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Efeitos do Treinamento de Força Sobre a Discinesia Escapular: uma Revisão Sistemática

Effects of Strength Training on Scapular Dyskinesia: A Systematic Review

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Abstract

Scapular dyskinesia refers to the functional disorder that affects the shoulder complex. Strength training has recently been used as a non-pharmacological strategy to minimize functional disorders that affect the musculoskeletal system. However, the evidence pointing to the contributions of strength training on scapular dyskinesia is still poorly understood. Therefore, the objective of the present study was to systematically review the evidence on the effects of strength training on scapular dyskinesia. The search for articles was carried out in the index databases Google Scholar, SciELO and PubMED until October 2017, with the application of the following descriptors: "scapular dyskinesia" and "strength training" in Portuguese and English, in different orders and combinations. Two researchers participated in the process of searching and selecting the articles and the PEDro scale was used as an instrument to evaluate the quality of the studies. 12 articles were found and after the application of the inclusion and exclusion criteria six manuscripts presented eligibility to compose the review. The evidences found allows us to point out the effects of strength training on the increase of lean mass, strengthening of the shoulder complex, reduction of reported pain and improvement in movement pattern. Therefore, considering the evidence found, strength training is suggested as one of the possible and efficient strategies in the people's rehabilitation with scapular dyskinesia.

Keywords: *Exercise Therapy. Rehabilitation. Musculoskeletal System.*

Resumo

A discinesia escapular faz referência ao distúrbio funcional que compromete o complexo do ombro. O treinamento de força, recentemente, tem sido utilizado como estratégia não farmacológica para minimização dos distúrbios funcionais que comprometem o sistema musculoesquelético. Todavia, as evidências que apontam as contribuições do treinamento de força sobre a discinesia escapular ainda são pouco conhecidas. Portanto, o objetivo do presente estudo foi revisar de forma sistemática as evidências sobre os efeitos do treinamento de força sobre a discinesia escapular. A busca dos artigos foi realizada nas bases indexadoras Google Acadêmico, SciELO e PubMED até outubro de 2017, com a aplicação dos seguintes descritores: "discinesia escapular" e "treinamento de força" em português e inglês, em diferentes ordens e combinações. Dois pesquisadores participaram do processo de busca e seleção dos artigos e a escala PEDro foi utilizada como instrumento de avaliação da qualidade dos estudos. 12 artigos foram encontrados e após a aplicação dos critérios de inclusão e exclusão seis manuscritos apresentaram elegibilidade para compor a revisão. As evidências encontradas permitem apontar como efeitos do treinamento de força o aumento da massa magra, o fortalecimento do complexo do ombro, a redução da dor relatada e a melhora no padrão de movimento. Logo, considerando as evidências encontradas, sugere-se a treinamento de força como uma das estratégias possíveis e eficiente na reabilitação de pessoas com discinesia escapular.

Palavras-chave: *Terapia por Exercício. Reabilitação. Sistema Musculoesquelético.*

1 Introduction

The shoulder joint is the most complex of the human body, because it includes different joints and that need to be in extreme harmony for a freedom of movement, these joints are: glenohumeral, sternoclavicular, acromioclavicular, coracoclavicular and scapulothoracic. In all this joint complex there are four muscles which contribute to the glenohumeral joint stabilization, namely: subscapular, supra-spinal, infra-spinal and teres minor, together form the rotator cuff. The function of the rotator cuff is to assist the rotational movements of the shoulder joint and give the glenohumeral joint stability by the fact that it is unstable. This stability is permitted by the muscles anatomy that make up the cuff compress the humeral head against the glenoid cavity[1].

The sternoclavicular joint and the clavicle proximal end articulates with the clavicular notch of the manubrium of the sternum and the cartilage of the first rib. This joint provides the main axis of rotation for the movements of the clavicle and scapula. This joint is classified as a spheroid modified articulation, allowing movements in the frontal plane, and transverse and sagittal rotation forward and backward allowed. A fibrocartilaginous articular disk improves the adjustment of articular bone surfaces and acts as a shock absorber to impacts. The rotation occurs in the joint during

movements like shruging shoulders, raising arms above one′s head and swimming. The locking position of the joint occurs with maximum shoulder elevation[1].

The acromioclavicular joint is the acromion joint of the scapula with the distal end of the clavicle. It is classified as an irregular synovial joint, although the joint structure allows limited movement in all the three planes. The joint stability is provided by coracoclavicular ligaments. Rotation occurs in the joint during the arm elevation. The joint locking position occurs when the shoulder is abducted at 90º[2].

The coordinated movement of the scapula and humerus to achieve the shoulder motion is the key to an effective function of the whole shoulder complex. Muscle weakness, lack of mobility, presence of lesions in soft tissues and bone can change the scapula roles and change the position of the scapular rest and dynamic movement, all those disorders originate problems and lesions in the whole shoulder complex. The changed scapular movement was called scapular dyskinesia[3].

The scapula has essential functions in the shoulder. Its stability is conferred by the scapular muscles that attach it to the thorax, properly positioning the glenoide cavity in relation to the humerus and providing a stable base for the rotator cuff. The thoracic scapular mobility obeys a proportional relation during the shoulder elevation on the movements of abduction and flexion[4].

Any imbalance in the thoracic scapular rhythm will cause a scapular dyskinesia condition. This alteration consists of positioning and the scapula normal mobility in relation to the rib cage[5].

The scapula dysfunction can be secondary to postural changes, glenohumeral pathologies, as labor injuries, impact, tendonitis of the rotator cuff or as a response of muscle inhibition to a painful stimulus, scapular dyskinesia is a generic term that means exactly the place where the dysfunction occurs. The term dyskinesia is applied to abnormal active movements (volunteer) that are measured neurologically with factors controlled by tardive dyskinesia[5].

In the rehabilitation proposal of scapular dyskinesia, exercises must be included that can integrate the muscles strengthening that control and stabilize directly the scapula and all the shoulder complex[6].

The principles of strength training are the basic procedures that govern the training prescription. Among the principles already described in the literature[7], they suggest the principles of progressive overload, adaptation and specificity as needed for a prescription of safe and effective strength-training.

The resistive exercises are efficient to increase strength, hypertrophy, muscular strenght and localized muscle resistance. But depending on the objectives and individual differences, the patterns of prescription may vary[8].

It has been demonstrated that the muscle strength training causes rapid gains in the beginning, without noticing a concomitant increase in muscle mass. This initial adaptation can be explained by improvement in the standards for recruitment of motor units and can be called neural adaptation[7].

Therefore, the literature is consistent to propose strength training as a strategy for health promotion, in the same way that points the scapular dyskinesia as a joint dysfunction that undermines the human health. However, although there is a consensus among the benefits of strength training and its importance in the maintenance of the joint stability, the effects of strength training on the scapular dyskinesia are still poorly known. Therefore, the objective of the present study was to systematically review the evidences on the effects of strength training on scapular dyskinesia.

2 Development

2.1 Methodology

It is a systematic review that, according to Sampaio and Mancini[9], makes reference to a scientific research that gathers relevant studies on a question formulated, using the data base from the literature that deals with this issue as a source and methods of identification, selection and systematic analysis, with the aim of performing a comprehensive and critical review of the literature. The systematization in the review aims to avoid biases that would occur in a non-systematic review. Including biases that may occur in the form of review and articles selection, as well as those detected in the critical evaluation of each study.

The search for articles to compose the research was carried out by means of indexing databases Google Scholar, PubMED and SciELO without retrospective time cut until November 2017. The keywords used were “scapular dyskinesia”, “strength training”, “Scapular dyskinesia” and “strength training” in different order of combinations. The search was performed in the first half of the year 2017. Only original studies were included that had as its object of study the effects of strength training on the scapular dyskinesia.

PEDro assessment scale [10] was included, translated into e Portuguese language in order to describe the methodology of selected studies. PEDro scale consists of 11 evaluative criteria (Table 1), which consists of granting a point when the item was sufficiently clear in the study. The classification consists of scores: between six and 10 points (high), four and five points (moderate), zero and three points (below). It is worth the exemption that the classification proposed by the scale was applied with the purpose to describe the quality of the study, not being an eligibility criterion in this review.

Table 1 - PEDro quality Scale - Portuguese (Brazil)[11]

1	The eligibility criteria were specified	Yes	No
2	The subjects were randomly distributed in groups in a cross study, subjects were placed in groups, randomly, in accordance with the treatment received)		
3	The allocation of subjects was secret		
4	Initially, the groups were similar regarding most important prognostic indicators		
5	All subjects participated in the study in a blind way		
6	All therapists who administered the therapy did it in a blind way		
7	All assessors who measured at least one key outcome did it in a blind way		
8	Measurements of at least one key outcome were obtained from more than 85% of the subjects initially distributed by the groups		
9	All subjects from whom the measurements were exhibited the outcomes received the treatment or control condition according to the allocation or, when this was not the case, the data analysis was performed for at least one of the key results by "treatment intention"		
10	The outcomes of the statistical comparisons among the groups were described for at least one key outcome		
11	The study provides both point measures and measures of variability for at least one key outcome		

Source: Researeh Date.

2.1.1 Studies Selection

The studies selection was given through the identification of possible studies (Time 1), Studies selection based on title and abstract (time 2), studies classification through the pre-defined eligibility criteria (time 3), and inclusion of articles suitable for this review (time 4).

Table 2 - Step by step of each moment of selection of articles

Step	Procedure
Time 1	Search result by literature (n = 12)
Time 2	Excluded articles: title (n = 2) and abstract (n= 1)
Time 3	Articles selected for evaluation (n = 9)
Time 4	Articles included in the systematic review (n = 6)

Source: Shiwa *et al*.[11]

The result of PEDro scale was 9.25 ± 0.95 (mean ± standard deviation) points for the articles included in the review. According to the scale criterion, the average quality of the articles included in the review is high. Furthermore, a high degree of variation in the quality of the selected studies was not observed. Table 3 illustrates the relevant score to each study by PEDro scale.

Table 3 - PEDro scale for assessing the quality of the included studies

Studies	1	2	3	4	5	6	7	8	9	10	11	Total
Merolla *et al*.[12]	1	1	1	1	0	1	0	1	1	1	1	9
Merolla *et al*.[13]	1	1	1	1	0	1	1	1	1	1	1	10
Merolla *et al*.[14]	1	1	1	1	0	1	1	0	0	1	1	8
Merolla *et al*.[4]	1	1	1	1	0	1	1	1	1	1	1	10
Merolla *et al*.[15]	1	1	1	1	0	1	0	1	1	1	1	9
Merolla *et al*.[12]	1	1	1	1	1	0	1	0	0	1	1	8

Source: Research Data.

The studies showed positive associations between the scapular dyskinesia and pain. In addition, strength training demonstrated important effects such as increased strength and, consequently, pain reduction. Table 4 presents a summary of the main information extracted from the studies.

Table 4 - Description of the selected studies

Study	Objective	Methodology	Outcomes
Merolla *et al*.[12]	This study tested the hypothesis that the infra-spinal strength in professional volleyball players can be evaluated with the scapula (infra-mirror resistance test) and retracted scapula (retraction test of the infra-mirror scapula) before and after the training of the scapular musculature.	31 professional volleyball players . Intra-mirror strength test and with the retraction test of the scapula infra-mirror. A hand dynamometer was used and compared with the values found after 3 and 6 months of rehabilitation. The magnetic resonance imaging was performed to exclude the joint and the cuff pathology Pain scores were evaluated using a visual analogue scale.	Strength after 3 months (P<0.01) and 6 months (P<0.001) of rehabilitation. The average difference between the infra-mirro resistance test and the infra-mirror retraction test decreased from 4.72± 0.0007 before the rehabilitation to 1.2 ± 0.26 at 3 months and 0.4 ± 0.006 at 6 months. The average score for pain was 2.4 ± 1.8 at 3 months and 2.6 ± 1.4 at 6 months.
Merolla *et al*.[13]	Determine the interraterial reliability of a new test designed to detect the scapular movement.	142 athletes who participate in sports that require intensive use of air arm. The participants were filmed from the posterior aspect while performing 5 repetitions of bilateral shoulder flexion and shoulder abduction in the frontal plane.	The percentage of agreement was between 75% and 82% of concordance and kappa coefficient and ranged from 0.48 to 0.61.

Mello *et al*.[14]	Investigate the presence of scapular dyskinesia and its association with painful symptoms in the shoulder in bodybuilding practitioners.	The study involved 37 male individuals, practitioners of bodybuilding. The questionnaire Penn Shoulder Score (PSS - Brazil) was applied for the evaluation of pain at rest, during daily life activities and to the efforts and the Lateral Scapular Slide Test was subsequently performed to check for the presence of scapular dyskinesia. To verify the association between pain and dyskinesia the chi-square test with Yates correction was used andthe oddsratio (MS) was subsequently calculated .	Significant association between the scapular dyskinesia and presence of pain during exertion (p = 0.006). Subjects with scapular dyskinesia showed 16x + chance to mention pain.
Santana *et al*.[4]	Check if there is an association between the scapular dyskinesia and shoulder pain of swimmers.	36 swimmers. Men between 18 to 36 years	Association of 86.1% (p = 0.7656) in the right shoulder Association of 83.3% (p = 0.6412) in the left shoulder 58.1% pain in the right shoulder. 25.8% pain in the left shoulder. 16.1% pain in both shoulders.
Merolla *et al*.[15]	To evaluate the strength of the spinous and supra-spinous in 29 athletes with scapular dyskinesia before and after 3 and 6 months of rehabilitation, with the aim of restoring balance of the scapular musculature.	The clinical evaluation was performed with the empty can test and the infra-mirror resistance test . The strength values increased at 3 months (P<0.01) and 6 months (P<0.01). Alterations of the gleno-humeral and reduction in pain scores were found in both segments.	The results recorded in pain and strength confirmed the role of a scapular position suitable for a ratio of length tension of the rotator cuff muscles. These data should encourage athletes to consider the restoration of the scapular muscle balance as an essential part of the athletic training.
Mey *et al*.[16]	A 6-week exercises program which consists of previously selected exercises is capable of improving the muscle activationand the start time during the shuolder elevation. This program can also alter the levels of pain and functionality in air athletes with symptoms of moderate impact.	47 air athletes with symptoms of mild shock (25 men and 22 women) were enrolled in this study. Before and after the 6-week training program, the score of the Index of Shoulder Pain and Disability Index (SPDI) was obtained individually and the values of maximum voluntary isometric contraction (MVIC) were determined by surface electromyography. Means activation muscle musclemolar ratio data, andmuscletiming beginning were assessed for the upper, middle and lower trapezius and serratus anterior muscle,during arm elevation in thescapular plane.	SPDI scores significantly decreased from 29.86 ± 17.03 during the initial evaluation to 11.7 ± 13.78 during postoperative measurements (P <0.001). In the 3 parts of thetrapezius muscle MVIC values were increased. Reduction of activation levels during the arm elevation. After the training program, upper trapezius, anterior serratus, decreased significantly, while upper trapezius, middle, lower. Activation of the lower trapezius showed significant activation in comparison with medium trapezius (-0.47; P <0.001) and MT (-0.49; P <0.001). The anterior serratius exhibited significant activation in relation to theupper trapezius muscle(-0.74; P <0.001), MT (-0.76; P <0.001) and LT (F = 0.27; P = 0.046).

Source: Research Data.

2.2 Discussion

The evidences found allows us to point out the effects of strength training on the increase of lean mass, strengthening of the shoulder complex, reduction of reported pain and improvement in movement pattern.

The studies evaluated the relationship among the scapular dyskinesia, pain and strength training. In order to identify possible changes in individuals, the scapula dynamic stability comes from the muscular action of the fibers, the occasion on which any impairment in the activation of these muscles can trigger abnormalities in shoulder kinematics and dysfunction of this joint.

Some studies[4,12,14] found a significant association between the scapular dyskinesia and shoulder pain. In this sense, if a literature review is carried out it will be probably found out that the muscle groups dysfunctions that surround the rotator cuff imply, in effect, the presence of scapular dyskinesia. Thus, one of the possible strategies to minimize the effects of this dysfunction may be acting on the muscular actions involving the rotator cuff.

This evidence can be observed in one of the studies[15] that prescribed in a period of 6 months a strength training for the rotator cuff muscles. On the occasion professional athletes of volleyball attended it and, indeed, it was observed that the increase in the level of the athletes′ strength, as a consequence,

minimized the pain level. This evidence demonstrates that the sports practioners, for presenting patterns of inappropriate movements experience pain and consequently develop the scapular dyskinesia.

The study[14] with 35 people showed complaints of pain in the glenohumeral joint, being twelve at the scapular region, two in the clavicle, two in the humerus, and twenty-five individuals reported relief after the exercise. The scapular dyskinesia was identified more frequently in exercises of concentric phase than eccentric ones. It was possible to observe a significant association between the scapular dyskinesia and the presence of pain. Individuals who had scapular dyskinesia showed sixteen times more probability to have pain. Thus, the strength training just end up relieving the pain and strengthening the shoulder complex.

On the other hand, a research[4] showed a high prevalence of shoulder pain in swimmers. The muscle pain is usually originated from the shortening of muscles that alter the activation pattern. The trapezium along with the anterior serratius form a couple system of force to provide the scapula dynamic stability. Thus, when this muscle is not being activated muscles in a functional way, the shoulder complex muscles tend to compensate, thus creating an instability in the region.

According to one study[16] the three parts of the trapezius muscle showed maximum voluntary isometric contraction increased and decreased activation levels during the arm lifting, while this was not the case with the anterior serratius. However, after the intervention the trapezius and the anterior serratius decreased significantly, while the upper trapezius, middle and lower did not change. In addition, it was found that the lower trapezius exhibited significant activation when compared to the upper trapezius. The anterior serratius showed significant activation in comparison with the upper trapezius and lower trapezius.

3 Conclusion

The research allowed to know that the main causes of the scapular dyskinesia are muscle weakness, lack of mobility, presence of lesions in the soft tissues, inappropriate movements, increasing the risk of impact and reduction of the rotator cuff strength. This disorder involves changes and lesions in the whole shoulder complex. Therefore, only strengthening the rotator cuff seems not to be so efficient.

The strength training was efficient to increase strength, hypertrophy, muscular strenght and localized muscle resistance. Thus, the training causes an increase in lean mass and, consequently, strengthens the shoulder complex, through exercises for stability and mobility, having as objective to improve the motion standard.

Therefore, considering that muscle strengthening has been seen as a possible intervention strategy in the prevention and recovery process of the scapular dyskinesia, as well as shoulder injuries it is important that greater attention be given to achieve adequate evaluation and exercises prescription for these conditions. It is worth stressing the importance of experimental studies, considering the lack of research on the subject.

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