



# Effect of kinesio taping in myoelectric activity in patients with shoulder impingement

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## ABSTRACT:

**Introduction:** The complex shoulder joint is equipped with the greater joint mobility of the body, however, is commonly injured in repetitive, sport or occupational activities. Shoulder Impact Syndrome (SIS) is one of the most common injuries affecting the shoulder, thus causing limitations in its functionality. Several strategies have been used by physiotherapy for prevention and rehabilitation of SIS, one of them is the Kinesio Taping (KT). However, even with its abundant use there is still no clear evidence of its benefits. **Objective:** The aim of the study was to examine the effect of KT on myoelectric activity and the level of pain in patients with SIS. **Method:** Seven women with SIS participated, which performed the flexion and shoulder abduction up to 90° with and without KT. During the gestures, the pain level and surface electromyography data of the upper trapezoid, middle deltoid and anterior serratus were acquired. The treatment of the electromyography data was performed in the BIOMECH-SAS software and presented as percentage values of the maximum voluntary contraction. To compare the myoelectric activity and pain levels, it was performed, respectively, one way ANOVA and the Wilcoxon test ( $\alpha < 0.05$ ). **Results:** Pain reductions were observed and myoelectric activity of upper trapezius ( $46.0 \pm 34.4\%$  MVIC to  $35.6 \pm 19.5\%$  MVIC) and middle deltoid ( $39.0 \pm 11.5\%$  MVIC to  $35.2 \pm 12.5\%$  MVIC) in motion abduction use of KT. No changes were observed in the signs during flexion movement. **Conclusion:** Finally, the KT generated a reduction in the level of pain and myoelectric activity of the middle deltoid and upper trapezius in the movement of abduction in patients with SIS.

**Keywords:** Bandages, Taping, Electromyography, Shoulder Impingement Syndrome, Pain

## INTRODUCTION

The most recurrent lesions which affect the shoulder complex represent about 10% of all referrals for physiotherapy<sup>(1)</sup>. Among these lesions, 44% to 65% of cases are considered as shoulder impingement<sup>(1, 2)</sup>. In the shoulder impact syndrome (SIS) there is a mechanical compression of the subacromial structures such as the tendons of the rotator cuff, in addition to a degenerative characteristic initiated by inflammation, followed by fibrosis and rotator cuff. The SIS presents a higher prevalence in young people who practice sports which involve repeated actions and of excessive amplitude as swimming, tennis, volleyball or in people from the 4th and 5th decade of life who in addition to the own aging process use the upper limb in positions above the head during their occupational, daily and sports activities<sup>(1, 3, 4)</sup>.

The most commonly injured structures in SIS are the supraspinatus tendon and the subacromial bursa, as well as the long head of the biceps which may be in compression against the anterior and lateral region of the acromion and the coracoacromial ligament<sup>(5)</sup>. Although it is not yet clear what

the real causes of impingement syndrome, it is believed that the development of compressions in the rotator cuff tendons are related to loads in excess and repetitive movements of the dominant upper limb, and the most common finding is muscle pain and weakness during shoulder lift and external rotation movements<sup>(6)</sup>. Another factor that may be related to shoulder injuries is related to changes in motor coordination and scapulohumeral rhythm<sup>(2)</sup>.

Regarding the myoelectric activity, subjects with SIS present reduced activity of the serratus anterior muscle, delayed activity of the middle and lower trapezius, in addition to a greater activation of the superior trapezius muscle<sup>(2, 7-10)</sup>. Patients with impingement syndrome exhibit increased fatigue in the anterior and middle deltoid muscles<sup>(10)</sup>. During the lifting movement in the scapular plane, it was observed a decrease in myoelectric activity of serratus anterior muscle and trapezius increased in patients with SIS when compared to individuals without injury<sup>(8)</sup>. This increased activation mainly of the upper trapezius and middle deltoid in individuals with SIS may be

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due to several factors, such as pain, scapular humeral rhythm altered, tendinitis in the rotator cuff muscles, poor positioning of the scapula or postural alterations<sup>(2, 9)</sup>. These factors lead to an increased activation of the myoelectric upper trapezius due to the necessity to increase the shoulder girdle as compensation due to the difficulty in realizing mainly the abduction movement in the shoulder joint<sup>(2)</sup>.

Currently, several strategies have been used by physiotherapy for the treatment of SIS. One of the most used is the elastic bandage, also known as Kinesio Taping (KT). The technique has been used in the prevention, rehabilitation of sports injuries, acute injuries, as well as in cases of chronic pain and functional disabilities<sup>(11-15)</sup>. This elastic band may have as purpose to facilitate or inhibit a specific muscle, and perform corrections on the biomechanics of the joint depending upon the application being used<sup>(11, 16, 17)</sup>. Among the expected effects with the use of KT are: stability, protection, support and proprioception during the execution of movements, these effects that may contribute to the correct biomechanics of movement<sup>(18, 19)</sup>.

However, there is no clear evidence regarding the mechanisms by which KT perform its beneficial effects. Considering the hypothesis that KT may facilitate or inhibit the activation of specific muscles, the use of surface electromyography may help elucidate this question. The aim of the present study was to analyze the effect of KT on the myoelectric activity of the medial deltoid, upper trapezius and serratus muscles and pain level in patients with SIS.

## METHOD

The study sample was intentional and non-probabilistic, consisting of seven women with a clinical diagnosis of shoulder syndrome, bursitis or supraspinatus tendinitis with mean age of  $55.5 \pm 8.3$  years, where three had left-sided lesions and four on the right side. The participants were in physiotherapeutic care at a physiotherapy clinic in Vale do Rio dos Sinos/RS. In order to participate in the study, the individuals signed the Informed Consent Form, which included the objectives and procedures to be performed. The study was approved by the Human Research Ethics Committee of the University of Vale do Rio dos Sinos under protocol nº 14/063. After approval by the Ethics and Research Committee of the University, the scheduling of the dates with the individuals was carried out initially, to perform an initial evaluation in order to verify if the invited individuals were in the proposed inclusion criteria: To present at least 90° of amplitude of flexion and abduction movement; a pain score below level 5 according to visual numerical scale from 0 to 10; complementary tests which are compatible with SIS or present a positive signal in at least one of the following clinical tests: (1) Jobe's test (2) Neer's test (3) Arm drop test.

Exclusion criteria were: (1) fracture in the joint complex of the shoulder, (2) dislocation or subluxation, (3) irradiation or

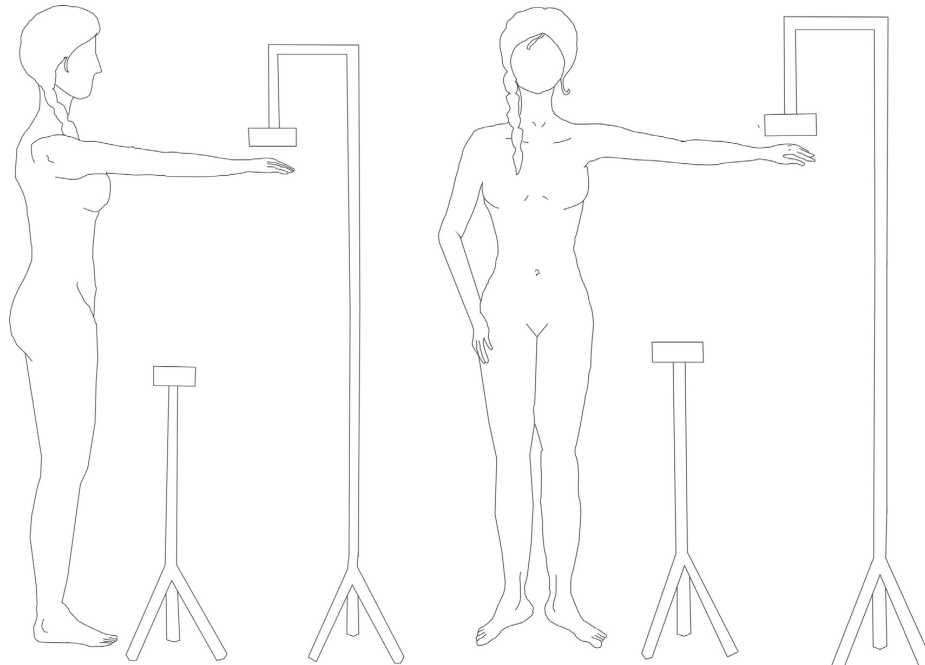
pain in the neck to the movement of the shoulder. The initial evaluation was performed in the physiotherapy clinic where the individuals were frequently attended. When the inclusion criteria were considered, new dates were scheduled for data collection with selected individuals.

The collections were carried out at the Biomechanics Laboratory at the Sports and Leisure Complex of the University of Vale do Rio dos Sinos (UNISINOS). Initially the subject underwent tricotomy and cleansing the skin with alcohol. For data collection of myoelectric activity, a 16-channel electromyograph (830 SB EMG system from Brazil LTDA) was used with a sampling rate of 2000 Hz connected to a Dell-branded notebook. Surface electrodes (Ag/AgCl) were used in the bipolar configuration. The collected muscles were: (1) middle deltoid (2) upper trapezius and (3) anterior serratus. The placement of the electrodes on the upper trapezius and medial deltoid muscles followed the SENIAM positioning recommendations<sup>(20)</sup>. Since the placement of the electrodes to the serratus anterior followed the recommendations of Selkowitz et al.<sup>(21)</sup>. The reference electrode was positioned in the right clavicle. After preparation, the individual was instructed to sit in a chair with fixed support for performing the maximum voluntary isometric contractions (MVICs) for each evaluated muscle. The MVICs were performed in muscular function test and consisted of 2 repetitions for each muscle, with a duration of 5 seconds, with 3 minute intervals between each MVIC. The highest value was used to normalize the results.

After the MVIC, the individual was positioned standing next to a structure developed to delimit the flexion and abduction movements between 0° and 90°. The structure allowed regulation to adapt the range of motion to height of each patient (FIGURE 1).

Two contact sensors were attached at the terminations of the used structure to restrict movement at the desired amplitude, which they were used in the analysis to divide the phases and repetitions of the movement. The movements consisted of 8 active repetitions free of flexion and abduction of the shoulder up to 90°, with only external strength as weight strength of the upper limb. For the flexion movement, the limiting structure of the movement was positioned anteriorly to the patient. In the abduction movement, the structure was positioned laterally. While performing the movements an audible feedback was provided by digital metronome to guide the evaluated individuals regarding execution speed, set at 60 bpm. After each movement, the pain level was evaluated through the visual numerical scale.

After the movements without KT, an interval for the placement of the KT (Kinesiology Tape CIEX do Brasil®, beige color), was performed, which lasted 10 minutes in average. The placement followed the protocol for rotator cuff tendinitis and impact syndrome proposed in the literature according Figure 2. It is the placement proposed because the influences



**FIGURE 1** - Flexion and shoulder abduction to 90° conducted along the structure which enabled the adjustment for adaptation of motion.



**FIGURE 2** - Placement method of the kinesio taping

proposed by KT on the upper trapezius muscles and middle deltoid which are the main affected in patients with SIS. Being formed by strips which act directly on both muscles.

The placement of the proposed KT begins with the placement of a Y-shaped strips representing the supraspinous and trapezius muscle. The strips which compose the "Y" are placed with the base of the band in the larger tubercle and in the acromion region, with the upper limb positioned in

adduction and the head in lateral flexion to the opposite side. The upper strip was placed over the supraspinous fossa toward the superior angle of the scapula, and the lower strip was placed along the supraspinous fossa and just below the upper strip. Both strips were placed with 15 to 25%.

The second strip placed for the deltoid muscle is represented by a Y-shaped strip. The base of the strip was positioned on the lateral portion of the arm near the deltoid tuberosity of the humerus. For the anterior strip, the upper limb was positioned in 90° abduction, external rotation and horizontal extension, being placed with 15 to 25% of tension aiming to inhibit along the border of the anterior deltoid and applied near the acromioclavicular articulation. Then the upper limb was positioned in horizontal flexion, adduction, internal rotation to then to be placed the posterior strip along the edge of the posterior deltoid with the same tension. Both "Y" strings used for the upper trapezius and middle deltoid muscles were aimed at muscle inhibition.

A third I-shaped string was applied from the coracoid process region towards the posterior deltoid for the purpose of mechanical joint correction with 50% to 75% tension in the string. For the third string, the upper limb was positioned in external rotation, shoulder flexion and a slight horizontal adduction. After KT placement, the individual performed again 8 repetitions of shoulder flexion and abduction movements, and myoelectric activity and pain level were collected.

For the analysis of EMG (EMG) signals, it was used the BIOMECSAS software, a signal analysis software developed by BIOMECS group<sup>(22)</sup>. Initially the signals collected during MVIC and tasks of flexion and abduction were subjected to a digital filtering procedure using a Butterworth band-pass filter of



4th order with frequency band between 20 and 500 Hz. After filtering procedure, the electromyographic (EMG) signal was processed in the time domain from the envelope calculation RMS (root mean square) with Hamming windowing 1 second. When calculated the RMS envelope, the signals obtained during the movements were normalized from the highest peak value of the RMS obtained envelope in the two performed MVICs. With the normalized signals, obtained during the movements, the first and the last repetition were discarded totaling 6 replicates analyzed. To represent and compare the electrical activity of the evaluated muscles in situations with and without KT, the peak value and the mean percentage of activation of the MVIC were used during the flexion and abduction movements of the shoulder of each repetition.

Statistical analysis was performed using the *software* SPSS 20.0, adopting a 5% significance level for all tests. Initially, the data normality was verified and the homogeneity of variances by the Shapiro-Wilk and Levene tests. Subsequently, when confirmed the data normality, we performed a one-way ANOVA test to compare the situations with and without KT. The Wilcoxon test was used to evaluate the pain level results in situations with and without KT.

## RESULTS

During the abduction movement, the upper trapezius and medial deltoid muscles showed a higher peak of activation in the KT-free situation when compared to the same movement with KT (Table 1), confirming in a certain manner the expected inhibition with the use of KT. However, this difference was not confirmed in the average results of the executions (Table 2). In the muscular activation of the anterior serratus, for both the peak value (Table 1) and the mean value (Table 2) of the MVIC% during the abduction movement, no differences were found in the situations.

During the shoulder flexion movement, no differences were found in none of the analyzed muscles, either in the peak values (Table 3) nor in the averages (Table 4) between the situations with and without KT.

Regarding the degrees of pain obtained from the application of the numerical visual scale, it was observed a reduction in the degree of pain in the situation with KT in the abduction movement. For the flexion movement, no differences were observed (Table 5).

**Table 1:** The normalized muscle activation peak values by the MVIC during abduction movement of the shoulder to 90° (n=7)

Muscle	Without KT (%)	With KT (%)	p value
Upper Trapezius	46.0 ± 34.4	35.6 ± 19.5	0.016*
Middle Deltoid	39.0 ± 11.5	35.2 ± 12.5	0.043*
Serratus Anterior	44.5 ± 19.1	42.5 ± 16.0	0.448

\*Significant difference (p<0.05)

**Table 2:** The normalized muscle activation average values by the MVIC during abduction movement of the shoulder to 90° (n=7)

Muscle	Without KT (%)	With KT (%)	p value
Upper Trapezius	29.3 ± 20.2	24.8 ± 12.8	0.91
Middle Deltoid	18.8 ± 5.0	17.3 ± 5.7	0.72
Serratus Anterior	20.9 ± 7.3	21.5 ± 7.8	0.615

\*Significant difference (p<0.05)

**Table 3:** The normalized muscle activation peak values by the MVIC during shoulder flexion movement to 90° (n=7)

Muscle	Without KT (%)	With KT (%)	p value
Upper Trapezius	26.6 ± 5.8	23.7 ± 3.4	0.241
Middle Deltoid	28.4 ± 15.1	30.3 ± 9.3	0.447
Serratus Anterior	60.7 ± 7.5	55.3 ± 5.0	0.150

\*Significant difference (p<0.05)

**Table 4:** The normalized muscle activation average values by the MVIC the during shoulder flexion to 90° (n=7)

Muscle	Without KT (%)	With KT (%)	p value
Upper Trapezius	16.6 ± 9.1	16.7 ± 10.5	0.961
Middle Deltoid	14.4 ± 5.5	16.0 ± 11.5	0.295
Serratus Anterior	28.3 ± 10.7	26.6 ± 8.0	0.286

\*Significant difference (p<0.05)

**Table 5:** Percentage and frequency level of pain levels during flexion and abduction (n=7)

VAS	Flexion				Abduction			
	Without KT		With KT		Without KT		With KT	
	N	%	N	%	n	%	N	%
0	0	0	0	0	0	0	1	14.3
1	0	0	1	14.3	0	0	0	0
2	2	28.6	2	28.6	0	0	3	42.9
3	2	28.6	3	42.9	2	28.6	1	14.3
4	2	28.6	1	14.3	2	28.6	1	14.3
5	1	14.3	0	0	3	42.9	1	14.3
<i>p</i> value	0.059				0.041*			

\*Significant difference ( $p < 0.05$ )

## DISCUSSION

The present study investigated the immediate effects of KT on the level of pain and myoelectric activity of the middle deltoid, anterior serratus and upper trapezius muscles, in individuals with SIS during the flexion and abduction movements to 90°. The method of KT placement resulted in a reduction of peak myoelectric activity of the upper trapezoid and middle deltoid in the KT situation during the shoulder abduction movement to 90°. In the same movement, it was also observed, with the use of numerical visual scale, the pain level reduction in the situation with KT. In the flexion movement, no alteration was observed either in the myoelectric signal of the muscles or in the level of pain.

Muscles which demonstrated alterations in myoelectric activity due to use KT are precisely the most overloaded in patients with SIS<sup>(2, 8-10)</sup>. Apparently, it is speculated that the correct application of KT may contribute to a reduction in pain and decreased values of peaks of these muscles. This reduction of pain may generate a lesser necessity for compensation in the region of the shoulder girdle for the accomplishment of the abduction movement which causes a reduction of myoelectric activity of the upper trapezius. Alterations in peak and medium myoelectric activities were not found during the flexion movement, possibly due to the low necessity for recruitment of these muscles during the movement, besides being a movement which does not generate great compensations when compared to the abduction and external rotation of the shoulder in patients with SIS<sup>(3)</sup>. Similarly the serratus anterior presenting low values during the abduction in patients with SIS which did not impact by KT on its magnitude<sup>(2, 7-10)</sup>.

The differences on the upper trapezius and middle deltoid could be related to the effects of KT<sup>(11)</sup>. The strips and KT were positioned exactly on the hyperactivated muscles in the patients (upper trapezius and middle deltoid) which generates a inhibition generator factor, resulting from the sensory action of KT on the mechanoreceptors, as these provide an analgesic effect by inhibiting the nociceptors according to the behavior of pain theory<sup>(11)</sup>. Regarding the high-tension strip, the KT

generates a mechanical correction which leads to improved proprioception and motor rehabilitation reducing movements that may be considered harmful and may produce an improved positioning of the shoulder girdle<sup>(18)</sup>.

Inhibition of the upper trapezius has been investigated in other studies<sup>(19, 23, 24)</sup> and agree with the findings of the present study when related to it. Using the KT transversely on the upper trapezius with and without tension, it was observed that, regardless of the exerted tension, a reduction of upper trapezius activity was observed during a typing task, which is an important clinical factor in the syndrome treatment of the impact since the upper trapezius is one of the most overloaded muscles in patients. These results agree with other KT studies in the literature which used KT on upper trapezius muscle with inhibition target<sup>(24)</sup>.

Apparently KT had influence only on the peak values of myoelectric activation during abduction. From the point of view of rehabilitation, it is an important result in the treatment of SIS, because with a technique considered complementary, it was possible to reduce the hyperactivity of the muscles most affected by the injury. This, together with the reduction of pain during abduction may help to improve the daily living activities of the patients, as well as support the shoulder during rehabilitation exercises.

The KT protocol was already used in an identified or adapted way in other studies, however the effects on myoelectric activity in the shoulder were not evaluated, only the level of pain in different situations<sup>(12, 13, 25, 26)</sup>.

Using the same protocol evaluating pain level, the investigators studied the influence of KT on pain and disability in individuals diagnosed with SIS or rotator cuff tendonitis in the abduction, flexion, elevation movements in the plane of the scapula during a period of 6 days, performing evaluations on the 1st, 3rd and 6th day<sup>(13)</sup>. Two groups were formed, one with a random placebo bandage and another with the experimental protocol suggested by Kase et al.<sup>(11)</sup>. They found a reduction in pain levels in the experimental group during the first day abduction (short term), thus agreeing with the





findings of the present study where only short-term relief for the shoulder abduction was found. Suppose, through the study, that the use of KT would be limited to term, where from 3 days of using it would lose its effects in the long term<sup>(13, 27)</sup>. Suggesting the use of KT during sports or during physiotherapy rehabilitation in order take advantage of its immediate effects<sup>(27, 28)</sup>. It is also reported the improved function provided by KT, because it does not restrict movement, giving more functionality<sup>(25, 28, 29)</sup>. Adapting the placement protocol, the researchers found that in the short term there is reduction of pain levels after the first week of intervention with KT in night pain, rest and activity scores<sup>(12)</sup>.

Even with the methodological limitations which were found in the study, however, the study provides indications of the possible benefits of using KT in patients with SIS, such as reduction of pain levels and reduction of upper trapezius and middle deltoid peak values at abduction. Initially, despite the results we are not absolutely sure if the influence on the EMG signal is an individual result of some strip or the combination of the three strips which compose the protocol, regarding this fact, we should check both individually, it is believed that if the strips are used individually they would have different behaviors, since each one has a goal in a different musculature. The reduced sample may become a hindrance to more precise results, a control group could be interesting for future studies. Another factor that may become extremely important for future studies is the evaluation of the scapular kinematics with the use of the KT protocol, which may be strongly related subsequently with the myoelectric activity of the shoulder complex muscles. An evaluation of the lower trapezius muscle myoelectric activity is necessary when evaluating shoulder injuries. Mainly by reversing the upper and lower trapezius activation<sup>(30)</sup> which was not observed in the present study.

The influence of KT on the lower trapezius had already been investigated<sup>(19)</sup>. Specifically the myoelectric activity of the upper trapezius, serratus anterior and inferior in baseball players with SIS in shoulder lifting movement at the scapula plane. As results, there was an increase in the activation of the lower trapezius muscle with KT when compared to the situation without KT in the final movements of elevation at the scapula plane. This is an important factor since patients have decreased activation of the scapula muscle. Currently, we do not know if the present protocol of placement influences the lower trapezius muscle which would be an important finding.

## CONCLUSION

It is possible to conclude that KT reduced pain level and peak activation of the upper trapezius and medial deltoid muscles during the shoulder abduction movement up to 90°. It should also remember that KT is a complementary technique to the physiotherapeutic treatment, where KT beneficial effects are reported in the clinical practice of physiotherapy and injury prevention, however, when we choose to use the

KT in prevention or rehabilitation of injuries, we must always take into account the history of the patient, daily or sports activities, the presence or absence of injury, the objective of the application of the specific KT according to the evaluation and proposed physiotherapeutic treatment<sup>(31, 32)</sup>.

## AUTHOR'S CONTRIBUTION

WD: Responsible for the study, EMG data collection, data analysis and article writing. MT: Responsible for the development of the study, data analysis and statistical analysis. JL: Responsible for data analysis, interpretation of data and discussion of the manuscript.

## CONFLICTS OF INTEREST

The authors declare no conflict of interests.

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