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Functional aspects of strength training using Vascular Occlusion

Aspectos funcionais do treinamento de força com a utilização do uso da Oclusão Vascular

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ABSTRACT

Searches for the practice of weight training have grown widely in Brazil and around the world. This practice is used for various purposes, such as maintaining health, improving performance and aesthetic purposes, seeking to promote muscle improvement, increased strength, among other benefits. Strength training with vascular occlusion consists of the use of a flexible cuff in the muscles worked at low intensity, and can be directed to different practitioners, from people in rehabilitation to even high-performance athletes. Thus, the objective of this study was to review the literature on strength training using vascular occlusion. This type of training has been offering excellent results for increasing muscle mass and strength, and can be applied to all types of bodybuilders from young people to the elderly, being recommended for people who cannot reach high load levels. The use of occlusion with low intensity induces an improvement in muscle hypertrophy and an increase in strength in the flexor muscles in general, contributing to the professional and academic scenario on occlusive training and its practice.

Keywords: Training, Vascular Occlusion, Hypertrophy, Strength, Bodybuilding.

INTRODUCTION

The practice of physical activities, when performed habitually, generates benefits for the subject, preserving their health, improving their quality of life and their functional capacity, where it is used in their daily lives (Macedo et al; 2012; Souza et al., 2024).

Currently, strength training (ST) has been used for various purposes, whether for aesthetic, athletic, therapeutic, or recreational purposes (Marchetii et al., 2014). ET is also known as resistance training or weight training and these terms have been used to describe a form of

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exercise that causes the body's muscles to perform movements or try to move against an opposition of a force exerted by some equipment (Fleck and Kraemer, 2017). Bompa (2002) defines SSD as a "neuromuscular capacity to overcome external and internal resistance".

Within the training strategies, there is a method little used in Brazilian weight rooms, it is vascular occlusion training or KAATSU training (Macedo et al., 2024), where the practitioner uses a flexible cuff in the muscles and works the series of exercises with low intensity, this type of training is highly recommended for people who do not achieve high levels of workloads (Takarada, 2000).

Occlusive training aimed at muscle hypertrophy can be worked with low load levels and also when used to failure, the effects are significantly high, when compared to conventional bodybuilding (KIMURA et al., 2016), however there are several factors that contribute to muscle hypertrophy, with hormones being considered significantly, where testosterone positively influences the increase in muscle mass and strength (Fett and Fett, 2003), and can be divided into two types of hypertrophy, acute and chronic. Acute is considered as the increase in muscle volume during the training session, due to the accumulation of intramuscular fluid. Chronic hypertrophy occurs during strength training and is related to changes in the physiological muscle cross-sectional area, also considering the increase in myofibrils, number of myosin actin filaments, connective tissue or a combination of these factors (Bucci et al., 2005).

This training method, when aimed at athletes, has a very significant gain in the level of muscle mass (Barcelos et al., 2016), when directed to the elderly, occlusive training promotes a hypertrophic gain of up to 20% in body volume, with a low intensity, one of the main benefits for the elderly is that this training minimizes damage to their joints (Teixeira, 2012).

Occlusive training when worked with very high loads does not have the same effect when compared to training with low intensity of up to 30% of 1RM, where it causes much more intense and accentuated muscle edema in the individual (Medrano et al., 2015). There are some restrictions for practitioners of the vascular occlusion method, such a method can cause some side effects such as subcutaneous hemorrhage, venous thrombosis, pulmonary embolism, numbness, sensation of cold, among others, thus, the work of vascular occlusion, when compared to training without vascular occlusion, shows superior results when worked at the same intensity (Nakajima, 2006).

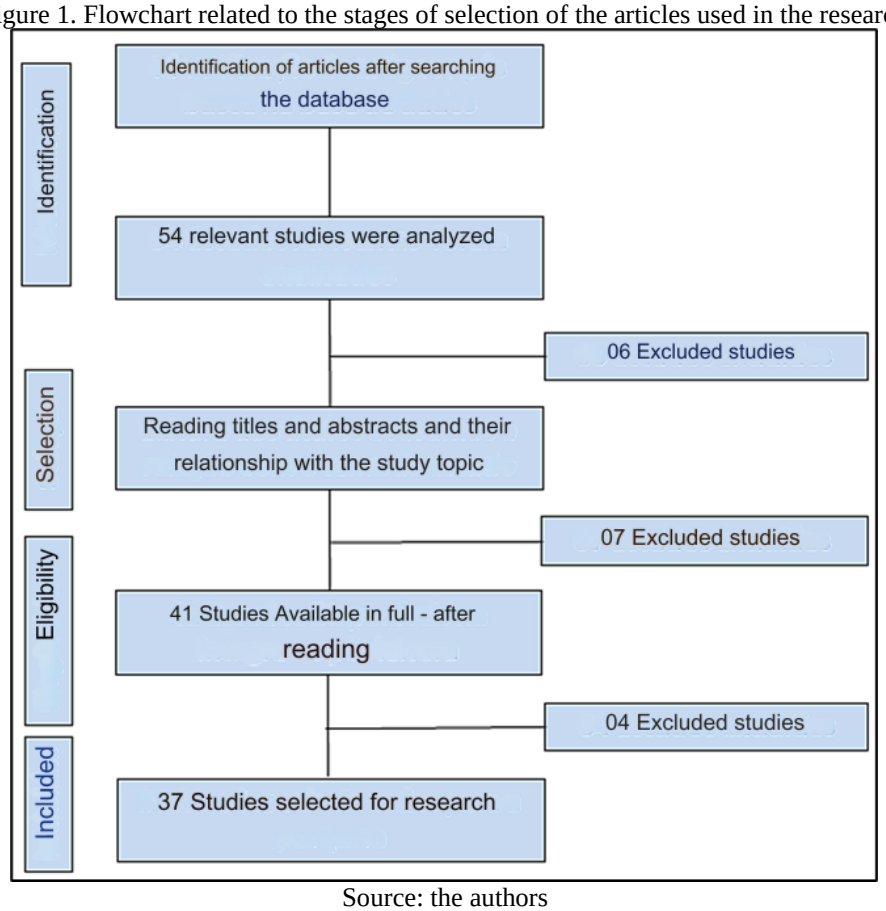
In view of these points, the objective of this article was to work on the functional aspects of strength training with the use of vascular occlusion, demonstrating greater dissemination in the academic scenario of a method that can be explored, as the number of professionals with knowledge and experience of occlusive training is scarce.

METHODOLOGICAL PROCEDURES

For the composition of this review, a bibliographic survey was carried out in the Scielo databases, Portal de Periódicos da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), specialized scientific journals indexed in Google Scholar with the selection of scientific articles published between the years 2000 and 2024, using as descriptors alone or in combination, English and Portuguese: Training, Vascular Occlusion, Hypertrophy, Strength and Bodybuilding.

For the selection of the material, three steps were carried out. The first was characterized by the research of the material that comprised between the months of November 2023 and May 2024 with the selection of 54 works. The second included the reading of the titles and abstracts of the papers, aiming at a greater approximation and knowledge, excluding those that had no relationship and relevance with the theme. After this selection, the texts that were available in full were searched, totaling 37 studies, which were included in the review Figure 1.

Figure 1. Flowchart related to the stages of selection of the articles used in the research



Source: the authors

The analysis of the researched references verified the evaluation of the methodology used, the results obtained and the conclusions presented. This analysis of different studies

provided a complete view of vascular occlusion and training. The articles selected and included in the research consisted of original articles, reviews and systematic reviews of the literature. As criteria for eligibility and inclusion of the selected articles, the origin of the journal and indexing were analyzed, as well as studies that presented data related to the theme addressed. In the reading and evaluation, the articles that presented the eligibility criteria were selected and included in the consensus search. As exclusion criteria, incomplete reference and information that is currently discredited and not consistent with the proposed objective were used.

RESULTS AND DISCUSSION

CHARACTERISTICS OF THE OCCLUSIVE METHOD

TF is suitable for increasing endurance strength, maximum strength, absolute strength, explosive strength and hypertrophic strength, muscle power and aid in quality of life. However, the patterns of application and objective may vary (ACSM, 2002). ET today is important not only for the improvement of athletes, but also for the health of people in general. To maximize the benefits, it is important to understand the mechanisms responsible for adaptations (Barroso et al., 2005).

Marchetti et al. (2014), exalt the importance of the three types of strength in training: concentric strength, eccentric strength and isometric strength. Thus, each athlete can originate different forces during the execution of movements, in addition to training for maximum strength, endurance and speed.

As for vascular occlusion training or KAATSU training, according to Sato (2005), the history of occlusive training begins in the middle of 1967 when, after using the occlusive method, SATO had to be hospitalized, leading to attacks of shortness of breath and later to pulmonary embolism. In 1973, after a major experimental accident where SATO had a fracture in his ankles and cartilage injuries, as he did not want to abandon his life's project, he decided to put one of his legs in molds, where a process of muscle atrophy occurred, and with that he began to apply his technique to himself, obtaining excellent results when he reached the ideal pressure of the method (Sato, 2005).

With almost 40 years of experiments with the aim of increasing muscle mass and improving people's quality of life (SATO, 2005), this method has come to be applied in different areas, such as sports and mainly in the health sector (Nakajima, 2006).

With the significant increase in the method, especially in Japan, it has become more explored and improved nowadays, where numerous studies have shown that occlusive training causes physiological adaptations with loads of up to 10%, and can be applied with a cuff or even

with an elastic band, not having the same efficiency as the cuff, as it is not possible to have an ideal control of blood pressure, with both the cuff and the elastic, it is necessary to reach sufficient pressure to block venous return (Loenneke et al., 2009).

According to Loenneke et al. (2009), occlusive training is more effective when used in smaller muscle groups, especially in upper limb muscles, with occlusive use it is possible to increase the number of repetitions with the same load when compared to conventional exercise (Cook et al., 2010).

When aimed at athletes with an intensity of 20% of 1RM, with at least 16 repetitions per training session, a blood pressure of 218 mmHg, with a weekly frequency of 2 times a week for 8 weeks, presents a significant gain in the level of muscle mass for athletes in recovery or even injured (Barcelos et al., 2016), when directed to the elderly, occlusive training promotes a hypertrophic gain of up to 20% in body volume, with a low intensity, one of the main benefits for the elderly is that this training minimizes damage to their joints (Teixeira, 2012).

According to Medrano (2015), who compared different levels of load for the application of the occlusive method, with experiments in 10 physically active men in resistance training using elbow flexion as an exercise, applied loads of 30% and later 70% with an interval of seven days between each protocol, the protocols were carried out until the concentric muscle failure of the individuals, Using 3 sets with 60 seconds of rest between sets, where variables such as arm circumference, muscle water content and lean content were analyzed, the study found more expressive results when the occlusive method was worked with an intensity of 30%, where it causes much more intense and accentuated muscle edema when compared to high intensity.

Another point addressed by Abe et al. (2009), the KAATSU does not bring major changes in relation to body weight and BMI index of the practitioners, however the muscle volume changes, the occlusive method manages to maintain a constant hypertrophy for 4 to 10 weeks of training, but does not present a significant increase in strength, an initial pressure of 140 vs 160 mmHg should be used and in the final training 160-240 mmHg so that it does not cause some risk to the practitioner (Loenneke et al., 2012).

This technique causes an increase in muscle volume in the first training session, in a short period of 7 days of KAATSU, the study showed an increase in muscle volume of approximately 5%, in relation to strength there was an increase of 17% in this period, when used at an intensity of 20% 1 RM being equivalent to a training with an intensity of 65% 1 RM of conventional training without occlusion, it also verified a 290-fold increase in GH in just 3 weeks of training (Loenneke et al., 2009).

According to Abe et al. (2012), occlusive training when prescribed for the muscles of the upper limbs causes hypertrophy in the restricted muscles and upper non-restricted muscles, and when used in the lower limbs it causes hypertrophy only in the blood flow, with the use of the method it improves the accumulation of blood lactate at low concentration levels (Takarada et al., 2000).

According to Loenneke et al. (2009), the American College of Sports Medicine (ACSM) recommends that to obtain hypertrophic results, the resistance used should be approximately 65% of 1RM of 6 to 12 repetitions so that the muscle is efficiently stimulated, increasing the cross-sectional physiological area, with the use of the occlusive method one should work with a resistance between 20 and 50% of 1 RM, such resistance causes similar edema and structural adaptations in the muscle when compared to high-intensity work without occlusion (Medrano, 2015).

Occlusive training can provide hypertrophic stimuli for high-level athletes who are very significant, the recovery time is shorter compared to conventional training, the method can be used with specific training in the athletes' training and inserted into their training routine, which favors a more effective training without a decrease in performance (Abe et al., 2005).

Twelve physically active subjects performed unilateral knee extensions, using non-occlusion training with 70% of the load on one leg and occlusive training with 30% loads on the other, the study showed an increase in resting tension for the acutely occluded leg up to 24 hours after exercise, causing muscle pain up to 72 hours after the exercise session (Wernbom et al., 2012). Muscle soreness after 8 hours of conventional exercise sessions progresses in the first 24 hours, reaching up to 72 hours. After this period, pain decreases, and 5 to 7 days after the session, it will cease (Wilmore et al., 2001).

As for the restrictions for practitioners of the vascular occlusion method, this method can cause some side effects such as subcutaneous hemorrhage, venous thrombosis, pulmonary embolism, brain numbness and anemia, feeling cold, among others (Nakajima, 2006). According to Loenneke et al. (2009), people with endothelial dysfunctions should not use this method because reduced blood flow can trigger thrombosis.

BENEFITS OF VASCULAR OCCLUSION

According to Nakajima (2006), occlusive training can be used in people with various types of physical conditions, such as people with heart and muscle diseases, diabetes, high blood pressure and respiratory diseases. It can be applied to people in a state of rehabilitation, stimulating hormonal responses, such as growth hormone (Sato, 2005).

According to Takarada et al. (2000), the use of occlusion with low intensity induces an improvement in muscle hypertrophy and an increase in strength in the flexor muscles in general, the use of occlusion, even when not stimulated through exercise, is effective in reducing muscle atrophy. The method does not show much difference between exercises performed in men or women, and does not find significant differences in relation to the lower limbs (Ysuda et al., 2014). Training does not alter the resting blood flow of practitioners, including an increase of approximately 3% in the diameter of the brachial artery (Hunt et al., 2012).

According to Sato (2005), because the population is becoming more and more macrobial, the occlusion method can contribute to the reduction of health-related expenses, thus contributing to the improvement of the quality of life in the elderly. According to Nakajima (2006), the main benefits of this method are improvement in the muscular system, improvement in paralysis, reduction in obesity and help in rehabilitation in elderly people, other benefits include improvement in BERGER's disease, reduces arteriosclerotic disease, bone atrophy, pain relief, aging control and health maintenance.

Vascular occlusion radically alters the plasma concentration of the bloodstream, with a 290-fold increase after the training session, thus leading to a significant increase in muscle power and in relation to the body's endocrine responses (Takarada et al., 2000). For the application of this method in people with local hemorrhage or heart disease, there must be specific monitoring by the professional responsible for the application of the KAATSU (Sato, 2005).

According to Letiere (2012) this method is extremely important for the population that suffers from joint difficulties, occlusive training for people with more advanced ages promotes gains in muscle volume index of approximately 12% in relation to the pectoral muscles (Thiebaud et al., 2013).

Regarding occlusion training protocols, Table 1 describes the use by numerous authors.

Table 1. Occlusion training protocols used.

Protocols	N for the experiments and exercise	Blood pressure	Intensity	Training frequency	Results Hypertrophic	Strength
Ysuda et al., (2010)	Men aged 22 to 28 years, Forearm flexion	100 to 160 mmHg	30% of 1RM	3x per week, 6 weeks	5% in arm hypertrophy	8,6 %
Weatherholt et al., (2013)	40 University Students, Push-up and Extension	90 to 180 mmHg	20% of 1RM	2x per week	4.7% Arm Hypertrophy	11% Flexion and 13% in Extension
Ysuda et al., (2014)	21 people, 6 men and 15 women, Leg Extension and Leg Press	270 mmHg	20 to 30 % of 1 RM	3 x weeks, for 6 weeks	Adductor 8% and gluteal 4.4%	Leg extension 26% and Leg 33.4%

Thiebaud et al., (2013)	14 untrained 64-year-old men, Bench Press and Row	80 a 120 mmHg	15 to 30% of 1 RM	2x per week, 8 weeks	12% on the pectoralis	12%
Fugita et al., (2008)	16 healthy young people, Extension Kneeling	200 mmHg	20% 1RM	2 x per day 6 weeks	Quadriceps 5,2%	1RM 6.7%
Abe et al., (2010)	16 men and women between 68 and 70 years old walk	160 to 210 mmHg	40% VO2 Max	3 x week	Quadriceps 4,6%	1RM 7,7%
Ysuda et al., (2011)	30 men aged 22 to 28 years, Bench Press	100 to 160 mmHg	30% 1RM	6 x per week	Triceps 8% and pectorals 16%	1RM 6%

Source: Adapted by the authors.

Abe et al. (2010), evaluated the effects of occlusive work for quadriceps muscles in 20-minute walks over a 6-week period. The study included 16 subjects, including men and women aged between 60 and 78 years, all of whom were physically active, and most of them performed daily walking exercises. The training took place for 6 weeks being carried out 5 days a week, walks were performed where the cuff pressure was increased every 30 seconds and released every 10 seconds of walks with an intensity of 40% in VO2max, this process was repeated until the final occlusion pressure for each day of training, with a blood pressure of approximately 160 mmHg and increasing by 10 mmHg per day of training, reaching the end with 210 mmHg. Quadriceps muscle activation was evaluated. The results showed that there was an increase in quadriceps muscle hypertrophy by 4.6% and the strength of 1RM increased by 7.7% in this period.

Abe et al. (2005), evaluated the effects of occlusive work on the quadriceps muscles over a period of 7 days. A 47-year-old male subject participated in the study. The training took place 7 days a week for 1 week, 30 repetitions were performed with a rest of 30 seconds per session, with an intensity of 20% of 1RM, and with a blood pressure of approximately 160 mmHg and increasing 20 mmHg per day of training reaching the end with 220 mmHg. Quadriceps muscle activation in knee extension was evaluated. The results showed that there was an increase in quadriceps muscle hypertrophy by 4.8% and isometric knee extension strength increased by 17% in this period.

Ysuda et al. (2010), evaluated the effects of occlusive labor for the triceps brachii muscles over a period of 2 weeks. The study included 10 male subjects, aged between 23 and 38 years, active practitioners of resistance training and aerobic exercises. The training took place for 2 weeks in a total of 24 training sessions, 30 repetitions were performed in elbow extension

without rest, and after 30 seconds 15 more repetitions were performed, adding to the total 75 repetitions, with an intensity of 30% of 1RM, and with a blood pressure of approximately 100 mmHg and increasing 10 mmHg per training day, reaching the end with 160 mmHg. Triceps muscle activation in elbow extension was evaluated. The results showed that for the increase in muscle hypertrophy there was a gain of approximately 5% and the isometric strength of elbow extension increased by 8.6% in this period.

Fugita et al. (2008) evaluated the effects of occlusive work on quadriceps muscles in knee extension over a 6-week period. A total of 16 healthy young subjects participated in the study. The training took place 2 days a week for 6 weeks, 30 repetitions were performed with a rest of 30 seconds per session, adding up to a total of 75 repetitions in 8 minutes, with an intensity of 20% of 1RM, and with a blood pressure of approximately 200 mmHg. The results showed that there was an increase in quadriceps hypertrophy by 5.2% and the strength of 1RM knee extension increased by 6.7% in this period.

Thiebaud et al. (2013), evaluated the effects of occlusive work on the pectoral muscles over a period of 8 weeks using low-intensity elastic bands. The study included 14 male subjects, aged 62 years, who were untrained. The training was 2 days a week for 8 weeks, 3 sets of 10 repetitions were performed, with an intensity of 15% to 30% of 1RM, and with a blood pressure of approximately 80 mmHg to 120 mmHg. Muscle activation of the pectoral muscles was evaluated. The results showed an increase in pectoral muscle hypertrophy of approximately 12% and 1RM strength of 12% in this period.

Weatherholt et al. (2013), evaluated the effects of occlusive work for the biceps brachii muscles in elbow flexion and unilateral triceps extension over an 8-week period. The study included 40 subjects, university students aged between 18 and 30 years. The training took place for 8 weeks, repetitions were performed within a stimulated time until muscle failure was reached, with an intensity of 20% of 1RM in elbow flexion and extension exercises, and with a blood pressure of approximately 90 mmHg to 180 mmHg. Muscle activation of the biceps brachii and triceps brachii in elbow extension and flexion was evaluated. The results showed an increase in muscle hypertrophy of approximately 4.7% in the arm muscles and the isometric strength of elbow extension increased by 13% and in flexion by 11% in the period evaluated.

Ysuda et al. (2011), evaluated the effects of occlusive labor for the triceps brachii and pectoralis major muscles over a period of 6 weeks. The study included 30 male subjects, aged between 22 and 28 years. The training took place 3 days a week for 6 weeks, 75 repetitions were performed divided into 3 sessions with a rest of 3 min per session, with an intensity of 30% of 1RM, and with a blood pressure of approximately 100 mmHg and increasing 10 mmHg per day

of training, reaching the end with 160 mmHg. Muscle activation of the triceps brachii and pectoralis major in elbow extension were evaluated. The results showed that there was an increase in triceps muscle hypertrophy by 8% and pectoralis major hypertrophy by 16% and isometric elbow extension strength increased by 6% in this period.

Ysuda et al. (2014), evaluated the effects of occlusive work for quadriceps muscles in flexion and leg press over a 12-week period. 21 subjects participated in the study, 5 men and 16 women aged between 61 and 84 years and the participants could not have suffered diseases or had chronic diseases such as hypertension, orthopedic disorders, deep vein thrombosis, peripheral vascular disease or cognitive dysfunction, so all subjects were free of these diseases. The training took place for 12 weeks, 75 repetitions were performed in knee extension without rest, and after 30 seconds 15 more repetitions were performed, adding up to a total of 75 repetitions, with an intensity of 20% to 30% of 1RM divided into 2 specific exercises, and with a blood pressure of approximately 90 mmHg to 180 mmHg. The following were evaluated: adductor and gluteal muscle activation in knee extension and leg press. The results showed that for the increase in muscle hypertrophy there was a gain of approximately 8% in the adductor muscles and 4.4% in the gluteal and the isometric strength of leg extension increased 26% and in the leg press 33.4% in the period evaluated.

FINAL CONSIDERATIONS

The use of low-intensity occlusion induces an improvement in muscle hypertrophy and an increase in strength in the flexor muscles in general, the occlusion method can contribute to the reduction of health-related expenses, due to the population reaching longevity and thus contributing to the improvement of quality of life in the elderly. With the use of the method, significant results are highlighted, for the purposes of muscle hypertrophy, without major joint wear, showing practitioners that hypertrophic gains can occur without a high level of load in training.

The main benefits of this method are the improvement in the muscular system, improvement in muscle paralysis, reduction in obesity and other benefits include improvement in BERGER's disease, arteriosclerotic disease, bone atrophy, pain relief, control of aging and maintenance of health in general. In view of the numerous benefits of the occlusive method, its application is very relevant, but it cannot be carried out without guidance, requiring professional knowledge.

Despite the need for new studies to corroborate for further clarification of the action of occlusive training, it is concluded that this theme has a lot of relevance both in the academic and

professional environments because it is a method that brings benefits to the bodybuilding public and can be applied from young people to the elderly, with restrictions of high load levels and can be athletes and not athletes.

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