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A Triple Application of Kinesio Taping Supports Rehabilitation Program for Rotator Cuff Tendinopathy: a Randomized Controlled Trial

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SUMMARY

Background. Rotator cuff tendinopathy (RoCT) is a common pathology among adults. Kinesio-taping (KT) represents a possible rehabilitative treatment. The aim of the present study is to investigate the efficacy of a combination of three different applications of KT combined with a standardized protocol of rehabilitative exercises in reducing pain and in functional recovery in patients affected by RoCT.

Materials and methods. 21 patients were enrolled in a real group (RG) and 19 in a sham group (SG). RG received a real KT application and SG received a sham KT application. Both groups received the same rehabilitative protocol. A Numeric Rating Scale (NRS) for shoulder pain, Medical Research Council (MRC) Scales for shoulder strength assessment and Costant Murley Score (CMS) were administered before (T0) and at the end of treatment (T1).

Results. Within-group analysis for RG at T1 showed significant improvement in: NRS at-rest ($p=0.002$), during-movement ($p<0.001$); CMS ($p<0.001$); MRC shoulder flexion ($p=0.003$), extension ($p=0.005$), abduction ($p=0.003$), adduction ($p=0.007$), external rotation ($p=0.011$), internal rotation ($p=0.002$), elbow flexion ($p=0.008$) and extension strength ($p=0.011$). Within-group analysis for SG at T1 showed significant improvement in: during-movement NRS ($p=0.010$); CMS ($p<0.001$).

Conclusions. 1. KT application combined with conventional rehabilitative treatment can facilitate immediate pain reduction during rehabilitative treatment. 2. KT application combined with conventional rehabilitative treatment can increase function recovery. 3. KT application combined with conventional rehabilitative treatment can increase strength recovery. 4. Our findings however are not strong enough to recommend the application of KT during rehabilitative treatment for RoCT. 5. These results are the basis for future prospective, randomized controlled trials of larger samples of patients

Key words: kinesio taping, rotator cuff tendinopathy, exercise therapy, rehabilitation, shoulder pain

BACKGROUND

Rotator cuff tendinopathy (RoCT) is a very common pathology within the working population caused by functional overload of the shoulder and clinically presenting with pain [1]. RoCT is an involution of the skeletal-muscle shoulder structures, which significantly increases after 50 years of age [2]. Literature is inconsistent in defining the prevalence rate and epidemiological characteristics of RoCT. A previous study supported the hypothesis that gender and co-morbidities may play a significant role in the progression of damage to shoulder structures [3]. A more recent epidemiological study based on analysis of the Health Improvement Network (THIN) database reported an increase in shoulder pathology in females compared to males (90 cases out of 100.000 persons/year for women, 83 cases out of 100.000 persons/year for males) [4]. Conservative treatment, consisting of drugs and rehabilitative treatment, is, in most cases, the first-choice, aiming at the greatest possible recovery of the shoulder articulation range of motion (ROM) and at restoring a correct scapular-thoracic rhythm [5,6]. A systematic review of the literature, in fact, showed that physical exercise has a significant effect on the reduction of pain and improvement in ROM [7]. Rehabilitative treatment should be as specific and customized as possible, based on the kind of tendinopathy, the time from onset of symptoms and the intensity of pain. Kinesio-taping (KT) is a possible rehabilitative option that produces beneficial effects, such as the facilitation or inhibition of muscle function. KT consists in the application of an elastic tape which promotes endogenous analgesic activation, reduction of circulatory congestion, improvement of hematomas, hemarthrosis, hydrocele and post-traumatic or post-surgical edema, promotes the control of muscle fatigue (neuromuscular facilitation and inhibition), helps muscle support, joint support, psychological function and improvement of athletic performance [8]. KT has been proved to have a positive effect on pain relief in shoulder pain, both when used alone [9] and in combination with shoulder mobilization [10,11], compared to physical therapies [6] and joint infiltrations [12]. However, a recent revision of literature highlighted the presence of biases in most randomized controlled trials comparing KT to other treatments: the absence of a standardized protocol of rehabilitative exercises with which to compare the effect of taping. These biases produce a significant degree of heterogeneity within studies, which, overall, furnish insufficient evidence to conclude on the efficacy of KT in patients with RoCT [13].

Rehabilitative treatments described in the literature aim at an early painless recovery of passive ROM, followed by recovery of active ROM and, subsequently, at restoring coordination, proprioception and strength [7,14–16]. The aim of the present study was to investigate the efficacy of an innovative combination of three different applications of KT when combined with a standardized and fully explained protocol of rehabilitative exercises in reducing pain and in functional recovery in patients affected by RoCT.

MATERIAL AND METHODS

This was a monocentric prospective double blind randomized controlled trial carried out at the Department of Physical and Rehabilitation Medicine of Campus Bio-Medico University of Rome. All enrolled subjects were referred to the Department on account of shoulder pain between September 2016 and December 2017 and were examined by a Physical and Rehabilitation Medicine specialist and diagnosed with RoCT. Inclusion criteria were: (1) radiologic diagnosis of RoCT (evidence of pathognomonic signs at musculoskeletal echography or magnetic resonance); (2) clinical positivity to at least one of the specific shoulder tests for RoCT; (3) provision of informed consent to participate; (4) shoulder pain. Exclusion criteria were: (1) total tendon lesion; (2) previous fracture or shoulder dislocation; (3) presence of skin lesions contraindicating the application of KT; (4) coexisting elbow, forearm, wrist, hand and fingers pathologies; (5) history of neoplasm; (6) cognitive impairment (MMSE<24); (7) diabetes mellitus; (8) statin use; (9) diagnosis of anxiety-depressive syndrome.

All subjects provided their informed consent to participate. The study was conducted with local Ethical Committee approval (Prot. N. 52/16 PT_Com Et CBM) in accordance with the Declaration of Helsinki, and subjects were randomly assigned to two groups by another examiner using the envelope system (Ratio 1:1). Real Group (RG) received application of real KT and underwent a standardized rehabilitative protocol of exercises, whereas Sham Group (SG) received sham KT and the same rehabilitative standardized protocol of exercises.

Rehabilitative protocol

All subjects attended 10 sessions of rehabilitative treatment, from Monday to Friday for two consecutive weeks, consisting of:

ROM improvement exercises: passive shoulder mobilization (pendulum exercises, 20 clockwise, 20 anti-clockwise; posture exercises with the patient leaning back and holding hands on hips); active assist-

ed mobilization (pulley exercises, cane exercises in flexion, extension, abduction, adduction, internal and external rotation); active shoulder mobilization (scapular adduction, arm abduction over 90° of ROM avoiding scapular compensation, periscapular muscle activation, repetition of rotation, flexion, extension, abduction, adduction).

Stretching exercises: anterior-shoulder and posterior-shoulder stretch, internal and external rotation stretch, lateral neck stretches.

Strengthening of shoulder muscle: scaption, chair press, push up plus, press up, seated and upright rows, low trapezius in upright standing position, external rotation and internal rotation with rubber bands and weightlifting.

Kinesio Taping

Taping application took place every other day during the rehabilitative treatment (on Monday, Wednesday and Friday) and consisted in:

RG: decompressive tape on deltoid muscle without tensioning (Figure 1A); functional tape on glenohumeral articulation with 25% tensioning (Figure 1B); decompressive tape on rhomboid muscle positioned at fourth thoracic vertebral level (Figure 1C).

SG: decompressive deltoid-like application (Figure 2A), functional-like application (Figure 2B) and a rhomboid-like application (Figure 2C). Taping was positioned without tensioning, with limb in neutral position, without joint involvement (exclusion of the humeral head for the deltoid-like application, exclusion of the vertebral column for the rhomboid-like application).

All participants underwent evaluations before starting treatment (T0) and at the end of treatment (T1). Shoulder pain modifications were measured as intensity at rest and during movement with a Numeric Rating Scale (NRS) (0 no pain – 10 worst possible pain). Functional shoulder modifications were measured with the CMS, which consists of a 100-point scale assessing qualitative function of shoulder (embracing pain, ADL, mobility and strength). ROM modifications were measured with goniometric assessment of shoulder ROM. Strength modifications were measured with Medical Research Council (MRC) scale (ranging from 0 = no contraction, to 5 = normal strength), which was used with the permission of the Medical Research Council. The examiner was blind to real/sham taping treatment. The physiotherapist involved in rehabilitative treatment was blind to the type of taping application. The physiotherapists who applied the taping never coincided with those who performed the standardized rehabilitative treatment.

Statistical analysis was performed using SPSS 17.0 (SPSS Inc. Chicago, IL, USA). P values below 0.05 were considered statistically significant. The Shapiro-Wilk test was performed for each variable to assess the Gaussian distribution, and means and standard deviations (SD) were calculated. Since the variables were found not to be normally distributed, the Wilcoxon test for paired samples was used to detect any within-group significant differences for each variable, whereas the Mann-Whitney U test for independent samples was used to detect any between-group significant differences for each variable.

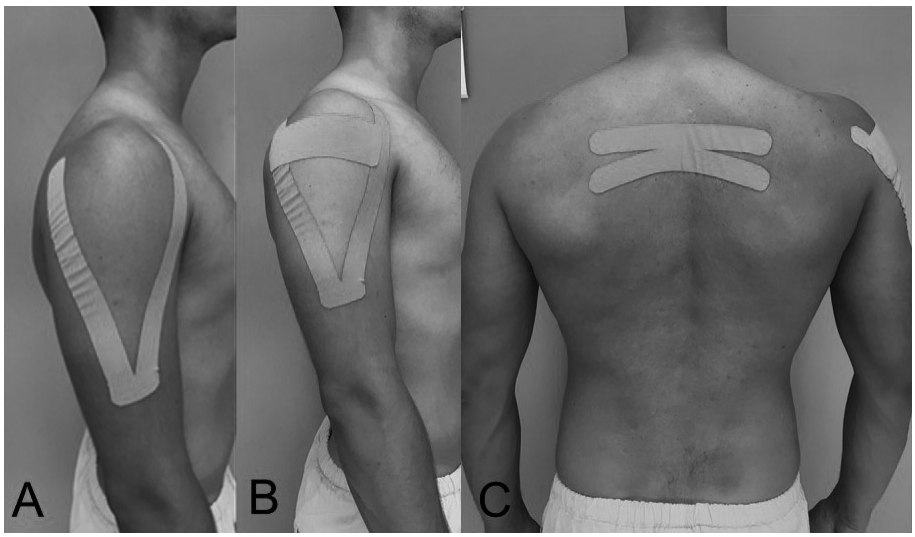

Fig. 1. Real Group KT application A) decompressive tape on deltoid muscle without tensioning; B) functional tape on glenohumeral articulation with 25% tensioning; C) decompressive tape on rhomboid muscle positioned at fourth-thoracic vertebral level

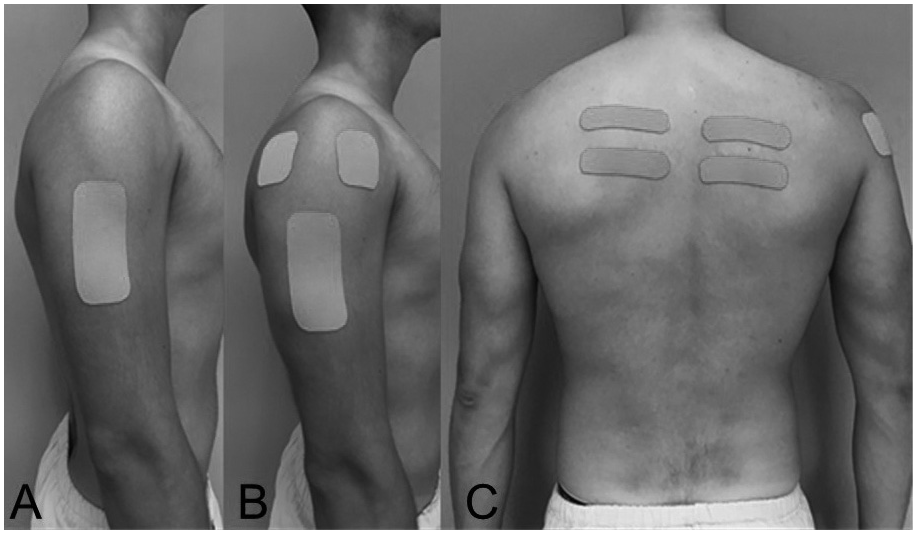

Fig. 2. Sham Group KT application A) decompressive deltoid-like application; B) functional-like application; C) rhomboid-like application

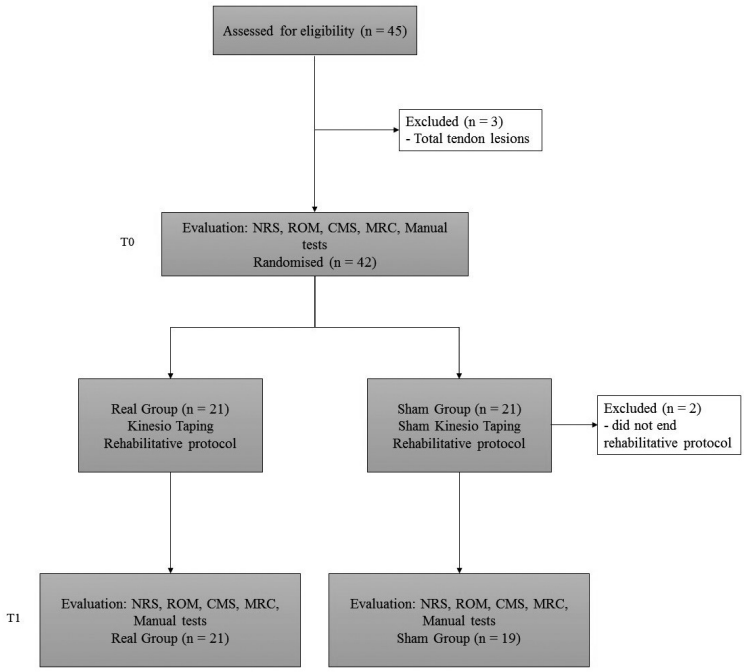

Fig. 3. Flow-chart of participants

RESULTS

Forty patients completed the study protocol, including 21 subjects assigned to RG and 19 to SG. A participation flow-chart is shown in Figure 3. Descriptive characteristics of the subjects are reported in Table 1.

No significant differences were found between the two groups at baseline for NRS, CMS and MRC strength assessment, as reported in Table 2.

Within-group analysis for RG at T1 showed significant improvement in the following (Table 3): at-rest NRS ($p=0.002$); during-movement NRS ($p<0.001$); CMS ($p<0.001$); MRC shoulder flexion ($p=0.003$); MRC shoulder extension ($p=0.005$); MRC shoulder abduction strength ($p=0.003$); MRC shoulder adduction strength ($p=0.007$); MRC shoulder external rotation strength ($p=0.011$); MRC shoulder internal rotation strength ($p=0.002$); MRC elbow flexion strength ($p=0.008$); MRC elbow extension strength ($p=0.011$). Within-group analysis for SG at T1 showed significant improvement in the following (Table 3): during-movement NRS ($p=0.010$); CMS ($p<0.001$).

Tab. 1. Descriptive data

Charateristic	Real Group (n = 21)	Sham Group (n = 19)
Participants		
Gender, n males	9	9
Age *(yrs)*, mean ± SD	61 ± 12	64 ± 10
Weight *(Kg)*, mean ± SD	72 ± 14	76 ± 17
Height *(Cm)*, mean ± SD	165 ± 8	165 ± 12
BMI, mean ± SD	26 ± 4	28 ± 5
Side Affected, n right	12	8
Manual tests		
Jobe, n positive	19	18
Palm Up, n positive	11	16
Hawking, n positive	13	11
Neer, n positive	12	11
Patte, n positive	7	6
Lift Off, n positive	14	17

Tab. 2. Between-group analysis. Medians (IQR) are shown

Outcome	**Real Group (n = 21)**	**Sham Group (n = 19)**	**Between-group statistics[ɻ] (p)**
At-Rest Numeric Rating Scale (NRS)			
Pre-treatment (T0)	3 (1-3)	2 (1-3.5)	0.539
Post-treatment (T1)	1 (1-2)	1 (0-3)	0.854
During-movement Numeric Rating Scale (NRS)			
Pre-treatment (T0)	6 (5-7)	5 (4-7)	0.956
Post-treatment (T1)	3 (2-4)	4 (2.5-4.5)	0.159
Costant Murley Scale			
Pre-treatment (T0)	44 (40-53)	42 (38-51.5)	0.664
Post-treatment (T1)	59 (57-68)	54 (46-58.5)	0.067
MRC shoulder flexion			
Pre-treatment (T0)	4 (4-4)	4 (4-4.5)	0.879
Post-treatment (T1)	5 (4-5)	4 (4-5)	0.109
MRC shoulder extension			
Pre-treatment (T0)	4 (4-5)	4 (4-4.5)	0.684
Post-treatment (T1)	5 (4-5)	4 (4-5)	0.029
MRC shoulder abduction			
Pre-treatment (T0)	4 (4-4)	4 (4-4)	0.938
Post-treatment (T1)	5 (4-5)	4 (4-4.5)	0.097
MRC shoulder adduction			
Pre-treatment (T0)	4 (4-4)	4 (4-4.5)	0.892
Post-treatment (T1)	5 (4-5)	4 (4-5)	0.058
MRC shoulder external rotation			
Pre-treatment (T0)	4 (4-4)	4 (4-4)	0.876
Post-treatment (T1)	4 (4-5)	4 (4-4)	0.061
MRC shoulder internal rotation			
Pre-treatment (T0)	4 (4-4)	4 (4-4)	0.669
Post-treatment (T1)	5 (4-5)	4 (4-4.5)	0.097
MRC elbow flexion			
Pre-treatment (T0)	4 (4-5)	5 (4-5)	0.677
Post-treatment (T1)	5 (5-5)	5 (4-5)	0.223
MRC elbow extension			
Pre-treatment (T0)	4 (4-5)	5 (4-5)	0.582
Post-treatment (T1)	5 (5-5)	5 (4-5)	0.223

[ɻ] Mann-Whitney U test

Tab. 3. Within-group analysis. Median (IQR) are shown

	Real Group (n = 21)			Sham Group (n = 19)		
	Pre-treatment (T0)	Post-treatment (T1)	Within-group statistics[↓] (p)	Pre-treatment (T0)	Post-treatment (T1)	Within-group statistics[↓] (p)
At-Rest Numeric Rating Scale (NRS)	3 (1-3)	1 (1-2)	0.002	2 (1-3.5)	1 (0-3)	0.112
During-movement Numeric Rating Scale (NRS)	6 (5-7)	3 (2-4)	<0.001	5 (4-7)	4 (2.5-4.5)	0.010
Costant Murley Scale	44 (40-53)	59 (57-68)	<0.001	42 (38-51.5)	54 (46-58.5)	<0.001
MRC Shoulder flexion	4 (4-4)	5 (4-5)	0.003	4 (4-4.5)	4 (4-5)	0.083
MRC Shoulder extension	4 (4-5)	5 (4-5)	0.005	4 (4-4.5)	4 (4-5)	0.157
MRC Shoulder abduction	4 (4-4)	5 (4-5)	0.003	4 (4-4)	4 (4-4.5)	0.083
MRC Shoulder adduction	4 (4-4)	5 (4-5)	0.007	4 (4-4.5)	4 (4-5)	0.157
MRC Shoulder external rotation	4 (4-4)	4 (4-5)	0.011	4 (4-4)	4 (4-4)	0.564
MRC Shoulder internal rotation	4 (4-4)	5 (4-5)	0.002	4 (4-4)	4 (4-4.5)	0.180
MRC Elbow flexion	4 (4-5)	5 (5-5)	0.008	5 (4-5)	5 (4-5)	0.157
MRC Elbow extension	4 (4-5)	5 (5-5)	0.011	5 (4-5)	5 (4-5)	0.157

[↓] Wilcoxon test

Between-group analysis showed significant differences for MRC shoulder extension strength (p= 0.029) as reported in Table 2.

DISCUSSION

The pathogenesis of RoCT seems to be closely related to the reduction of subacromial space, shoulder posterior capsule tightness and glenohumeral internal rotation deficit, as described in several studies [17-19]. KT is commonly used in clinical practice as a support during rehabilitative treatment, even if, as described before, there is little evidence of efficacy due to the significant heterogeneity of studies and the lack of standardized rehabilitative protocols [13]. The innovative combination of three kinds of KT in our study aimed at gleno-humeral decoaptation, giving continuous eccentric anteroposterior stimulation during movement (deltoid decompressive KT), counteracting shoulder antalgic anteposition (functional KT application to the gleno-humeral joint) and decontracting rhomboid muscles in order to facilitate scapular-thoracic movements (decompressive KT application to the rhomboid muscles). The combination of these KT applications aimed at reducing the deficit in glenohumeral internal rotation and posterior capsule tightness. Moreover, the standardized rehabilitative protocol aimed at strengthening the rotator cuff and stabilizing scapular muscles (anterior serratus, rhomboids, dorsal and trapezius) to reduce humeral instability and limit upward migration. The results show that this triple KT application supports rehabilitative treatment as it improves both at-rest and during-movement pain in RG and during-movement pain in SG. These results suggest that KT has an effect on pain, probably due to the gate control mechanism, according to which KT produces sensory stimulation that reduces nociceptive signals [9,20]. Moreover, pain reduction should likely explain the improvement observed in shoulder function as measured by CMS [21]. Strength improvement, observed in RG only, confirms literature findings about KT influence on facilitating muscle activity [22] and immediately increasing muscle strength, which could be due to a concentric pulling of fascia [20]. However, between-group analysis suggests that KT application does not consistently affect the rehabilitative process, since, except shoulder extension strength, there were no significant differences between RG and SG. These results are in accordance with literature, since, even if studies show some clinical efficacy of taping application, there is insufficient evidence of rehabilitative benefits to strongly recommend KT application [13,23]. Other studies investigating the effect of KT on the treatment of other joints, such as the knee, confirm that KT can support rehabilitative therapy; however, there are no significant effects in terms of recovery [24,25].

The lack of a control group of patients undergoing the same rehabilitative protocol without KT application represents a limitation of this study; this makes it difficult to clearly define if the impact on pain, function and strength is due to KT or exercise therapy as shown by our results in accordance with the literature [26]. Further studies are therefore necessary to better clarify KT efficacy in RoCT.

CONCLUSIONS

1. KT application combined with conventional rehabilitative treatment can facilitate immediate pain reduction during rehabilitative treatment

2. KT application combined with conventional rehabilitative treatment can increase function recovery
3. KT application combined with conventional rehabilitative treatment can increase strength recovery
4. Our findings, however, are not strong enough to recommend the application of KT during RoCT rehabilitative treatment
5. These results are the basis for future prospective randomized controlled trials with larger samples of patients

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