main purpose of this test being to highlight an eventual progress made by gymnasts during this experimental. To achieve the analysis of physical parameters, were tested a total of 4 and 2 artistic tasks:

Tabel 1. High jump

	Experimental group		***Control group***	
	Initial test	***Final test***	***Initial test***	***Final test***
X ± Ds	***29.333± 0.577***	***32.333± 1.155***	***28.667 ± 1.155***	***29.667 ± 0.577***
Cv%	***1.967%***	***3.572%***	***4.029%***	***1.945%***
t	***5.196***		***1.732***	
p	***p<0.025***		***p>0.05***	

Initial test

- At this task, during the initial test the average score obtained by the experimental group was 29.333± 0.577cm and the coefficient of variation was equal with 1,967 %. A homogenus group as we can see in chart nr. 1.
- Control group had an average of 28.667 ± 1.155 cm and a coefficient of variation equal with 4.029%. Was also a homogenus group like experimental group.
- As shown in the above results we can conclude that at this test, the two groups showed a relatively equal average and a good homogeneity.

Final test

- In this test, after we applied the program of work, we found an increase in the average for the experimental group, reaching 32,333±1,155cm, with a 3.572**%** coefficient;
- Control group, having an average of 29.667±0,577cm in this final test, doesn't show a real progress as we can see above.

From the results above we can conclude the following:

- Experimental group is in progress as the increased rate of the average emphasizes . A group with a very good homogeneity (Cv= 3.572%);
- Control group is a homogenus group (Cv =1.945%) but the average of the final test (29.667±0,577 cm) doesn't confirm the fact that this group has shown a progress after the program;
- For this reason we can say that the difference between the averages it's in favor of the experimental group. In conclusion, the program applied is efficient.

Tabel 2. Jump from a cm

	Experimental group		***Control group***	
	Initial test	***Final test***	***Initial test***	***Final test***
X ± Ds	***31.667± 0.577***	***36.667± 0.577***	***30.667± 0.577***	***32 ± 1***
Cv%	***3.647%***	***1.574%***	***1.882%***	***3.125%***
t	***5***		***1.512***	
p	***p<0.025***		***p>0.05***	

Depth starting platform /

Initial test

- During the initial test the average score obtained by the experimental group was 31.667± 0.577cm, and the coefficient of variation was equal with 3.647 % ; a homogenus group.
- For the control group, the average of the initial test is 30.667 ± 0.577 cm, coefficient of variation equal with 1.886 % , showing a homogenus group here too.

Final test

- After the program was applied on the both groups, we can see that the average obtained by the experimental group in the final test shows a real progress (36.667cm ± 0.577) with homogeneous values (cv = 1.574 %).
- The control group, although is a group with a good homogeneity, as shown in the chart above, between the two test the group doesn't show a great improvement of the average, the difference being very small (1.333 cm);
- In conclusion, the difference between the averages at the final test is in favor of experimental group, which is why we can say that the program applied is efficient.

Tabel 3. Vertical jump having two steps for upsurge.

	Experimental group		***Control group***	
	Initial test	***Final test***	***Initial test***	***Final test***
X ± Ds	***31.333 ± 0.577***	***34.333 ± 0.577***	***30.667 ± 0.577***	***31.667 ± 0.577***
Cv%	***1.842%***	***1.681%***	***1.882%***	***1.882%***
t	***5.196***		***1.732***	
p	***p<0.025***		***p>0.05***	

Initial test

- From the results obtained by the both groups, we can see that we almost got identical values at initial test (the average of the experimental group was 31.333±0.577 cm and the average of the control group was 30.667±0.577cm);
- Coefficient of variation shows low variability and high homogeneity achieved by both groups;

Final test

- The final test shows a significant progress for experimental group (34.333±0.577cm). The control group had 31.667± 0.577cm;
- The progress shown by the experimental group between the two test (represented by the „t" variable) denote positive results. (p<0,025).
- The group control deosn't show a progress at this task because the „t" variable denote negative results p>0.05, and for that matter we can say that the results are in favor of the experimental group.

Tabel 4. Back squat followed by a vertical jump

	Experimental group		***Control group***	
	Initial test	***Final test***	***Initial test***	***Final test***
X ± Ds	***27.333 ± 0.577***	***28.333 ± 1.155***	***27 ± 1***	***27.667 ± 0.577***
Cv%	***2.111%***	***4.077%***	***3.704%***	***2.086%***
t	***1.732***		***2***	
p	***p>0.05***		***p>0.05***	

Initial test

- In this first test, the experimental group presented values of the average equal with 27.333±0.577cm, compared to the control group that had te following values: 27±1cm. This means that both groups are rated „good" in this first test with almost equal values;

Final test

- The average recorded by the experimental group in this final test was 333±1.155cm, while control group doesn't show any progress (27.667±0.577cm).
- The variable "t" calculated for the experimental group (1.732cm) is located below the limit (p>0.05). Thist is the same for the control group

(2cm) where also the „t" variable is below the limit (p>0,05).

- After the data recorded on the progress of the two groups in this task and after applying the experimental training program we can see a stagnation of the values, which does not confirm the effectiveness of the experimental program proposed for this task.
- The control group had an average of 69.333±1.528 cm, an average less than the experimental group, but is also a homogeneus group as we can see in chart nr. 5.

Tabel 5. Developpé jump on the ground

	Experimental group		***Control group***	
	Initial test	***Final test***	***Initial test***	***Final test***
X ± Ds	***71.333 ± 1.155***	***73 ± 1***	***69.333 ± 1.528***	***71 ± 1.732***
Cv%	***1.619%***	***1.37%***	***2.204%***	***2.439%***
t	***5***		***2.5***	
p	***p<0.025***		***p>0.05***	

Initial test

- Because of the average obtained at the beggining of this program by the experimental group (71.333±1.155 cm) and a coefficient of variation equal with 1.619 %, we can say that they are a homogenus group because of the values;

Final test

- From the results obtained by the experimental group at the final test it appears that they are in progress, average of the final testing demonstrating this. They are a homogeneous group, as we can see from the chart 5, with a coefficient of variation equal with 1.37 %. So after the two tests, the difference between the averages is 1.667 cm, in favor for the experimental group;
- Control group doesn't show a progress because the average after the final test was equal with 71 ± 1.732cm. So the difference between the initial test and final test is insignificant.
- Following the results we can see that the difference between the averages (2 cm) at the final test is in favor the experimental group (p<0,025), as we can see in chart 5.

Tabel 6. Developé jump on the beam

	Experimental group		***Control group***	
	Initial test	***Final test***	***Initial test***	***Final test***
X ± Ds	***66.333±1.155***	***68.333± 2.082***	***65.667± 1.155***	***66.333±1.155***
Cv%	***1.741%***	***3.047%***	***1.759%***	***1.741%***
t	***3.464***		***0.5***	
p	***p<0.025***		***p>0.05***	

Initial test

- The average recorded by the experimental group at this task is rated as „good" (66.333±1.155cm). It's a homogeneus group as we can see from the calculated value of the coefficient of variation.
- Control group had an average of 65.667±1.155 cm, an average almost equal with the value of the experimental group, evidence that proves a low level of training for both gymnasts according to the demands.

Final test

- After we implemented the training program, the experimental group has a remarkable increase of average (68.333± 2.082cm), and a very good homogeneity, the value of the coefficient of variation strengthening this (Cv%= 3.047).
- Control group doesn't have a spectacular evolution, they only obtained 66.333±1.155 cm. But the homogeneity is very good, the value of the coefficient of variation strengthening this (Cv%=1,741).
- After applying the experimental training program, there is an increase from the intial test to final test that favors the experimental group. However, we can see a stagnation for the control group in the same period of time, which confirms the effectiveness of the experimental program proposed for this test for the experimental group, because the difference between the two gymnasts from initial testing to final testing is statistically significant in favor of the experimental group ($p<0.025$).
- So after applying physical training program we can see an increase in value in 5 of the 6 tasks tested within the experimental. The results obtained by the experimental group proves the efficiency of the experimental program that we proposed.

Discussions

The efficiency of this experimental program is demonstrated by the fact that after it was applied on the experimental group the results obtained show a higher level compared with the results obtained by the control group.

The low value obtained at task 4, ***back squat followed by a vertical jump***, can be explained by the fact that at this age athletes must develop a general force in a very short time, by not having enough experience but also because the trainings are overloaded.

The different significance of the means was determined by the period, stage and the tasks that had to be solved in certain points of the training.

Conclusions

After applying this experimental program regarding physical training on the 3rd category of gymnasts, we suggest the following recommendations:

- The content of the sport training will be made depending on the somatic, functional and physical baggage that every gymnasts are endowed. Also, for finishing the preparation program and for setting the final goals we must take into consideration the inhomogeneous dynamic baggage of gymnasts, taking into account that in sport uniform progress is not achieved;

We recommend that physical training be conducted by a specialized person, in every training and with a well determined length depending on wich stage the gymnasts are.

By applying video analytics when the junior gymnasts are being prepared, training becomes more objective, having a scientific base. For that reason it must be implemented as much as possible in training.

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