LONG TERM IMPROVEMENT OF PERFORMANCE INDEXES IN BASKETBALL PLAYERS.

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INTRODUCTION

Training is an important factor for optimal performance in sport. Many studies have shown the adaptation of the organism to exercise in general. With regards to factors like aerobic capacity, muscle fiber recruitment, force-velocity relationships and speed of movement, many authors demonstrate that adaptations are dependent on the specific modality of the training used. In fact the dynamics of movement often combine high strength demands with speed requirements. In particular muscle hypertrophy is a general mechanism for power improvement. The success of training is measurable. Besides classical measures of force and velocity, there are several tests which give performance indexes related with the specific sport considered. There are also limits of the normal training. These include : the induction of central and periferic fatigue, the difficulty in evaluating exercises (for particular muscular strength improvement) and the necessity of continued training to maintain the optimal performance for a long time. These phenomena lead one to reflect on the goals of strength training and its evaluation in research. During this study electrical stimulation was used as means to improve muscular strength and performance indexes in basketball players, in addition to the normal training. This technique was compared to the use of the normal training during evaluation of a long term performance improvement.

METHOD

The present study was held for a period of more than 2 years and consisted of tests and measurements which were conducted on 12 basketball players of a D-series team of the Italian basketball championship. The team was divided into two groups : 7 subjects formed the stimulated group (SG) and the remaining 5 subjects served as control group (CG). All the players were allowed a training period before the championship began. The SG added a stimulation cycle to the normal training.

Muscles and electrodes: the quadriceps and the triceps surae (gastrocnemious and soleus) were the muscles chosen. They are easy to stimulate by virtue of their size and accessibility. The electrodes used consist of sheets of lead 0,6 mm thick and rectangular in shape, varying from 4x12 to 6x18 centimeters. The electrodes were put in suitable flannel covers which were soaked in water. The skin was cleaned with ether before the electrodes were placed on it so as to improve conductivity. The electrodes were placed immediately above and below the belly of the muscle from four to five centimeters apart according to the size of the muscle. In every case the electrodes were so placed as to ensure maximum contraction. The quadriceps and the triceps surae of both legs were stimulated using a sequence of four channels for each subject.

Stimulation parameters: The frequency of the current controlled voltage output was fixed at 2500 Hz. The following stimulation pattern was adopted: 10 seconds stimulation followed by a 50 seconds pause for 20 minutes each day for 15 consecutive days. A four channel stimulator was used. It was designed and built at the "Centro Teoria dei Sistemi del C.N.R." (Department of Bioengineering of "Politecnico di Milano"). Particular attention was paid to subject and operator safety in the design of the stimulator.

Tests: Data from three tests (Abalakov, standing long jump and 30 m dash) were acquired before the stimulation cycle was begun. In the Abalakov test we measured the difference between the static height, which is the highest point that the subject can reach with his finger tips in standing position with both feet and heels on the ground, and the jump height, which is the highest point that the subject can reach with his finger tips jumping with a take-off of both feet. For both Abalakov and standing long jump the best result obtained in three trials was taken into account. For 30 m dash the average time of three trials was considered. The anthropometric data and the tests regarding the two groups at the beginning of the experience are shown in table 1.

table 1: **ANTHROPOMETRIC DATA , INITIAL VALUES OF INDEXES**

	STIMULATED GROUP mean values (7 athletes)	CONTROL GROUP mean values (5 athletes)
AGE (years)	20,1 ± 1,9	20,8 ± 2,5
HEIGHT (cm)	187,7 ± 5,0	189 ± 2,8
WEIGHT (Kg)	83,8 ± 6,4	80,6 ± 3,7
ABALAKOV (cm)	58,1 ± 3,5	59,0 ± 4,1
STANDING LONG JUMP (cm)	234,4 ± 12,7	239,4 ± 14,3
30 METERS DASH (s)	4,64 ± 0,11	4,50 ± 0,16

Each year the players were trained and stimulated in the month of October at the beginning of the championship, which ends in May. The following epoch sequence was used (each epoch is characterised by progressive month numbers):

1st year : training/stimulation (1) → championship (2-7) → summer holidays (8-12);
2nd year : training/stimulation (13) → championship (14-19) → training/stimulation (20) → → summer holidays (21-24);
3rd year : training/stimulation (25).

Lactic-acid analysis was also carried out by means of Roche model 640 Lactate Analyser, to investigate muscular fatigue.

Data analysis: before and after each stimulation cycle, at the beginning and at the end of the agonistic season several tests were performed to evaluate the three performance indexes. The collected data were normalised (to the initial value) to evaluate percentual increments and analysed by means of linear regression between the data of two tests.

RESULTS AND DISCUSSION

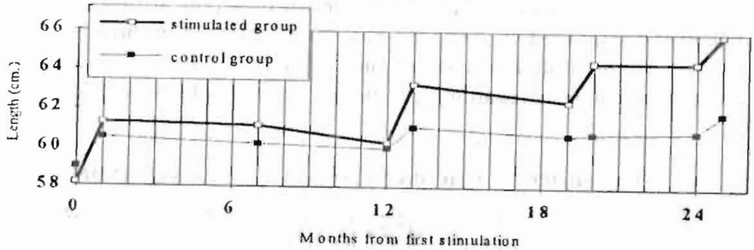
This study has shown that after 25 months the SG reached increments of performance indexes twice greater than the CG, as shown in table 2.

table 2: **PERCENTUAL INCREMENTS OF PERFORMANCE INDEXES AFTER 25 MONTHS**

Test	STIMULATED GROUP	CONTROL GROUP
Abalakov	13,27 %	4,75 %
St. long jump	10,91 %	3,97 %
30 m dash	5,29 %	2,67 %

In figure 1 the mean absolute values for the SG and the CG in the Abalakov test are shown. It can be seen that the CG started with values better than the SG, but after 25 months the SG improved the performances so that it has better values than the CG. The same happens for the standing long jump test. After summer, before the beginning of the agonistic season, the absolute increments for the SG remained higher than the CG, suggesting that the improvement of the muscular performance by means of sinusoidal electrical stimulation is maintained by a normal training and constitutes a basic resource for the following improvements.

FIG. 1 - TEST : ABALAKOV
Absolute values



In figures 2-3-4 the percentual increments, normalised to the first value, are shown. From a certain period on the percentual increments in all the three tests were always higher in the SG than in the CG. Immediately after the stimulation cycle the SG had always higher percentual increments than the CG.

FIG. 2 - TEST : ABALAKOV
Increments %

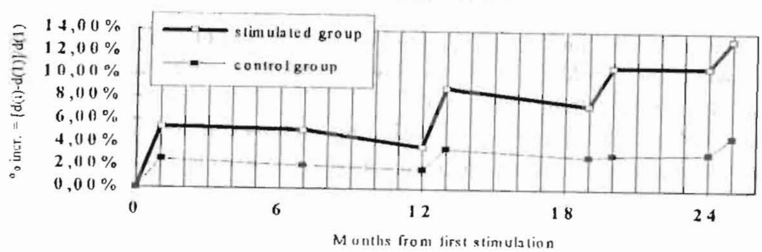


FIG. 3 - TEST : STANDING LONG JUMP
Increments %

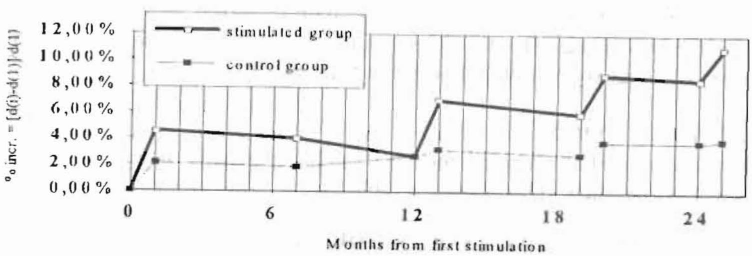
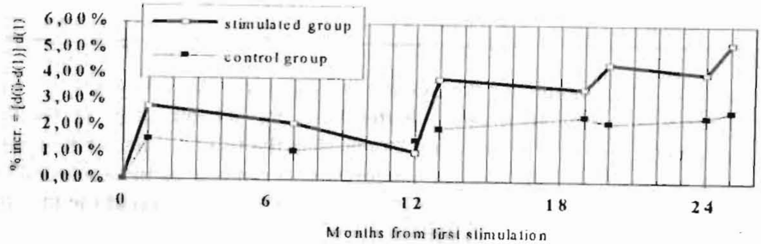


FIG. 4 - TEST : 30 M
Increments %



Linear regression between the values in the three tests was also carried out, for the SG and for CG. The analysis has shown a consistent correlation between the tests, particularly between Abalakov and Standing long jump ($R_{SG} = 0,9986$; $R_{CG} = 0,8953$) , because of a similar muscular activity in performing the two tests. The plots (figures 5-6) show the original data values with the estimated regression line and a pair of dotted lines representing the +/- standard deviations (SD) limits ($SD_{SG} = 0,4399$; $SD_{CG} = 1,4354$). This result shows that, evaluating the performance of an athlete, only one of the two tests can be considered, because of their redundancy (one is proportional to the other).

FIG. 5 - LINEAR REGRESSION
ABALAKOV-ST.LONG JUMP (stimulated group)

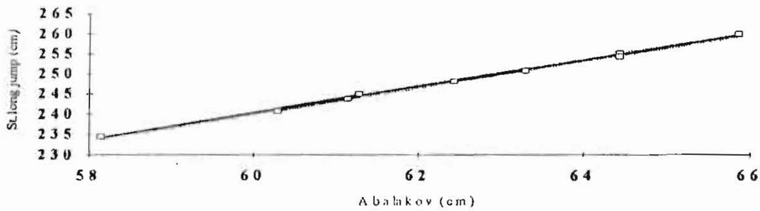
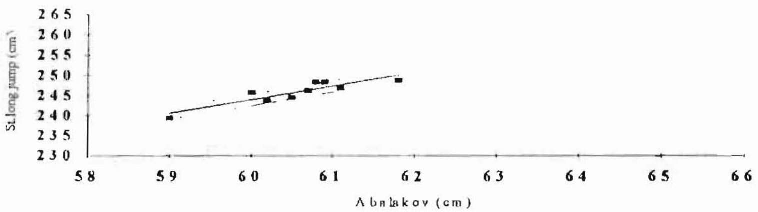


FIG. 6 - LINEAR REGRESSION
ABALAKOV-ST.LONG JUMP (control group)



Lactic acid analysis has shown that no fatiguing phenomena are related with this stimulation procedure.

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