Journal of Advanced Sport Technology 5(2):12- 21

Received: June. 30, 2021 *Accepted: October. 16, 2021*

Journal of Advanced Sport Technology

Original Research

Comparing the Effect of Exercise with 3 ISO Device and Traditional Resistance Exercises on the Strength Control of Biceps Brachii Muscle of Semi-Professional Male Volleyball Players

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ABSTRACT

The use of modern technology has allowed athletes to train to the best of their ability and prepare for the competition. Volleyball is a discipline in which speed (velocity) and accuracy play a key role. The present study aims to investigate force control by the inventive device. In this semi-experimental research, 31 volleyball players males were randomly assigned to the traditional training group (n=11), 3ISO device group (n=11), and control group (n=9). One-repetition maximum of biceps brachii, an isometric maximum strength test in four angles, and a force control were tested at baseline and 8 weeks later at the study completion. Right, and left-hand force control improved from baseline to post-intervention by training with 3ISO device (P=0.0001), furthermore, these changes were not significant in the control and the traditional training groups. Finally, the results of this study revealed that the force control produced by 3ISO device is better than the traditional training, which leads to more precise and controlled movements in athletes.

Keywords: Resistance training, Strength, Force control, 3 ISO machine

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INTRODUCTION

For a long time, strength has been one of the most important factors of bio-motor abilities, especially in sports. However, in most sports, not only is there a need for increased strength, force control is also very important. For instance, in volleyball serves, in addition to the strength and high power of the muscles (armpits, chest, and deltoid), the players need to apply the force with high precision and control to deliver the ball to the desired location of the opponent's ground and this pattern exists in most sports. Strictly and controlled force application requires the coordination between the agonist and antagonist muscles as well as the optimal performance of the deep receptors (1).

Thus, during the contraction and expansion of the muscle, the length of the extrafusal fibers constantly increases and if the performance of the muscle spindle is maintained in response to changes in muscle length, then the length of the muscle spindle should also be adapted to the change in the initial length of the extrafusal fibers, and this process occurs in performing sports activities that indicate the important functions of efferent gamma nerves (2). In other words, when stimulating the nerves of Ia (type one alpha), the gamma nerves are also stimulated, so that the variation in intrafusal fibers is aligned with extrafusal fibers. This process is called the alpha-gamma cooperation or coordination and allows the muscle spindle to remain in sensitivity close to the optimal level, the alpha-gamma interaction during contraction enables afferent feedback of the contracting muscle to inform the central nervous system of the muscle length, which is also referred to as a sense of motion (3).

Accordingly, one of the important issues relevant to the effective design of training conditions is the information resources of afferent used to control motor skills; for example, recognizing the information resources of afferent used by skilled individuals to control movements can help to draw the attention of beginners to these resources. Therefore, as long as the role of these resources is concerned, there are two different views after a different amount of exercise: The first view is indicative of the fact that at the beginning of the exercise afferent sensory information is important to correct errors, but this importance is diminished with more training and a change in the skill level. The second view about the role of sensory resources suggests that as the training increases, not only will the importance of the role of sensory information be increased but they will also be considered as dedicated afferent information resources. This view, first proposed by Porter et al, is opposed to and starkly different from the theory of hierarchical motion control, the Schmidt schema theory, and the Adams closed-loop theory. Proto et al. demonstrated in their experiments that after exercises with vision, if necessary, a sight-free transfer test had to be conducted, and the best performing groups had practiced with the least amount of visual feedback.

In the same way, in all sports, human beings can control their body according to the information they receive from senses such as sight, tactile, hearing, body position, distance, temperature, position, etc., and perform the right move according to the need. In this regard, one of the most important senses or it might be better to say the best sense, is a sense of sight which gives a lot of information as visual feedback to humans and during performing various sports activities, especially resistance exercises, it's important to obtain such feedback for better performance. Accordingly, the type of contraction, the relationship between muscle length and muscle tension, which depends on the type of muscle and joints involved in different muscles, should be considered when performing resistance exercises, either with the machine or with free weights that can be developed at different angles of a joint's range of motion (4).

Furthermore, when designing resistance training, the speed of the exercise and the type of muscular force curve is of paramount importance (5). For example, the force curve of the biceps muscle is a bell-shaped curve, or the curve of the chest press is an ascending curve (6). Nowadays, with the advancement of sports sciences, the construction of various sports machines with higher efficiency is one of the most important components of sports activities, and new and more functional products are being introduced to the market on a daily basis. The application of these machines has attracted more enthusiasts that,in turn, has led to the improvement and

enhancement of the athletes' performances through utilizing and operating the cognitive sciences of sport. Accordingly, various types of machines have been designed and manufactured to enable athletes to perform resistive activities that have different implementational and contraction capabilities. Neverthelesss, the point that has gone unnoticed in the existing machines is the ability to perform resistance training with all three contraction types and gleaning feedback from them (7).

Therefore, the researchers designed a 3 ISO machine that is capable of isometric, isotonic, and isokinetic contractions by providing visual feedback for force control for the user and registered it with the patent number 83599 in the Registry Organization of Documents and Landed Estate of the country. The machine is forced by a motor and a gearbox without the use of weight, and has the force control capability based on the user's visual feedback from the monitor. The machine also has the necessary conditions for the implementation of all three contraction types and the researchers took advantage of its isotonic ability in this research. The sensors and processor of the 3 ISO machine make it possible for researchers to precisely control the force. The machines and instruments used in the clubs, that we generally see as performing isotonic contractions, such as the back or thighs, or dumbbells and barbells are not able to perform the exact movements in the form of isotonic and it is difficult to imagine a machine that can match the force curve of all people for a particular sport (6).

Therefore, the 3 ISO machine, which can perform all kinds of contractions, including isotonic contraction, also provides the capability of using visual feedback by force sensor and visual feedback with the help of a monitor to work with the machine during exercise. Therefore, not only is the use of this machine effective in the development of force, but it can also provide appropriate force control feedback, which will lead to better performance of movements in various sports activities. From among the sports activities in which the precise and controlled performance of the movement and the application of force are important, is the implementation of skills, movements and rehabilitation of athletes after an injury, more specifically in volleyball players.

In other words, in volleyball like many sports, it is necessary to develop maximum force and, at the same time, to control force by using visual feedback. In this regard, several studies have been carried out on the development of force or force control, such as Ramezani, (8); Sadeghi et al., (9); Mallahi et al., (10); Lashani and Tahmasebi, (11). Researchers used visual feedback in their research, and often reported a positive impact of visual feedback. A study was conducted by Hedayatpur and Hamedinia to investigate the mechanism of contraction of the musculoskeletal system in response to different muscle contraction severities, the intramuscular and skin surface raw signals at the level of 0.015 between patellar surface and iliac crest of the lower part of the external muscle. Fifteen male subjects performed during 5-second contractions with intensity levels of 0.04, 0.016, 0.022 maximum voluntary contractions. It was concluded that the contraction of the skeletal muscle during the change of force intensity can be controlled by the mechanism of increasing the potential emission for action. Moreover, Gholami et al. probed into the relationship between control of force generation and dominant hand angle adjustment with some psychological characteristics of athletic and non-athletic students (12). The results revealed that there was a significant relationship between mood disorder and force control error and angle adjustment of the dominant hand. Bellew also examined the effect of force exercises on force control in older men and women and concluded that high-intensity exercise improves force but does not have a significant effect on force control.

Since this study aimed at developing and applying existing knowledge, it seems that the most effective method of active exercises is isokinetic training. This method has favorable benefits and decreases the likelihood of injury. Furthermore, in sports clinics, isokinetic machines are used to rehabilitate and improve sports performance, but due to their high prices, this has led to the underuse of such machines. Therefore, in order to operationalize the combination of existing knowledge and the use of knowledge of domestic sports experts, the researchers used this new machine and carried out the following research entitled "Comparison of the training method of machine 3 ISO as an innovative method with traditional resistance training" so that it can be effective in finding suitable training tools and strategies to improve muscle strength and force control, whether in the upgrade stage or in the rehabilitation phase which is shown in Figure 1.

Figure 1- 3 ISO machine

MATERIAL AND METHODS

Subjects

The present study was a semi-experimental one and was conducted in two stages (pre-test and post-test), which were performed respectively before and after the implementation of the training protocol. The statistical population of this study consisted of 60 adult volleyball players in Mobarakeh, 31 of them were from the middle age of 20 to 35 years old with the mean (average) height of 183 cm and the mean weight of 75.41 kg. They were selected as the research sample after completing the medical history questionnaire and the consent forms. According to research, the sample size for causal and experimental research should at least be 15 people and in studies that need to classify the community for sampling, at least 20 to 50 people are suggested. This indicates that the selected sample size for this study can be regarded as sufficient (13).

Procedure

Subjects were randomly divided into three groups: training group with 3 ISO, training group using traditional methods (with current equipment), and the control group. The independent variables of the study were training with 3 ISO and the traditional resistance training and the dependent variable, force control of the biceps muscle, which is shown in Table 1.

Table 1- subject's specifications

Variable	Total N=31	Control N=9	Machine N=11	Traditional N=11
Weight(kg)	75.41	75.6	75.7	74.9
Height(cm)	1.836	1.835	1.841	1.831

After grouping, the subjects participated in the force control test with the 3 ISO Device. The validity and reliability of the test were examined by testing eight subjects (piloting the study). The re-test Method was used for testing the reliability. At first, a test was administered, and to avoid the effect of learning and memory, the second test was administered after one month. Then, the correlation between the first and second tests was measured by using the Spearman correlation test (right hand = 0.873 and left hand = 0.735). The validity of the test was also examined by experts and professors of the university.

A force control test using 3ISO device:

This test was performed using a 3ISO device. In this way, after taking the test of a maximum repetition using dumbbells, 80% of a maximum repetition measured as a pattern is entered in the device memory and drawn on the monitor. The thickness of this template is adjustable and can be thinner depending on the professionalism of the user. After determining the pattern and initial settings such as lever length, height, etc., the subject starts the movement of the device by applying pressure equal to half the pattern, and in the scope

of the subject, he is obliged to follow the desired pattern and try to overlap with the pattern as accurately as possible. The thickness of the force applied by the subject is the same as the pattern but with a different color. This test was taken 3 times from the subjects and the best result was recorded based on the percentage of the overlap. In the figure displayed below, an example of the pattern and force of the subject can be easily seen. The horizontal axis is according to the degree of range of motion and the vertical axis is due to the force applied in kilograms. The first chart on the left is the introverted movement and the second chart on the right is the extroverted movement.

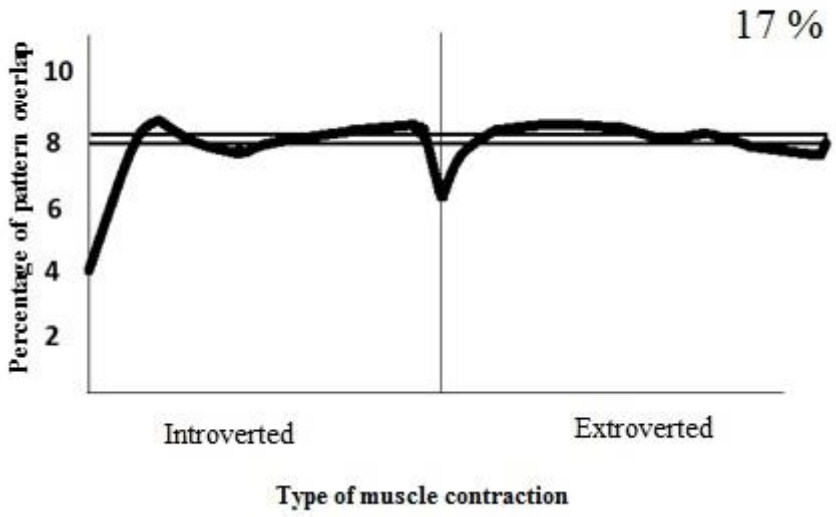

Figure 2 - Force control output of 3 ISO machine

This test was taken once before performing the exercise protocol and the other time after performing it. The experimental group's practice protocol included exercising resistance training for eight weeks three sessions each week at 50-85% intensity with one maximum repetition of 2 to 3 sets, starting in the first week with 50% of a maximum repetition of 20 repetitions in 2 sets and in the eighth week, the intensity increased to 85% with a maximum repetition of 8 repetitions in 3 sets. Therefore, the two experimental groups performed with the same intensity and volume of exercise, and only the instrument used in these groups was different so that the training group with the machine did this exercise with 3 ISO machine, The amount of weight, right and left hand and elbow joint angle were different during training. These variables were determined by the test and the participants were unable to change them. And the traditional resistance training group exercised with a dumbbell, and then in the post-test also the force control was examined for the maximum of the subject's new strength. The following table shows the way of practicing eight weeks in the two experimental groups, as displayed in Table 2.

Table 2 - Practice protocol

Traditional group	3 ISO group	
Repetition 15-20 ، pressure50-60)1RM(2-3 sets	Repetition 15-20 ، pressure50-60) 1RM(2-3 sets	**Weeks 1 and 2**
Repetition 12-15 ، pressure 60-75 2-3 sets	Repetition 12-15 ، pressure 60-75 2-3 sets	**Weeks 3 and 4**
Repetition-10 ، pressure 75-85 3 sets	Repetition-10 ، pressure 75-85 3 sets	**Weeks 5 and 6**

Repetition below 8 ، pressure above 85 3 sets	Repetition below 8 ، pressure above 85 3 sets	**Weeks 7 and 8**

Statistical analysis

The Shapiro-Wilk Test was used to check the normality of the data distribution. Regarding the normality of the data, the researchers employed MANOVA and follow-up LSD tests to compare the subject's intergroup and intra-group. Statistical analysis was performed using SPSS software with a significant level of $p < 0.05$.

RESULTS

Having collected and analyzed the data, the researchers obtained the following results from the right-hand control force test with the 3 ISO machine. While the right-hand control in the traditional group increased by 17.3% and it increased by 38.44% in the 3ISO Device group. In sharp contrast to the improvements made in the above-mentioned groups, the researchers observed no significant changes in the control group. Moreover, the increase in the machine group in the post-test stage was 21.14% higher than that of the traditional group. In other words, a significant difference existed between the pre-test and post-test 3 ISO in the exercise group with Device ($P = 0.0001$), while the difference was not significant in the traditional and control groups ($P = 0.094$ and $P = 0.073$ respectively). In the same vein, in the post-test, a significant difference existed in the amount of right-hand control in the exercise group with the machine compared to the traditional resistance and control groups ($P = 0.016$ and $P = 0.0001$ respectively).

Table 3 - Kolmogorov-Smirnov Test

Variables / Groups	Smirnov statistic	Smirnov Sig	Shapiro statistic	Shapiro Sig
3ISO Device	0.094	0.20	0.969	0.486
Traditional	0.109	0.20	0.978	0.746
Control	0.156	0.052	0.969	0.505

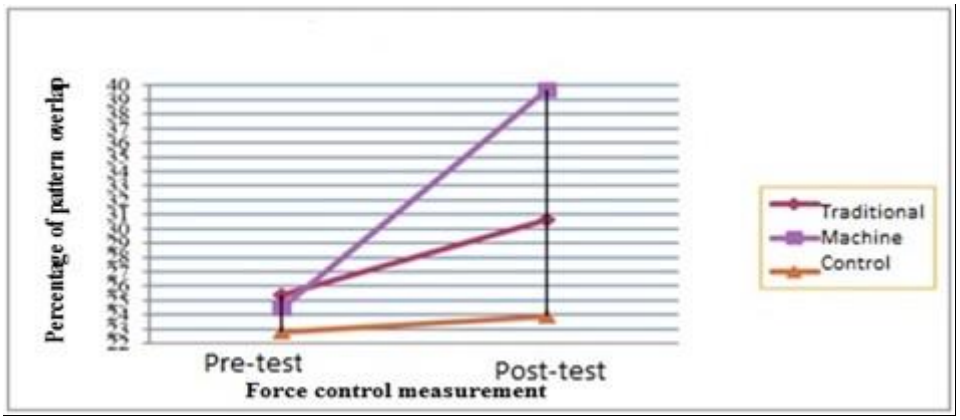

Diagram 1 - Right-hand control

The left-hand force control test showed that the left-hand force control in the traditional group increased by 10.17%, and in the machine group it increased by 33.41%, while there were no significant changes in the control group. Furthermore, the increase in the machine group in the post-test stage was 23.24% higher than that of the traditional group. In other words, there was a significant difference between the pre-test and post-test in the exercise group with 3 ISO ($P = 0.0001$), while it wasn't significant in the traditional and control groups ($P = 0.163$ and $P = 0.315$, respectively). Similarly, in the post-test stage, there was a significant

difference in the amount of left-hand force control in the exercise group with the machine compared to the traditional resistance and control groups (P = 0.018 and P = 0.001, respectively).

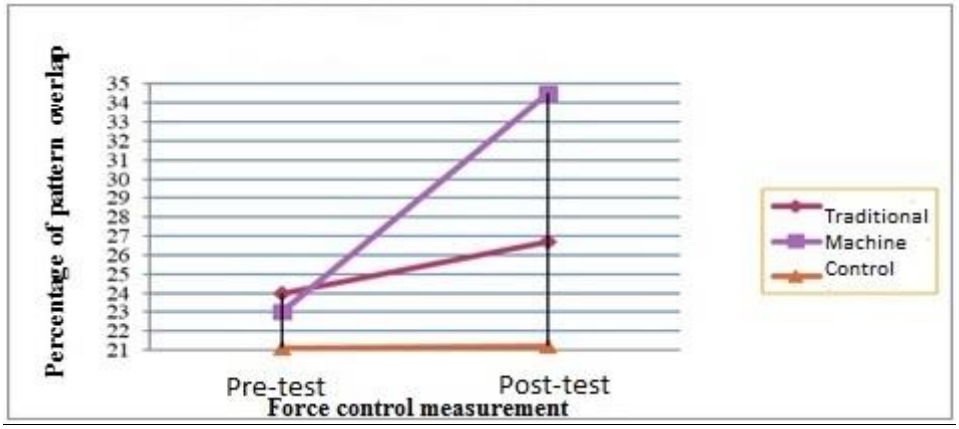

Diagram 2- left-hand force control

DISCUSSION

The aim of this this study was to compare resistance training with 3ISO device and traditional resistance exercises on biceps brachii muscle strength control on male volleyball players. The results showed a significant difference between the exercise group with the 3ISO device and the other two groups. In the 3ISO device, force control was conducted by visual feedback may be due to coordinating of motor units of muscles in applying force on all range of motion and aligning the direction of the motor units of the muscle fibers, thus producing more and better force. At the same, in a study conducted by Bellew on older people, he examined the force control and the maximum force after a period of intense exercise (15). He measured the isometric power at 30, 60, and 90 percent of the maximum force in a different range of knee extensors. But an intense exercise period did not have any effect on force control. Therefore, the result of this study was consistent with the findings of this research.

The most striking example of this is the passes of a passer in the volleyball, in which the ball should be delivered to the precise point with a precise height, and for this purpose deltoid, armpit, biceps and triceps, and forearm extensors and flexors should apply the proper force to the ball with superb high coordination, that in this group is the precise control of the applying force to the ball. In the 3 ISO machine, due to the visual feedback received from the computer monitor at any given moment, the force applied to the lever must be set at any moment in the range of motion (17, 19). According to the results, this method is likely to have a positive impact on the control of the force. Therefore, the results of this study showed that the force control by using 3 ISO Device is much higher than the traditional resistance training, which leads to more precise and more controlled movements in athletes along with increased strength and would be useful for injury rehabilitation (21).

Moreover, studies are available that show that exercise develops the athletes' Proprioception. In this regard, Swanik et al in their research stated that the Proprioception and motor sense of athletes significantly improves after plyometric exercises (22). They argued that Proprioception was altered by the adaptations of the central

nervous system and mechanosensory neurons. They also believed that continuous stimulation of joint mechanical receptors could create adaptations in the peripheral nervous system. In this regard, plyometric exercises require muscle activation in the preparation phase in anticipation of catching the ball and involuntary activation of the muscles to produce introverted force during throwing, and these adaptations can lead to conscious awareness of the joint position.

In the same vein, similar findings were reported by Boyar (23). He found that the shoulder joint Proprioception of skilled tennis players in service, forehand, and backhand conditions was better than that of the non-athlete control group, but in another study done by Kabel et al, they found that there was a significant difference between the shoulder joint Proprioception of volleyball players(24). There were no skilled and novice in the three different angles, before and after fatigue. Accordingly, it can be concluded that athletes possess a stronger sense of Proprioception in comparison with non-athletes due to exercise and also due to motor learning of their lower nerve centers that (e.g. Muscular spindle and Golgi tendon organ) play a dominant, pivotal and determining role in producing, launching and controlling movements.

CONCLUSION

In summary, it seems that this device can improve the Proprioception receptors and the central and peripheral nervous system by Muscular spindle and Golgi tendon organ, and in general using visual feedback similar to biofeedback devices can help improve athletic performance in a long time by enhancing better error detection capacity and creating a better movement pattern similar to a sports skill pattern such as spike volleyball.

Based on the obtained results of this research, coaches and athletes for better results, especially in professional athletes, would use modern sports technology such as the 3ISO device which can lead to improved force control and greater accuracy and speed than traditional resistance training.

ACKNOWLEDGEMENTS

And finally, I would like to express my gratitude to all the professors of Sport Sciences at University of Qom, the managers of the physical education and sports departments of Mobarakeh city of Isfahan, and all volleyball players in Mobarakeh who assisted and accompanied the researchers to carry out this research.

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چکیده فارسی

مقایسه تاثیر تمرین با دستگاه 3 ISO و تمرینات مقاومتی سنتی بر کنترل نیرو عضله جلو بازو مردان والیبالیست نیمه حرفه ای

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چکیده: استفاده از فناوری های مدرن به ورزشکاران این امکان را داده است تا در حد توان خود تمرین کرده و خود را برای مسابقات آماده کنند. والیبال رشته ای است که سرعت و دقت در آن نقش اساسی دارد. هدف از این مطالعه بررسی کنترل نیرو توسط دستگاه اختراعی می باشد. در این تحقیق نیمه تجربی، ۳۱ بازیکن والیبال مرد به طور تصادفی در گروه تمرین سنتی (۱۱ نفر)، گروه دستگاه 3ISO (۱۱ نفر) و گروه کنترل (۹ نفر) قرار گرفتند. آزمون یک تکرار بیشینه دو سر بازو، آزمون حداکثر قدرت ایزومتریک در چهار زاویه، و آزمون کنترل نیرو در ابتدا و ۸ هفته بعد در پایان مطالعه بررسی شد. کنترل نیروی راست و چپ از ابتدا تا بعد از مداخله با آموزش با دستگاه 3ISO بهبود یافت، در حالی که این تغییرات در گروه های کنترل و تمرینات سنتی معنادار نبود. در نهایت، نتایج این مطالعه نشان داد که کنترل نیرو توسط دستگاه 3ISO بهتر از تمرین سنتی است، که منجر به حرکات دقیق تر و کنترل شده در ورزشکاران می شود.

واژه های کلیدی: کنترل نیرو، قدرت عضلانی، تمرین مقاومتی، دستگاه تمرین مقاومتی، دستگاه 3 ISO