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EFFECT OF KINESIO TAPE ON SCAPULAR KINEMATICS IN SUBJECTS WITH SCAPULAR DYSKINESIS

Júlia Araújo Momo[1], Natália Miranda Flores[1], Matheus Pitrez da Silva Mocellin[1], Alisson de Carvalho Chaves[1], William Dhein[2 3], Joelly Mahnic de Toledo[2] Jefferson Fagundes Losss[2]

Abstract: Scapular dyskinesis is an abnormality in scapula static or dynamic position. There are several techniques for scapular dyskinesis conservative treatment, including Kinesio Tape application, which is used to promote and support scapula joint alignment, decrease pain and improve local muscle control. The study aim to investigate the effect of kinesio tape on scapular kinematics in subjects with scapular dyskinesis. Fourteen subjects with scapular dyskinesis performed flexion and scaption movements in two conditions: (1) without load and (2) holding a dumbbell. A scapular tape was applied over the lower trapezius (Y shaped) muscle with a 20% tension. Kinematic data were captured with 10 infrared cameras and analyzed based on Euler angles, peak values of upward rotation, internal rotation, and posterior tilt angles. To compare the situations with and without kinesio tape the repeated measures two-way ANOVAs ($\alpha = 0.05$) was performed using SPSS software. Scapular tape increase upward rotation and posterior tilt during flexion of the shoulder. No interaction (Load x KT) was found during flexion, suggesting that KT effect in the peak values is the same, regardless the load condition. Scapular tape decreases internal rotation during scaption and a significant interaction was found between load x KT, suggesting the effect of using KT could depend the load used during this movement. The results suggest that kinesio tape may can be use as assistant to increase upward rotation, posterior tilt and decrease internal rotation in scapular dyskinesis subjects.

Key words: kinesio tape; shoulder; scapular dyskinesis; kinematics.

Afiliação

[1] Centro Universitário Ritter dos Reis – UniRitter – Rio Grande do Sul, Porto Alegre, Brasil.; [2] Universidade Federal do Rio Grande do Sul – UFRGS – Rio Grande do Sul, Porto Alegre, Brasil.; [3] Centro Universitário da Serra Gaúcha – FSG – Rio Grande do Sul, Caxias do Sul, Brasil.

Introduction

Scapular dyskinesis is a collective term that refers dysfunctional in the scapula kinematics on resting position or during dynamic motion[1]. It can be classified as dysrhythmia, in which scapula moves early or with excessive elevation[2] or protraction, also an nonsmooth movement during elevation with an rapid downward rotation during arm lowering[1, 3] or with an inadequate scapular upward rotation during arm lifting[2]. It can also be classified as winging, in which scapula medial border or the inferior angle are posteriorly dislocated and prominent in relation to the thorax[3].

The alteration on scapular kinematics has been associated with musculoskeletal disorders of the shoulder complex [4], like shoulder impingement syndrome. The most cited alterations on scapular kinematics are decrease in upward rotation[5, 6], less posterior tipping[7, 8], increase in internal rotation[8-10] and scapula elevation[11]. Knowing that scapula plays important role of shoulder function [10], there are several techniques for scapular dyskinesis such as kinesio tape (KT) application over scapular muscles[12].

Several studies investigated the effects of different KT shapes on scapula kinematic of healthy subjects and with shoulder impingement syndrome[13-20]. Most of the studies investigated the I-shaped over the upper trapezius[14, 16, 19], while others use the Y-shaped over lower trapezius[13, 20] and also are studies that combined the use over the upper trapezius with the glenohumeral muscles[15, 17, 18, 21] . In all different shapes are different results as increase in posterior tilt[13, 19], increase of upward rotation[16, 19], increase retraction and external rotation[22] and also no effect over scapula kinematics[15, 17, 20, 21].

The literature may suggest an increase on upward rotation and posterior tilt on subjects with scapular dyskinesis, with both, the I and Y-shaped over the upper trapezius [7, 12]. But still inconclusive with application of the Y-shaped over the lower trapezius, finding increase in posterior tilt[13] and no effects on scapular kinematics on healthy subjects [20] and with scapular dyskinesis[12]. Another important point is that the difference on posterior tilt was found during an movement with dumbbell[13].

Based on the literature, it is notice that the results remain inconclusive about kinesio tape Y-shaped over the lower trapezius on subject with scapular dyskinesis. Thus, the aim of the study was to investigate the effect of kinesio tape on scapular kinematics in subjects with scapular dyskinesis, during shoulder flexion and scaption without load and with dumbbell.

Methods

Participants and study design

This is a quasi-experimental research with a sample of 14 healthy young participants (age, 22.4 ± 2.7 years; mass 72.2 ± 6.1 kg; height 1.8 ± 0.1 m) who had normal or below normal body fat for their age group, in accordance with standards set by the American College of Sports Medicine[23] participated on the study. The eligibility criteria of the included subjects was: scapular dyskinesis, evaluated by classification method [3, 24], right upper limb dominance and free range of motion and excluded if they had: (1) pain or history of upper limb injury and/or surgery in the last six months; (2) engaged in physical activity more than three times a week; (3) who used shoulder taping in the last 30 days and (4) who presented a positive result on the clinical tests (Jobe, Hawkins and Apreension) performed during the collection procedures. The study was approved by the Research Ethics Committee of Universidade Federal do Rio Grande do Sul under the nº 908.977 following the Declaration of Helsinki. Informed consent has been obtained from all individuals included in this study.

Procedures

Data acquisition was carried out at Laboratório de Pesquisa do Exercício from Universidade Federal do Rio Grande do Sul and scheduled according to the participants' availability. Each individual signed the free informed consent and questions were answered prior to data collection. Sociodemographic and anthropometric data were obtained during the anamnesis. A physiotherapist evaluated the participant through clinical tests (Jobe, Hawkins and anterior/posterior apprehension of the shoulder).

The *Scapular Dyskinesis Test* is a validated and reliable method to evaluate the presence of scapular dyskinesis[3, 24]. It rates the movements of scapula in: (1) normal scapulohumeral rhythm; (2) scapular dyskinesis (Dysrhythmia or Winging), were it also rate on: (I) Subtle abnormality or (II) Obvious abnormality. The classification was given: first, by analyzing the smoothly and continuously scapulohumeral movements during elevation. Secondly, analyzing the scapular prominences, such as the superior and inferior angle of the scapula and the distance from the medial border of the scapula in relation to the posterior

thorax[3, 24]. The subject performed five repetitions of flexion and scaption of the shoulder with a dumbbell equivalent to 5% of their body weight (3.6 ± 0.3 kg), bilaterally alternating the right and left sides with each movement. The test was carried out by a shoulder expert physiotherapist (15 years of experience), which was positioned 3 meters behind the individual, observing and classifying scapular dyskinesis.

After the scapular dyskinesis test, 13 reflective markers were positioned on the upper limb according to the the International Society of Biomechanics[25, 26] over spinous processes from C7 and T8, suprasternal notch, xiphoid process, acromioclavicular joint, angulus acromialis, processus coracoideus, inferior angle of scapula, trigonum spinae scapulae, medial epicondyle, lateral epicondyle, radial styloid processus, and ulnar styloid processus. To collect the kinematics data, the BTS Smart-DX 7000 tracking system with 10 infrared cameras were used at a frequency rate of 100Hz.

Afterwards, the individual was instructed to stand with his upper limbs relaxed in the acquisition area. The flexion and scaption movements were performed in two different situations: (1) active-free movement and (2) resistance movement with dumbbell load. The order and load were randomized. Three (3) repetitions were performed for each situation with a velocity of 45° per second using a digital metronome. The plane of movement during scaption was 45º of scapular plane delimited by nylon threads that provided tactile feedback to the participants. All movements were performed with a 90° range of motion and the load adjustment was determined has 5% of body weight[27].

After the movements were completed, the KT (Kinesio Tex Gold®) was placed. It is a "Y" shaped tape apply over the lower trapezius muscle[13, 28] (Figure 1). Initially, the base of the tape was positioned on the scapular spine and the individual performed a horizontal flexion of the shoulder. The Y-shaped strips were positioned with an inclination of approximately 45º involving the lower trapezius with tension of 20%.The control of tension applied on the tape followed an equation adapted from the literature[15, 29]. After KT placement, the participant performed the movements of flexion and elevation in the same conditions previously descripted.

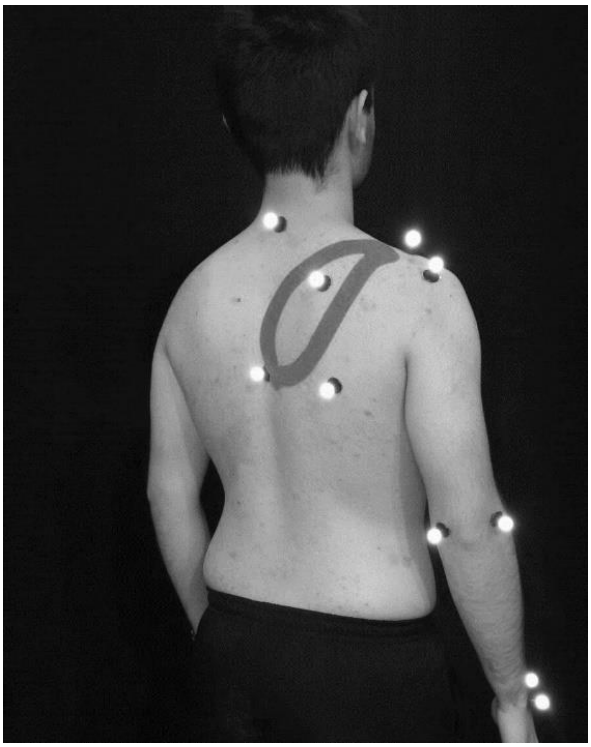

Figure 1 - Y tape position

Data Analysis

Kinematic data were analyzed using the software BTS Smart-Analyzer. The kinematic data were digital filtering using a 4º order butterworth lowpass with a frequency of 5Hz. The articular angles were expressed at Euler angles[25, 26]. The axes were based on the local coordinate system of the bone. The order of rotation of the Euler angles was based on the standardization proposed by the International Shoulder Group of the International Society of Biomechanics[25].

The rotations of the scapula (Y-Z-X Euler sequence) were defined relative to the thorax. The first rotation of the scapula was defined as upward rotation (negative) and downward rotation (positive). The second rotation was defined as internal rotation (positive) and external rotation (negative). The third rotation was defined as anterior (negative) tilt and posterior (positive) tilt. The glenohumeral angles were defined following the globe system described by Doorenbosch *et al.*[30], and the thoracohumeral angle was used for cutting the repetitions. The scapulohumeral peak values were selected to statistics.

Statistical Analysis

Statistical analyses was performed using the software SPSS version 20.0.Initially, the normality of data was verified by the Shapiro-Wilk Test. The kinematics data was considered parametric ($p>0.05$). The comparisons of each Euler angle (upward rotation; internal rotation and posterior tilt) in the movements (flexion and scaption) were performed through two-way repeated measures ANOVA considering the main factors load (2 levels) and KT (2 levels). Statistical results are reported according to Field *et al.* [31], presenting the value of ANOVA ratio (F), level of significance (p-value) and effect size eta² (partial eta squared). The level of significance was $\alpha<0.05$.

Results

Fourteen subjects present scapular dyskinesis during the movement of shoulder flexion, while, eleven presented during scaption movement. The most common case presented was subtle winging, with 78% of sample during flexion and 81% during scaption movement (Table 1).

Table 1 - Sample dyskinesis classification

Movement	Dysrhythmia	Winging	
		Subtle	Obvious
Flexion (n=14)	1 (8%)	11 (78%)	2 (14%)
Scaption (n=11)	0 (0%)	9 (81%)	2 (19%)

Flexion of the shoulder

Regarding to the main factors, there were significant KT effect in upward rotation [$F = 13.336$; $p = 0.004$; $eta^2 = 0.548$], where the use of KT represent, in average, an increase of 2.5° in the peak value; and posterior tilt [$F = 16.538$; $p = 0.005$; $eta^2 = 0.535$], where the use of KT represent an increase of 1.2°; but, there was no effect of KT in internal rotation [F =

4.538; p = 0.057; eta² = 0.292]. There was significant load effect only during posterior tilt [F = 8.073; p = 0.016; eta² = 0.423], where the movement performed with load represent, in average, an increase of 2.1° in the peak value (Table 2).

No significant interaction was found between load x KT during upward rotation [F = 0.543; p = 0.477; eta² = 0.047] and posterior tilt [F = 0.212; p = 0.654; eta² = 0.019] suggesting that KT effect in the peak values is the same, regardless the load condition. During internal rotation, significant interaction was found between load x KT [F = 5.523; p =0.038; eta² = 0.334] suggesting the effect of using KT could depend the load used during the movement. The behavior of scapular kinematics during flexion are shown in figure 2.

Table 2 - Main effects in the scapula kinematics during flexion and scaption movements. Peak value described in degrees as average and (standard error).

Movement	Rotations of the scapula	KT			Load		
		Without KT	With KT	Within factor difference	Without Load	With Load	Within factor difference
Flexion	Upward Rotation	-21.7° (1.4)	-24.2° (1.5)	2.5*	-22.6° (1.4)	-23.3° (1.6)	0.7
	Internal Rotation	49.5° (1.7)	48.3° (1.5)	1.2	48.5° (1.3)	49,4° (2,1)	0.9
	Posterior Tilt	-4.1° (1.2)	-5.3° (1.4)	1.2*	-3.7° (1.3)	-5.8° (1.4)	2.1*
Scaption	Upward Rotation	-26.4° (1.8)	-27.2° (1.9)	0.8	-26.4° (1.8)	-27.3° (1.8)	0.9
	Internal Rotation	43.0° (1.3)	41.6° (1.5)	1.4*	42.2° (1.3)	42.3° (1.4)	0.1
	Posterior Tilt	-7.0° (1.5)	-7.4° (1.7)	0.4	-6.7° (1.6)	-7.6° (1.6)	0.9

* Significance differences in the main factor KT and load.

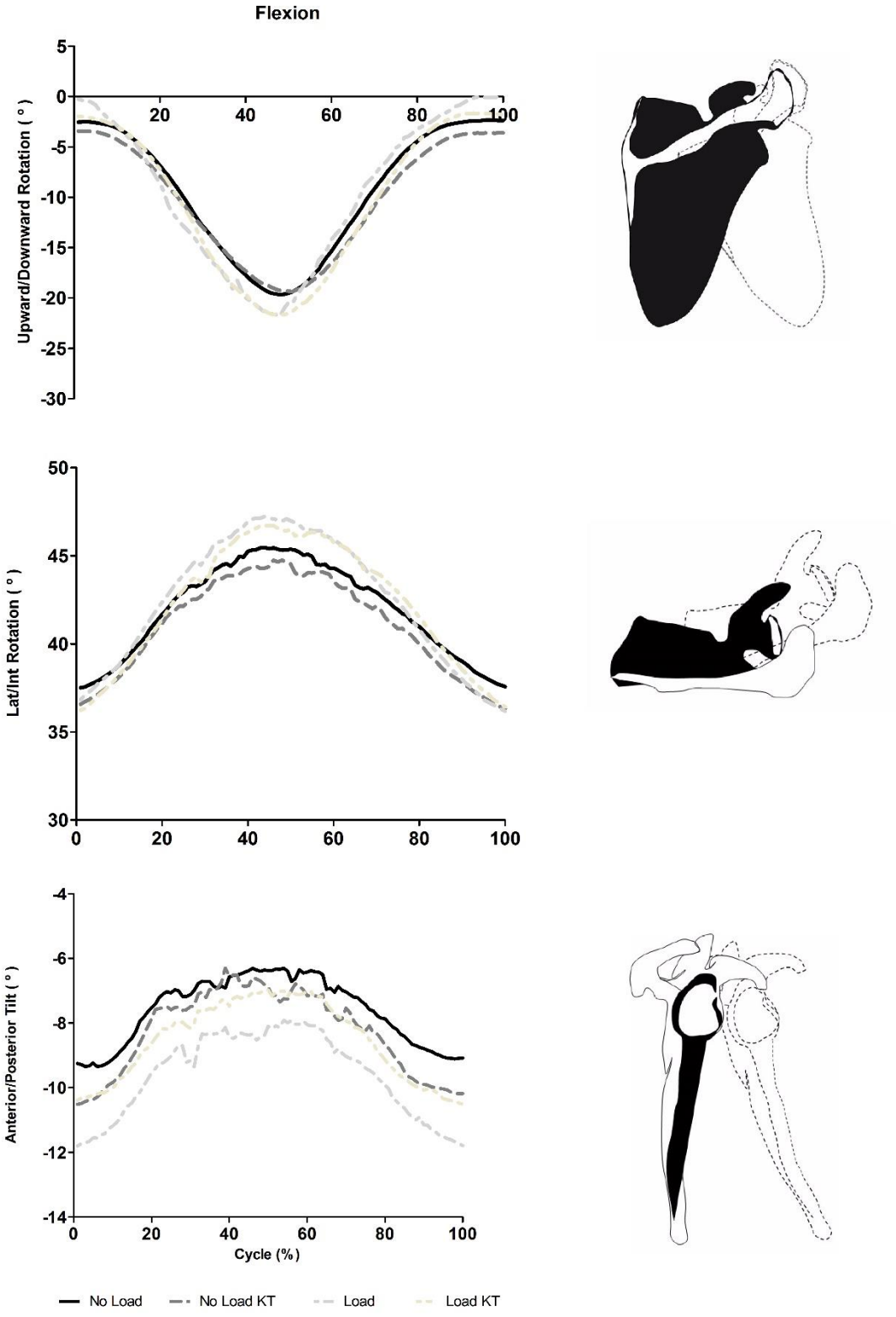

Figure 2 - Behavior of scapular kinematics (mean) during flexion of the shoulder.

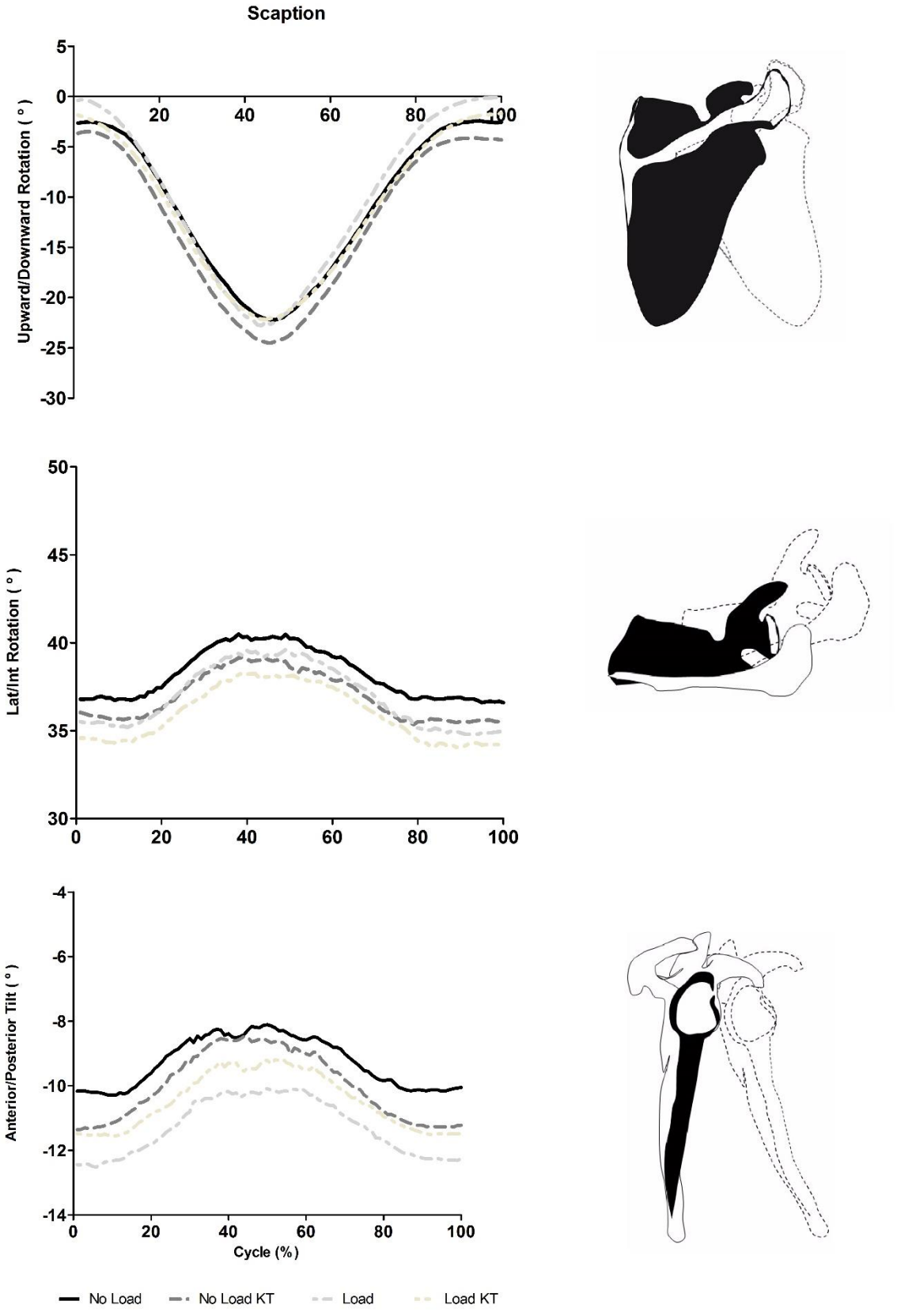

Figure 3 - Behavior of scapular kinematics (mean) during scaption.

Scaption – Elevation on scapular plane

Regarding to the main factors, there were significant KT effect only in internal rotation [F = 5.906; p = 0.035; eta² = 0.371], where the use of KT represent, in average, an decrease of 1.4° in the peak value, but there was no significant effect of KT in upward rotation [F = 1.319; p = 0.278; eta² = 0.117] and posterior tilt [F = 1.530; p = 0.244; eta² =0.133]. Concerning to load, there was no effect during upward rotation [F = 2.063; p = 0.181; eta² = 0.171], internal rotation [F = 0.109; p =0.748; eta² = 0.011] and posterior tilt [F = 4.878; p = 0.052; eta² = 0.328], suggesting the load has no effect on the angle peak value in the scapula kinematic during the scaption movement (Table 2).

No significant interaction was found between load x KT during upward rotation [F = 0.106; p = 0.752; eta² = 0.010], internal rotation [F = 0.122; p = 0.735; eta² = 0.012] and posterior tilt [F = 0.604; p = 0.455; eta² = 0.057] suggesting that KT effect in the peak values is the same, regardless the load condition during the scaption movement. The behavior of scapular kinematics during scaption are shown in figure 3.

Discussion

The results give perspectives of the effects of Y shaped KT over the lower trapezius on subjects with scapular dyskinesis during flexion and scaption. Considering the rehabilitation programs of scapular dyskinesis subjects, is important to emphasize that to restore the alterations on scapula kinematic the rehabilitation program may have to inhibit the upper trapezius and activate the lower trapezius and serratus anterior in patients with medial border or inferior angle prominence[8]. Because, these muscles are precisely related with the decrease of the movements of upward rotation and posterior tilt and increase of internal rotation of the scapula[2, 8]. In our sample, with patients predominantly with winging, we found and increase in upward rotation and posterior tilt during flexion and a decrease in internal rotation during scaption with use of KT. So, the results of the study seems useful to subjects with scapular dyskinesis.

The change of scapular kinematics with KT may are connected by a new recruitment of motor units of the periscapular muscles[10]. We can't assure this with our results, because we

didn't evaluate electromyography activity of shoulder and scapular muscles. But it gives indication that the KT use on this study may help to improve this stimulus and so be a complementary technique during the rehabilitation program. In agreement with the finds of the study, Hsu et al. [13] found an increase in posterior tilt to 30° and 60° degrees and increase on lower trapezius EMG, but it was find during the scaption movement. Huang et al. [12] found no difference on scapula kinematic with the use of Y shaped tape. Zanca et al. [20] also don't find difference on scapula kinematics, but the application of KT was different (proximal insertion to distal insertion). With the I-shaped tape are found decrease on the upper trapezius[14, 32]. The increase on upward rotation[16] and posterior tilt was also found with the I-shaped tape over the upper trapezius[7, 19]. The increase on external rotation and retraction of scapula was found with a KT with 3 strips over the shoulder complex[18]. Differences on participant's pattern of scapula dyskinesis and the movements evaluated, may explain these results.

Considering the difference on application over the studies and the mechanisms which KT may have effects, there are some points to discuss. First, the essential function of tape is to provide support during the movement[33]. Proprioceptive and mechanical mechanisms are related to taping effectiveness[14, 34]. Proprioceptive mechanism works through cutaneous stimulation, which means that the area where the tape is applied receives sensory stimulation for the patient to correct undesirable movement patterns. Over time, these patterns become suitable and part of the patient's motor engram, consequently changing joint kinematics[35]. The second is the position and level of tension apply in the tape. Hsu et al. [13] found increase (facilitation) on lower trapezius during the scaption movement with a Y-shaped tape with low tension, as our study. According to Kase et al. [28], the effect of facilitation occur when applying KT with >25% tension and throw insertion to origin like Zanca et al. [20]. However, the application tension and position was different, and so, there are inconsistences in the method of application and consequently the possible effects that can occur. Studies have shown that there is no effects of inhibition and facilitation [36, 37] with KT. Therefore, futures studies should investigated different tensions and positions with the Y shaped tape over the lower trapezius. We must highlight in our study the control on KT application with the tension equation [15, 29] and the same physiotherapist who apply it in the study.

There were a few limitations and perspectives when considering the results. First, we evaluated movement until 90º degrees. The choice to delimit the movement in this range of motion is justified by the evaluation method with reflective markers. In some point, the

markers attached to the scapula don't follow the behavior of the bone, because of the skin. So, the results are limited to this range of motion. Despite that, there was a control in the plane of motion by nylon threads. A limitation is that we have a small sample with just a few classification of scapular dyskinesis[3]. Practically all our participants were classified as winging and only one with dysrhythmia. Besides that, it was possible to even so find difference on scapular kinematics. We must highlight too, that the evaluation of scapular dyskinesis were done by an expert physiotherapist. Another limitation refers to our sample size, which may have under-powered our study for some outcome measures (type II error possibility). Other perspective, can be evaluated the same condition with a sham group like others mentioned from the literature[13]. We didn't evaluated electromyography of the scapular muscles like upper, middle, lower trapezius, serratus anterior, which are important to scapular kinematics. So, future studies should evaluate these muscles to sustain the scapula kinematic results and the hypothesis of new recruitment of motor units of the periscapular muscles.

Conclusion

It can be concluded in the present study that the application of kinesio tape in subjects with scapular dyskinesis results in increase in upward rotation and posterior tilt during flexion of the shoulder and decrease of internal rotation during scaption. The results suggest that kinesio tape may can be use as assistant to rehabilitation on scapular dyskinesis subjects.

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