

# Comparative Analysis of Experiment on Lower Limbs Flexibility of the Artistic Gymnastics Students Based on the PNF Stretching Training Method

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## Abstract

Through the analysis of the concept of PNF stretching training method, this paper summarized its basic principles and common methods, used the method of PNF stretching training under the condition of different resistance time to test the subjects, and tested the forward-backward and transverse and longitudinal split. Combined with the actual results, corresponding suggestion for the artistic gymnastics students of lower limbs flexibility training was proposed to promote the flexibility training of students.

*Keywords:* PNF stretching training method; Flexibility quality; Transverse and longitudinal split.

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## 1 Introduction

Flexibility ability is indispensable important physical condition and basic skills for artistic gymnastics students. The good flexibility capability not only can liberate the body of artistic gymnastics students, but also can enhance the capacity of performance and reduce the damage probability. The current flexibility training methods mainly include energy stretching method, dynamic stretching method and PNF stretching method. Many scholars have done a lot of research for the three training methods. The results showed that PNF training method for flexibility quality effect is significantly better than the other methods of stretch training, and has rapidly developed in recent years [1-3]. This article tested and analyzed subjects with PNF stretching training method, observed the resistance of transverse and longitudinal split of subjects. Based on this, it put forward the corresponding suggestion, providing certain reference for the lower limbs flexibility training of artistic gymnastics students.

## 2 Pnf Stretching Training Method

PNF stretching training method also called proprioceptive neuromuscular facilitation (PNF), which was invented by Dr. Herman in 1940s for neuromuscular paralysis patients. It is an exercise method using kinesthesis, posture, and stimulation of feeling to enhance the neuromuscular reaction and promote corresponding muscle contraction. The basic principle is to let the

stretched soft tissue to do transitory isometric contraction through repeated static stretching [4, 5].

The key technology of PNF stretching training method is exerting the external force to stimulate muscle spindle and tendon organs with the companion's cooperation, thus to fell the muscle traction and shrink. The common methods include rhythmic initiation, compound isotonic exercise, slow reversal and repeated contraction [2]. The rhythmic movement is that, coach guide right consciousness for subjects with verbal explanation, and positively help subjects to do rhythmic movement against resistance; the compound isotonic exercise refers to muscles resistance training with constant isometric contraction, plyometrics contraction, centrifugal contraction and inward contraction; the slow reversal is to make antagonist do slow and rhythmic isometric contraction and inward contraction based on the effective training of antagonist to increase muscle strength and stabilize joints; the repeated contraction is that, the participants are given the quick stretch on muscle in the process of single direction isotonic contraction of a muscle group, thus to strengthen muscle contraction force.

### A. THE COMPARATIVE EXPERIMENTS AND ANALYSIS OF THE PNF STRETCHING TRAINING METHOD

The experimental subjects are 21 male college students. Requirements of subjects include joint angle of the transverse and longitudinal split is 130-175 degrees, ranging in age from 19-24. The subjects basically on the same level. The above subjects were randomly divided

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into three groups and labeled as A, B, C. Group A was 5s against external forces; group B was 10s against external force; group C was 15s against external forces. Experimental period was 10 weeks (2 times per week). Subjects received explanation and demonstration of PNF stretching method to completely master shrink-resist-

reverse draft technology in PNF stretching and were required not to do any forms of flexibility exercise to reduce error and ensure the experimental accuracy. Transverse and longitudinal split of lower limbs was taken as two test indexes. Training test methods was as shown in TABLE 1:

TABLE 1: Lower limbs transverse and longitudinal split by PNF stretching training method

Test time	Test method
First test class	Jogging for 800 meters, 10 minutes of simple warm-up and test joint angle of transverse and longitudinal split of group A, B, C. Do 3 times of pressure test and record maximum value.
PNF stretching training for 19 lesson	Jogging for 800 meters; do PNF stretching exercises after 15 minutes of simple warm-up; group A actively shrink muscle group that will be stretched and reach the pain points; use 70% of their power against the external force for 5s and then relax muscles; draft muscle slowly towards the opposite direction at the same time; stretch muscle to pain point for 30s; each muscle group repeat 3 times and then rest for 1 minute for three times. Group B positively shrink muscle group that will be stretched of the muscle group and reach the pain points; use 70% of their power against the external force for 10s and then relax muscles; draft muscle slowly towards the opposite direction at the same time; stretch muscle to pain point for 30s; each muscle group repeat 3 times and then rest for 1 minute for three times. Group C positively shrink muscle group that will be stretched and reach the pain points; use 70% of their power against the external force for 15s and then relax muscles; draft muscle slowly towards the opposite direction at the same time; stretch muscle to pain point for 30s; each muscle group repeat 3 times and then rest for 1 minute for three times.
Second test class	Last lesson is test class (method as above); test results keep integer.

Joint angle tester was used to test the range of joint movement. Test flexion and extension and abducent angle of hip joint to reflect the flexibility of the transverse and longitudinal split. SPSS18.0 was used to process experimental data. Group A, B and C were compared by one-way analysis of variance. Indexes before and after experiment within the group was done matching T test analysis. Test result was expressed by mean ± standard deviation. p<0.05 means significant difference and p<0.01 means very significant difference. Method of comparative analysis was used to analyze the training effect of transverse and longitudinal split in group A, B and C to confirm the group with best flexibility effect, that is, the group with largest effect on transverse and longitudinal split.

**B. THE EXPERIMENTAL RESULTS AND ANALYSIS OF PNF STRETCHING TRAINING METHOD**

Group A actively shrink muscle group that will be stretched and reach the pain points; use 70% of their power against the external force for 5s and then relax muscles; draft muscle slowly towards the opposite direction at the same time; stretch muscle to pain point for 30s; each muscle group repeat 3 times and then rest for 1 minute for three times. The analysis results showed that, flexibility after 5s resistance experiment by PNF stretching method improved compared to that before experiment, and longitudinal split had significant difference and transverse split has very significant difference. Result of 5s resistance by PNF stretching method is as shown in TABLE 2:

TABLE 2 Result of 5s resistance by PNF stretching method (unit: degree)

Subjects	1	2	3	4	5	6	7	P
Longitudinal split before the experiment	143	160	133	138	141	135	147	
Longitudinal split after the experiment	163	171	148	148	153	147	155	<0.05
Transverse split before the experiment	138	150	128	133	138	128	143	
Transverse split after the experiment	151	162	143	144	149	141	152	<0.01

Group B positively shrink muscle group that will be stretched of the muscle group and reach the pain points; use 70% of their power against the external force for 10s and then relax muscles; draft muscle slowly towards the opposite direction at the same time; stretch muscle to pain point for 30s; each muscle group repeat 3 times and then rest for 1 minute for three times. The analysis results

show that take the method of PNF stretching resistance 10 s experiment before and after, horizontal and vertical fork have very significant difference, the horizontal, vertical fork flexibility are improved compared with before the experiments.

Result of 10s resistance by PNF stretching method is as shown in TABLE 3:

TABLE 3 Result of 10s resistance by PNF stretching method (unit: degree)

Subjects	1	2	3	4	5	6	7	P
Longitudinal split before the experiment	136	140	134	143	144	150	143	
Longitudinal split after the experiment	156	158	155	162	161	170	162	<0.01
Transverse split before the experiment	135	136	133	138	139	144	137	
Transverse split after the experiment	150	153	150	157	154	164	156	<0.01

Group C positively shrink muscle group that will be stretched and reach the pain points; use 70% of their power against the external force for 15s and then relax muscles; draft muscle slowly towards the opposite direction at the same time; stretch muscle to pain point for 30s; each muscle group repeat 3 times and then rest for 1 minute for three times. The analysis result indicated

that, transverse and longitudinal split before and after the experience adopting PNF stretching method has very significant difference, that is, the flexibility of transverse and longitudinal split improved compared with that before experiment. Result of 15s resistance by PNF stretching method is as shown in TABLE4:

TABLE 4: Result of 15s resistance by PNF stretching method (unit: degree)

Subjects	1	2	3	4	5	6	7	P
Longitudinal split before the experiment	133	143	145	147	139	137	136	
Longitudinal split after the experiment	148	158	156	158	153	147	140	<0.01
Transverse split before the experiment	128	138	138	140	133	130	133	
Transverse split after the experiment	149	153	151	153	150	141	138	<0.01

Compared longitudinal split of group A, B and C, the results showed that, the flexibility improvement of group B was better than that of other two groups. That is, in the exercise process of longitudinal split flexibility quality,

10 s resistances by PNF stretching method has better effect compared with 5s and 15s resistance? Result comparison and analysis is as shown in TABLE 5:

TABLE 5: Longitudinal split comparison between group A, B and C (unit: degree)

Subjects	1	2	3	4	5	6	7	
Longitudinal split after the experiment	163	171	148	148	153	147	155	155±9
Longitudinal split after the experiment	156	158	155	162	161	170	162	161±5
Longitudinal split after the experiment	148	158	156	158	153	147	140	151±7

Compared transverse split of group A, B and C, the results showed that, the flexibility improvement of group B was better than that of other two groups. That is, in the exercise process of longitudinal split flexibility quality,

10 s resistances by PNF stretching method has better effect compared with 5s and 15s resistance? Result comparison and analysis is as shown in TABLE 6:

TABLE 6: Transverse split comparison between group A, B and C (unit: degree)

=Subjects	1	2	3	4	5	6	7	$\bar{x} \pm s$
Transverse split after the experiment	151	162	143	144	149	141	152	149±7
Transverse split after the experiment	150	153	150	157	154	164	156	155±5
Transverse split after the experiment	149	153	151	153	150	141	138	148±6

### 3 Suggestions

Shrink-resistance-reverse stretching is the model in the PNF stretching exercise. Whether it's 5 s, 10s or 15s, the flexibility of transverse and longitudinal split improves significantly. It can be found that, the effect was best

when the resistance was 10s. The following suggestions were proposed in order to solve the above problems:

(1) It can be found that flexibility increase when the resistance was 5s, 10s and 15s. Different sports require different flexibility. Therefore, we can adjust according to the requirements of the flexibility degree. Rhythmic

gymnastics have higher requirements for flexibility, so 15s resistance was adopted for training. Other sports such as wushu competition routines, gymnastics, diving and so on can use 10s resistance, sports that use power has low requirements on flexibility and can adopt 5d resistance.

(2) Flexibility quality and muscle power has certain influence relationship. Strong muscle power needs big muscle. Muscle can fix joint. The size of muscle affects the application extent of joint, thus flexibility will be restrained. Therefore, we should pay attention to the organic combination of these two in some sports that need both power and flexibility. One accurate PNF stretching can lower the power of muscle, thus we should pay attention to exercise of power in PNF stretching process.

(3) Compared with traditional static stretching method and dynamic stretching method, PNF stretching method has its superiority. But the combination of these three stretching methods also should be paid attention to. We should formulate relative stretching method through experimental research according to different sports.

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Meanwhile, this kind of stretching method need the cooperation between companions, can increase publicity of PNF stretching method, let teachers and students understand PNF stretching method, enrich students' interest, improve enthusiasm and promote the application of PNF in flexibility quality.

#### 4 Conclusion

Good flexible quality is the basic condition to complete rhythmic gymnastics. PNF stretching method stimulates sensory nerve of muscle, promotes inhibition, excitement, shrinkage and relaxation and improve muscle function by a series of positive and negative motivation and static stretching. The application of PNF stretching method can not only enrich traditional static and dynamic stretch method and improve the single flexibility quality training method, but also can provide reference for future flexibility quality training.

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