Kinesiotaping for the Rehabilitation of Rotator Cuff–Related Shoulder Pain: A Randomized Clinical Trial

Fábio Carlos Lucas de Oliveira, PT, PhD,*†‡ Benoit Pairot de Fontenay, PT, PhD,†‡ Laurent Julien Bouyer, PhD,†‡ François Desmeules, PT, PhD,§‖ and Jean-Sébastien Roy, PT, PhD†‡

Background: Kinesiotaping (KT) has been widely used in clinical practice. Current evidence is insufficient to support the use of KT for treating rotator cuff–related shoulder pain (RCRSP), as its mid- and long-term effects have not been investigated.

Hypotheses: Individuals using KT will achieve faster improvements in symptoms and functional limitations compared with those not using it. They will also present a greater increase in pain-free range of motion (ROM) and acromiohumeral distance (AHD) at the end of the treatment.

Study Design: Randomized controlled trial (NCT02881021).

Level of evidence: Therapy, level 1b.

Methods: A total of 52 individuals with RCRSP, randomly assigned to 1 of 2 groups (experimental: KT; control: no-KT), underwent a 6-week rehabilitation program composed of 10 physical therapy sessions. KT was added to the treatment of the KT group. Symptoms and functional limitations were assessed using the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire (primary outcome); Brief Pain Inventory (BPI); and Western Ontario Rotator Cuff (WORC) index at baseline, 3 weeks, 6 weeks, 12 weeks, and 6 months. AHD, pain-free ROM, and full ROM were measured at baseline and at week 6. The effects of KT were assessed using a nonparametric analysis for longitudinal data.

Results: No significant group × time interactions ($0.112 \leq P \leq 0.726$) were found for all outcomes. Time effects were observed as both groups showed significant improvements for all studied outcomes (DASH, BPI, and WORC, $p < 0.0001$; AHD, $p = 0.017$; pain-free ROM, $p < 0.0001$; and full ROM abduction, $p \leq 0.0001$).

Conclusion: Whereas symptoms, functional limitations, ROM, and AHD improved in both groups, the addition of KT did not lead to superior outcomes compared with exercise-based treatment alone, in the mid and long term, for individuals with RCRSP.

Clinical Relevance: Clinicians should not expect supplementary mid- or long-term gains with KT to reduce pain, improve shoulder function and ROM, or increase AHD if a rehabilitation program focusing on shoulder neuromuscular control is concurrently provided as treatment for individuals with RCRSP.

Keywords: elastic tape; kinesiology taping; physical therapy; rotator cuff; shoulder pain; tendon injuries

From †Center for Interdisciplinary Research in Rehabilitation and Social Integration, CIUSSS-CN, Quebec City, Quebec, Canada, ‡Department of Rehabilitation, Faculty of Medicine, Université Laval, Quebec City, Quebec, Canada, §Orthopaedic Clinical Research Unit, Maisonneuve-Rosemont Hospital Research Center, University of Montreal Affiliated Research Center, Montreal, Quebec, Canada, and ‖School of Rehabilitation, Faculty of Medicine, University of Montreal, Montreal, Quebec, Canada
*Address correspondence to Fábio Carlos Lucas de Oliveira, PT, PhD, Center for Interdisciplinary Research in Rehabilitation and Social Integration, CIUSSS-CN, Department of Rehabilitation, Faculty of Medicine, Université Laval, 525, boul. Wilfrid-Hamel, Local H-0610, Quebec City, Quebec, G1M 2S8 Canada (email: fabio-carlos.lucas-de-oliveira.1@ulaval.ca).

The following authors declared potential conflicts of interest: J.-S.R. and F.D. are supported by salary awards from the Fonds de Recherche Québec-Santé (FRQS) and the Canadian Institutes of Health Research (CIHR). This work was supported by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior–CAPES.
DOI: 10.1177/1941738120944254

Shoulder pain is a very common musculoskeletal disorder that affects a large portion of the population,[51] with a point prevalence up to 26%.[26] A frequent type of shoulder pain is rotator cuff–related shoulder pain (RCRSP),[4] which is an umbrella term that encompasses several diagnoses related to subacromial structures.[16,52] Although RCRSP is likely multifactorial, a dynamic narrowing of the subacromial space with compression of the subacromial soft tissues has been suggested to be one of the leading causes of chronic RCRSP. A lack of coordination among rotator cuff and scapulothoracic muscles[5] affects shoulder neuromuscular control, which may explain the narrowing (estimated using the acromiohumeral distance [AHD]) and the limited shoulder range of motion (ROM)[29] evidenced within the population.

The use of graduated exercises is the cornerstone to recovering proper shoulder neuromuscular control.[37,39] Exercises have been demonstrated to be effective for the management of RCRSP[16,25] since they improve pain and function.[46] Notwithstanding that many patients with RCRSP are symptomatic for 12 months or more,[52] new approaches are encouraged to optimize the effects of a rehabilitation program. Within the past decade, kinesiotaping (KT) has been widely used for the rehabilitation of musculoskeletal disorders. KT is argued to relieve pain via neural pathways, as postulated within the gate control theory, through the stimulation of peripheral modulation mechanisms,[53] resulting in increased stimulation of the cutaneous mechanoreceptors.[12] In theory, it is believed to improve proprioceptive feedback[3,40] and to enhance joint sensorimotor control, contributing to the restoration of adequate shoulder function. Accordingly, KT has been considered an interesting option to improve shoulder control.[34] Thelen et al[50] found a significant increase in pain-free shoulder abduction immediately after the application of KT, and de Oliveira et al[8] demonstrated an immediate and significant increase in the AHD among individuals with RCRSP. Nonetheless, current evidence is insufficient to support or to discard the use of KT for the rehabilitation of RCRSP.[9,38] The majority of the clinical trials that have studied KT have examined it as an isolated method of treatment instead of in conjunction with other interventions, as typically employed within a clinical setting. In addition, only its immediate or short-term effects have been reported at this time.

The primary objective of this randomized controlled trial (RCT) was to evaluate the mid- and long-term effects of KT, added to a 6-week rehabilitation program, on the symptoms and functional limitations of individuals with RCRSP. To better understand the underlying mechanisms of KT, our secondary objective addressed the effects of KT on pain-free and full ROM and on AHD.

We hypothesized that individuals using KT will achieve faster improvements in symptoms and functional limitations compared with those who do not, and that individuals receiving KT would display a greater increase in pain-free ROM and AHD at the end of the treatment.

METHODS

Participants

Consecutive individuals with RCRSP (N = 52) were recruited from the mailing list of the Université Laval (Quebec City, Canada). To be included, participants had to (1) be between the ages of 18 and 65 years; (2) have a baseline score of at least 11 points on the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire (which is based on the minimal clinically important difference [MCID] for the DASH); and (3) have 1 positive sign in each of the following 3 categories[37]: (1) painful arc of movement,[32] (2) Neer or Hawkins-Kennedy impingement signs,[1] and (3) pain during resisted external rotation, abduction, or empty can test[1] (combined sensitivity and specificity >0.74).[32] Potential participants were excluded if they had (1) an open wound or allergy to KT compromising the application; (2) previous shoulder surgery; (3) adhesive capsulitis (passive shoulder ROM <50%)[43]; (4) a history of glenohumeral dislocation (<12 months) or fracture to the shoulder girdle; (5) shoulder pain reproduced by cervical movements or cervicobrachialgia; or (6) clinical signs of full-thickness rotator cuff tears (positive lag signs).[17,33]

Study Design

This study was a single-blind, parallel-group RCT and included outcome assessments at 5 time points (baseline, 3 weeks, 6 weeks, 12 weeks, and 6 months). At baseline, participants first provided written consent and completed a sociodemographic questionnaire. They then completed the DASH questionnaire (the primary outcome), the Brief Pain Inventory (BPI), and the Western Ontario Rotator Cuff (WORC) index. Finally, pain-free and full shoulder ROM, as well as AHD on ultrasonography, were measured.

Participants were then randomly assigned to either the experimental (KT group) or the control group (no-KT group) and attended 10 physical therapy sessions over 6 weeks. The DASH, BPI, and WORC index were reevaluated at 3 weeks, 6 weeks, 12 weeks, and 6 months of follow-up, whereas pain-free and full shoulder ROM and ultrasonographic measurements of the AHD were reevaluated at week 6. The Sectorial Rehabilitation and Social Integration Research Ethics Committee of the CIUSSS-CN granted ethical approval. The study was conducted following the CONSORT (Consolidated Standards of Reporting Trials) guidelines, and the study protocol was registered on ClinicalTrials.gov (NCT02881021) and published.[6]

Randomization, Blinding, and Allocation Concealment

Randomization was performed by an independent researcher before the initiation of the study, using a computer random generator. Randomization was stratified by sex (as it was unclear whether sex could influence the KT responses), and a block design (block size of 4-6-8) was utilized.[27] The allocation was concealed in sequentially numbered sealed opaque envelopes that were opened by the treating physical therapist

(blinded to outcome assessments) at the first intervention. Participants were unaware of the treatment provided to the participants in the other group; they were also unaware that the KT was the central element of this RCT. Participants were instructed not to reveal or discuss treatments with the evaluator. To ensure evaluator blindness, outcome assessments were performed on a different day than the actual physical therapy sessions. As participants only began to take the questionnaires at the week 3 evaluation and as KT was no longer used at the week 6 evaluation, participants did not present with any evidence of KT on their skin. To assess the blinding effectiveness, the evaluator answered a question at the week 6 evaluation point related to the allocation ("In your opinion, which intervention did this participant receive?"). The possible answers were (1) conventional (control group); (2) intervention testing a new technique (experimental group); or (3) I have no idea.

Intervention

Rehabilitation Program

Both groups received the standardized 6-week rehabilitation program advocated by the same physical therapist, who possessed more than 15 years of experience in the clinical treatment of RCRSP. Composed of 10 physical therapy sessions of 30 to 45 minutes duration, the rehabilitation program was provided individually to all participants (twice weekly during the first 4 weeks, then once weekly). The only difference between the programs received by the 2 groups was the addition of Kinesio Taping in the KT group. At least 75% of each physical therapy session was devoted to sensorimotor training using motor control exercises to reduce sensorimotor deficits associated with RCRSP and, hence, to restore adequate shoulder neuromuscular control.[28,37,39] Exercises were chosen according to the specific needs of each participant. The rehabilitation program also included patient education and strengthening exercises. A full outline of each component of the rehabilitation program can be found in Appendix 1 (available in the online version of this article). A list of 4 home exercises was established after each session. It included sensorimotor training (3 sets per day) and strengthening exercises (1 set of 10 repetitions per day)[28] selected by the physical therapist according to individual needs. Compliance with home exercises was monitored using a logbook throughout the study. To reduce the possible impact of external factors, participants were requested to interrupt parallel treatments for their shoulder pain.

KT Application

All taping procedures followed the Kinesio Taping Association International (KTAI) guidelines[20] and were performed by the same physical therapist, who is a certified KT practitioner by KTAI. After cleansing of the skin with isopropyl alcohol, 3 strips of blue Kinesio Tex Classic (Kinesio Holding Corp., Albuquerque, New Mexico) was applied on the affected shoulder (Figure 1). All strips were rubbed after the application to increase adherence to the skin. Participants were advised to remove the KT immediately if adverse effects (chafe, rash, etc) were felt. Otherwise, they were instructed to keep the KT on their skin for 72 hours[20] or until the next intervention, whichever came first. New KT was applied at the end of each session.

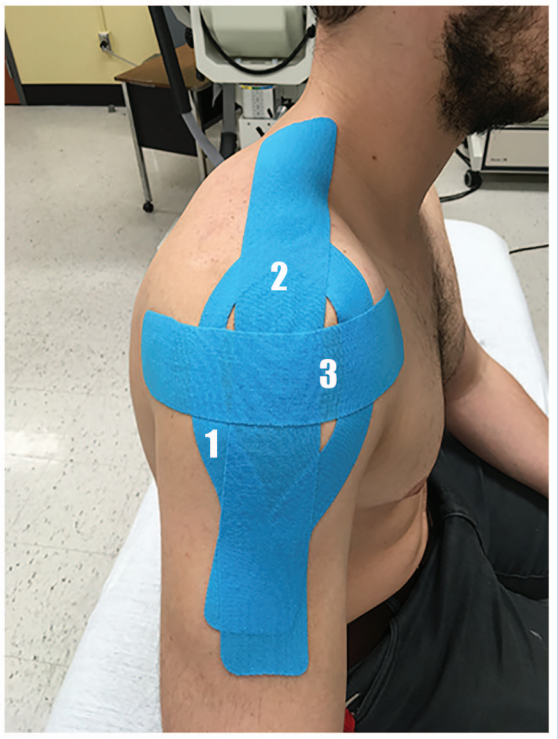

Figure 1. Kinesiotaping technique for rotator cuff–related shoulder pain and underlying deficits. An anchor of 5 cm was laid with 0% tension in each extremity of all strips. First strip (1: Y-shape for hypothetical inhibition and muscle relaxation, light tension [15%-25%], surrounding the 3 portions of the deltoid muscles as a group, from insertion to origin), second strip (2: I-shape for shoulder functional correction, recommended for multiaxial shoulder instability, severe tension [50%-75%], from 7 to 10 cm above the acromioclavicular joint to 7 to 10 cm below the deltoid tuberosity, passing over the supraspinatus, trapezius, glenohumeral joint, and middle deltoid muscle), and third strip (3: I-shape, for mechanical correction of glenohumeral joint, severe tension [50%-75%], placed with inward pressure, from the coracoid process to posterior deltoid, just slightly below the coracoacromial arch).

Outcome Measures

A blinded independent evaluator (physical therapist with expertise in the evaluation and ultrasound imaging of musculoskeletal disorders), not involved in any other process of the study, conducted all outcome measure assessments.

Table 1. Baseline characteristics of participants (N = 52)[a]

	Kinesiotaping (Experimental Group, n = 26)	No-Kinesiotaping (Control Group, n = 26)
Demographic data		
Age, y, mean ± SD	30.9 ± 9.0	29.4 ± 7.5
Sex, male, n (%)	15 (57.7)	15 (57.7)
Height, cm, mean ± SD	1.77 ± 0.12	1.73 ± 0.10
Weight, kg, mean ± SD	75.5 ± 15.0	72.2 ± 12.7
Dominance (right), n (%)	24 (92.3)	23 (88.5)
Dominant shoulder affected, n (%)	18 (69.2)	17 (65.4)
Overhead sports, n (%)	18 (69.2)	15 (57.7)
Use of medication, n (%)[b]	4 (15.4)	4 (15.4)
Hormonal alteration, n (%)	1 (3.8)	0 (0.0)
Educational level, n (%)[c]		
Certificate or diploma	2 (7.7)	3 (11.5)
Bachelor	16 (61.5)	12 (46.2)
Master	4 (15.4)	5 (19.2)
Doctorate	4 (15.4)	5 (19.2)
Other	0 (0.0)	1 (3.8)
Sick leave, n (%)	0 (0.0)	0 (0.0)
Daily workload, n (%)		
Part-time	12 (46.2)	15 (57.7)
Full-time	11 (42.3)	5 (19.2)
Unemployed	3 (11.5)	6 (23.1)
Previous physical therapy treatment for the current shoulder episode, n (%)	11 (42.3)	11 (42.3)
Symptoms of RCRSP		
Duration of symptoms, mo	20.6 ± 27.7	24.6 ± 25.7
Origin of symptoms, n (%)[c]		
Sports	17 (65.4)	20 (76.9)
Accident/fall	4 (15.4)	3 (11.5)
Overuse	3 (11.5)	2 (7.7)
I don't know	2 (7.7)	1 (3.8)

(continued)

Table 1. (continued)

	Kinesiotaping (Experimental Group, n = 26)	No-Kinesiotaping (Control Group, n = 26)
Clinical examination, n (%)		
Presence of painful arc of movement (flexion)	21 (80.8)	21 (80.8)
Presence of painful arc of movement (abduction)	22 (84.6)	25 (96.2)
Positive Neer impingement sign	18 (69.2)	19 (73.1)
Positive Hawkins-Kennedy test	24 (92.3)	25 (96.2)
Positive Jobe test	15 (57.7)	18 (69.2)
Pain on resisted external rotation	15 (57.7)	14 (53.8)
Pain on resisted abduction	19 (73.1)	18 (69.2)

RCRSP, rotator cuff–related shoulder pain.
[a]Continuous variables: *t* tests. Categorical variables: Fisher exact probability tests.
[b]Medication used included: antacid (1), anti-inflammatory (1), antipsychotic (1), hormonal regulator (1) (experimental group); antipsychotic (1), antidepressant (1), immunosuppressant (1) (control group).
[c]Percentages may not total 100 due to rounding.

Primary Outcome

Symptoms and functional limitations. The DASH (intraclass correlation coefficient [ICC] = 0.93 [95% CI, 0.87-0.96], MCID = 10.2 DASH points)[45] was used to measure physical disability and symptoms of the upper limbs.[13,36] It consists of 30 items addressing the level of difficulty in performing daily activities and the severity of the symptoms.[13] A score of 100 points indicates the most severe disability.[36]

Secondary Outcomes

Pain intensity and rotator cuff–specific symptoms. As the DASH has only a few questions related to pain, the BPI (ICC >0.80)[47,49] was used to assess pain intensity. It is an 11-point numerical rating scale (0-10) that evaluates pain interference with general activity, mood, walking, normal work, personal relationships, sleep, and enjoyment of life, over the period of the past 24 hours.[47,49] The WORC index (ICC = 0.96 [0.92-0.98]; standardize response mean [SRM] = 1.54; minimal detectable change [MDC 90%] = 12.3; MCID = 17.5%)[45] was used to evaluate symptoms and functional limitations specific to RCRSP. It consists of 21 questions, with responses reported on a 100-mm visual analog scale; the questions address areas such as perceived responses on pain and physical symptoms, sports and recreation, work, and social and emotional function.[23,45] The final score is reported as a percentage, and higher scores are associated with fewer symptoms.

Range of motion. Shoulder ROM was measured in 2 conditions (active pain-free and full ROM) using a universal goniometer (ICC = 0.96-0.98). In a standing position, participants performed 2 trials of arm elevation, in the frontal (abduction) and sagittal (flexion) planes, for each condition. To measure pain-free ROM, participants were requested to actively elevate their injured arm at a comfortable speed, until the first sensation of pain was felt. The mean values of the 2 trials were used for data analysis. The same procedures were followed for the assessment of full ROM. Participants were instructed to reach their maximal amplitude, even if pain was felt. Compensatory body motions were visually monitored by the evaluator, who instructed participants to maintain a stable body position and to avoid compensatory trunk motions before each trial.

Acromiohumeral distance. The AHD was measured in 2 arm positions: at rest (0°) and at 60° of shoulder abduction. An ultrasound scanner (Logic *e*9; GE Healthcare) with a 4- to 15-MHz linear-array probe was used to obtain images.[10,39] Images were recorded with the probe on the anterior aspect of the lateral surface of the acromion, along with the longitudinal axis of the humerus in a frontal plane, where it is possible to visualize the acromion and humeral head simultaneously.[7] Measurements were first taken at rest, with participants seated upright against the backrest of the chair, arm in a neutral position, elbow flexed at 90°, and forearm resting on a pillow on their lap.[8] Thereafter, AHD at 60° of abduction was quantified, where participants were requested to raise their arm, with the elbow flexed at 90°, until 60° of shoulder abduction. In both arm positions, 2 trials were performed, and the average was used for statistical analysis. This method is deemed reliable for estimating the AHD (ICC = 0.98; MDC = 0.70 mm).[30]

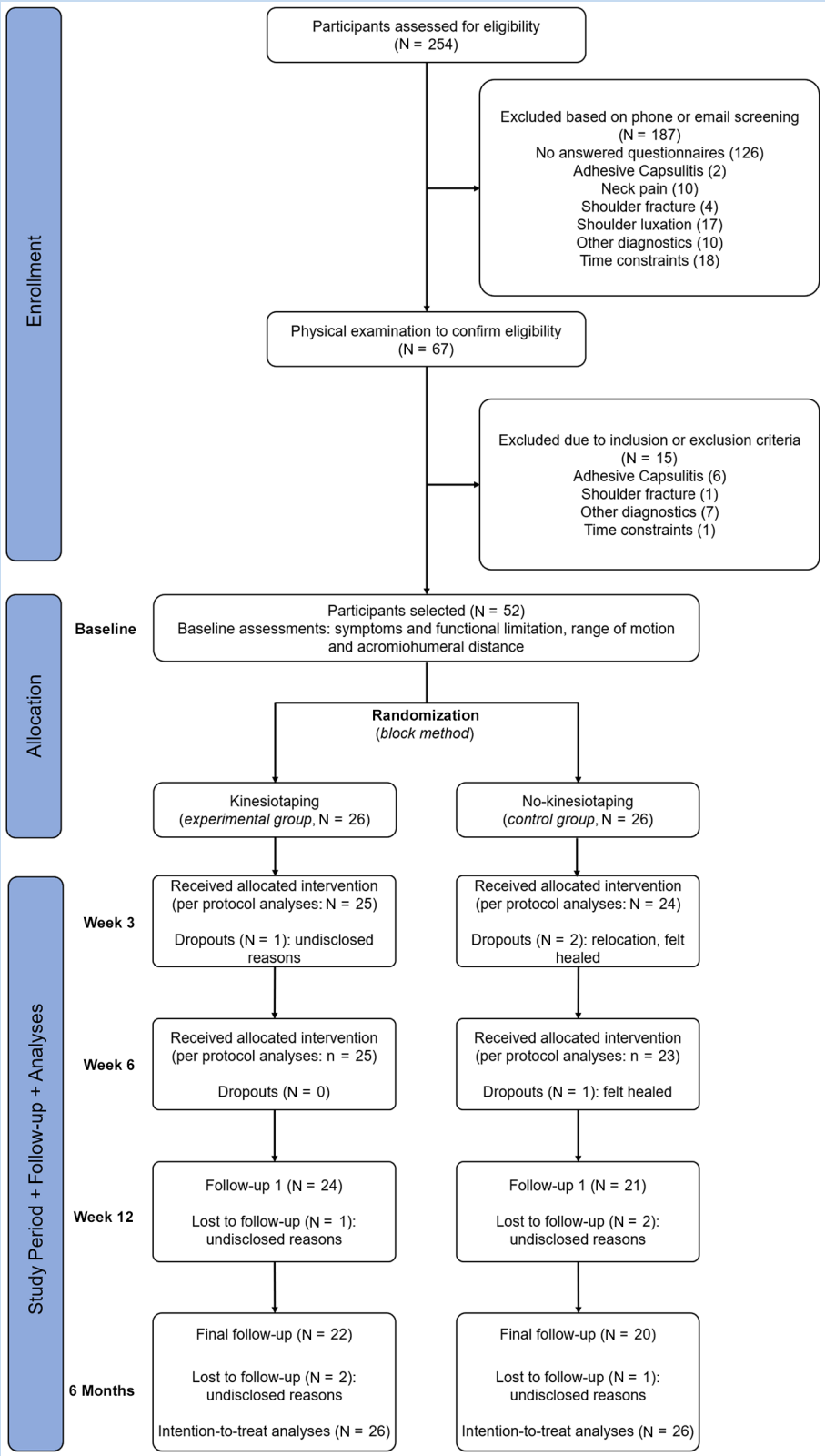

Figure 2. Flow diagram of participants through the study.

Table 2. Group mean scores for all outcomes[a]

	Kinesiotaping (Experimental Group, n = 26)	No Kinesiotaping (Control Group, n = 26)	Pooled Group (N = 52)
DASH scores (0-100)			
Baseline	28.1 ± 11.8	27.8 ± 10.0	27.9 ± 10.8
3 weeks	16.2 ± 11.2	18.8 ± 8.1	17.5 ± 9.8
6 weeks	9.3 ± 7.6	12.1 ± 8.3	10.7 ± 8.0
12 weeks	7.8 ± 8.3	8.9 ± 8.8	8.4 ± 8.5
6 months	7.4 ± 9.6	7.3 ± 8.2	7.4 ± 8.8
BPI scores (0-10)			
Baseline	2.9 ± 1.6	2.9 ± 1.5	2.9 ± 1.5
3 weeks	1.3 ± 1.4	1.5 ± 1.0	1.4 ± 1.2
6 weeks	0.7 ± 0.9	0.9 ± 0.9	0.8 ± 0.9
12 weeks	0.8 ± 1.2	0.8 ± 0.9	0.8 ± 1.0
6 months	0.5 ± 1.0	0.8 ± 0.9	0.7 ± 1.0
WORC index (0-100)			
Baseline	60.5 ± 19.2	56.2 ± 18.3	58.3 ± 18.7
3 weeks	80.7 ± 14.2	76.5 ± 13.1	78.6 ± 13.7
6 weeks	89.5 ± 14.5	85.7 ± 12.3	87.6 ± 13.4
12 weeks	90.1 ± 15.1	88.8 ± 13.2	89.4 ± 14.1
6 months	90.3 ± 15.7	90.3 ± 12.5	90.3 ± 14.0
ROM			
Pain-free—injured shoulder, flexion (deg)			
Baseline	138.8 ± 24.5	141.4 ± 18.8	140.1 ± 21.7
6 weeks	158.1 ± 9.9	156.8 ± 10.3	157.7 ± 10.0
Pain-free—injured shoulder, abduction (deg)			
Baseline	125.2 ± 29.1	120.5 ± 25.2	122.8 ± 27.1
6 weeks	163.1 ± 17.8	156.6 ± 19.6	159.9 ± 18.8
Full—injured shoulder, flexion (deg)			
Baseline	160.7 ± 11.2	160.4 ± 9.3	160.6 ± 10.2
6 weeks	165.3 ± 7.9	163.9 ± 9.2	164.6 ± 8.5
Full—injured shoulder, abduction (deg)			
Baseline	160.9 ± 17.5	158.3 ± 19.0	159.6 ± 18.1
6 weeks	173.5 ± 8.9	170.6 ± 10.2	172.0 ± 9.6
AHD at rest (0°) (mm)			
Baseline	10.98 ± 2.17	11.77 ± 2.12	11.38 ± 2.16
6 weeks	11.20 ± 2.23	11.78 ± 2.08	11.49 ± 2.15
AHD at 60° of abduction (mm)			
Baseline	8.18 ± 2.33	8.57 ± 2.15	8.37 ± 2.23
6 weeks	8.64 ± 2.66	8.88 ± 2.29	8.76 ± 2.46

AHD, acromiohumeral distance; BPI, Brief Pain Inventory; DASH, Disabilities of the Arm, Shoulder and Hand questionnaire; ROM, range of motion; WORC, Western Ontario Rotator Cuff index.
[a]Data expressed as mean ± SD.

Table 3. Results (*P* values) of ANOVA statistical tests for the intention-to-treat analysis

	Group Effect	Time Effect	Movement Effect	Group × Time	Group × Movement	Movement × Time	Group × Time × Movement
nparLD							
DASH scores	0.621	<0.0001		0.112			
BPI scores	0.248	<0.0001		0.726			
WORC index	0.373	<0.0001		0.430			
ROM							
Pain-free	0.282	<0.0001	0.052	0.607	0.203	<0.0001	0.839
Full	0.504	<0.0001	<0.0001	0.456	0.611	<0.0001	0.933
GLM							
AHD at 60° of abduction	0.621	0.017		0.613			

AHD, acromiohumeral distance; ANOVA, analysis of variance; BPI, Brief Pain Inventory; DASH, Disabilities of the Arm, Shoulder and Hand questionnaire; GLM, general linear model; nparLD, nonparametric longitudinal data; ROM, range of motion; WORC, Western Ontario Rotator Cuff.

Sample Size Calculation

An a priori sample size was calculated using a superiority trial design based on changes reported by the DASH scores for individuals with RCRSP. According to the sample size calculation (G*Power 3.1.9.2; $\alpha = 0.05$; effect size = 0.85; power $[1 - \beta] = 0.80$; SD = 14.17 DASH points;[42] MCID = 12.4 DASH points),[15] 22 participants per group were required. Considering a possible loss to follow-up of 15%, 26 participants per group were recruited.

Data Handling and Statistical Analyses

Except for the AHD measurements, Nonparametric Analysis for Longitudinal Data (nparLD; Package 2.1; R software, Version 3.3.3) for repeated-measures was used since distributions were normal at baseline (as there was a wide range of clinical conditions) and gamma at 6 weeks, 12 weeks, and 6 months (as most participants improved close to optimal values).[35] The nparLD is the only procedure that manages a change of distribution between groups and measurement times.[35] A 2-way (2 groups × 5 time points) nparLD was used to compare the KT effects on the DASH, BPI, and WORC scores. Changes in the pain-free and full ROM were analyzed using a 3-way (2 groups × 2 time points × 2 plane of movements) nparLD. As far as assumptions were reached, the effects of KT on AHD were analyzed with a 3-way (2 groups × 2 time points × 2 angles) repeated-measures analysis of variance (SPSS Version 20; IBM Corporation). Effect size (Glass Δ or η^2) were reported for all outcomes. The α criterion was always set at 5%. Intention-to-treat was used for self-reported questionnaires, while to ensure appropriate insight on mechanisms underlying changes in symptoms and function, only participants who completed the 6-week evaluation were considered for AHD and ROM.

RESULTS

A total of 52 participants were recruited between November 2016 and November 2017 (Table 1, Figure 2). Four participants dropped out (2 for undisclosed reasons and 2 who declared to be healed, including a single participant [KT group] who declared to have received a corticosteroid injection for relieving pain after the fifth session; participation rate = 92.3%) before the end of the 6-week treatment period, while 4 additional participants missed 3 physical therapy sessions each, totaling 39 interventions missed (attendance rate = 92.5%). Seven and 10 participants (including the 4 dropouts) did not return their follow-up questionnaires at 12 weeks and 6 months, respectively (follow-up rate = 86.5% and 80.8%). Home exercises presented an adherence rate of 90.4%. No participants reported adverse effects to KT or the treatments provided. As for blinding effectiveness, the evaluator correctly identified the group for only 1 participant (2.1%).

Effects of KT

There were no significant group × time interactions ($0.112 \leq P \leq 0.726$) or group effect ($0.248 \leq P \leq 0.621$) for all outcomes analyzed (Tables 2 and 3). However, time effects ($P < 0.0001$ for all except for AHD, $P = 0.017$) were detected for all measured outcomes (Table 4).

Table 4. Outcome changes over time (mean improvements) compared with baseline values throughout treatment (overall sample, N = 52; intention-to-treat analysis)[a]

	Mean Score Change (95% CI)	*P*	Effect Size (Glass Δ)
DASH scores (0-100)			
3 weeks[b]	−10.4 (−13.3 to −7.5)[c,d,e]	<0.0001	0.961
6 weeks	−17.2 (−20.5 to −13.9)[d,e,f]	<0.0001	1.593
12 weeks	−19.6 (−22.9 to −16.3)[c,f]	<0.0001	1.806
6 months	−20.6 (−23.9 to −17.2)[c,d,f]	<0.0001	1.899
BPI scores (0-10)			
3 weeks	−1.5 (−1.9 to −1.1)[c,d,e]	<0.0001	0.950
6 weeks[b]	−2.1 (−2.6 to −1.7)[f]	<0.0001	1.364
12 weeks	−2.1 (−2.6 to −1.7)[f]	<0.0001	1.367
6 months	−2.2 (−2.7 to −1.8)[f]	<0.0001	1.445
WORC index (0-100)			
3 weeks[b]	20.2 (15.1 to 25.4)[c,d,e]	<0.0001	1.083
6 weeks	29.2 (23.4 to 35.1)[d,e,f]	<0.0001	1.565
12 weeks	31.1 (25.3 to 36.9)[c,f]	<0.0001	1.662
6 months	32.0 (26.2 to 37.7)[c,f]	<0.0001	1.711
Pain-free ROM—injured shoulder (deg)			
6 weeks (abduction)	37.0 (28.9 to 45.1)	<0.0001	1.368
6 weeks (flexion)	17.4 (11.3 to 23.4)	<0.0001	0.801
Full ROM abduction—injured shoulder (deg)			
6 weeks (abduction)	12.5 (7.8 to 17.2)	<0.0001	0.687
6 weeks (flexion)	4.0 (1.6 to 6.5)	0.100	0.397
AHD at 60° of abduction (mm)			
6 weeks	0.38 (0.07 to 0.69)	0.017	0.109[g]

AHD, acromiohumeral distance; BPI, Brief Pain Inventory; DASH, Disabilities of the Arm, Shoulder and Hand questionnaire; ROM, range of motion; WORC, Western Ontario Rotator Cuff.
[a]Data are expressed as mean (95% CI), determined by the minimal clinically important difference. Intention-to-treat analyses (n = 26 per group).
[b]Evaluation time points at which the clinically important difference was reached.
[c]A statistically significant change in mean score compared with values at 6 weeks ($P < 0.05$).
[d]A statistically significant change in mean score compared with values at 12 weeks ($P < 0.05$).
[e]A statistically significant change in mean score compared with values at 6 months ($P < 0.05$).
[f]A statistically significant change in mean score compared with values at 3 weeks ($P < 0.05$).
[g]Partial eta square (η^2).

Description of the Time Effects for All Outcomes

Mean DASH score improved ($P < 0.0001$) from baseline to week 3 (−10.4 points [95% CI: −13.3 to −7.5]) and from week 3 to week 6 (−6.8 [95% CI: −9.0 to −4.7]); thereafter, the scores did not significantly change (Figure 3a). Mean DASH score changes surpassed the MCID of 10.2 points[36] at week 3 (Table 4). Similarly, mean BPI and WORC scores improved ($P < 0.0001$) from baseline to week 3 (−1.5 mm [95% CI, −1.9 to −1.1] and

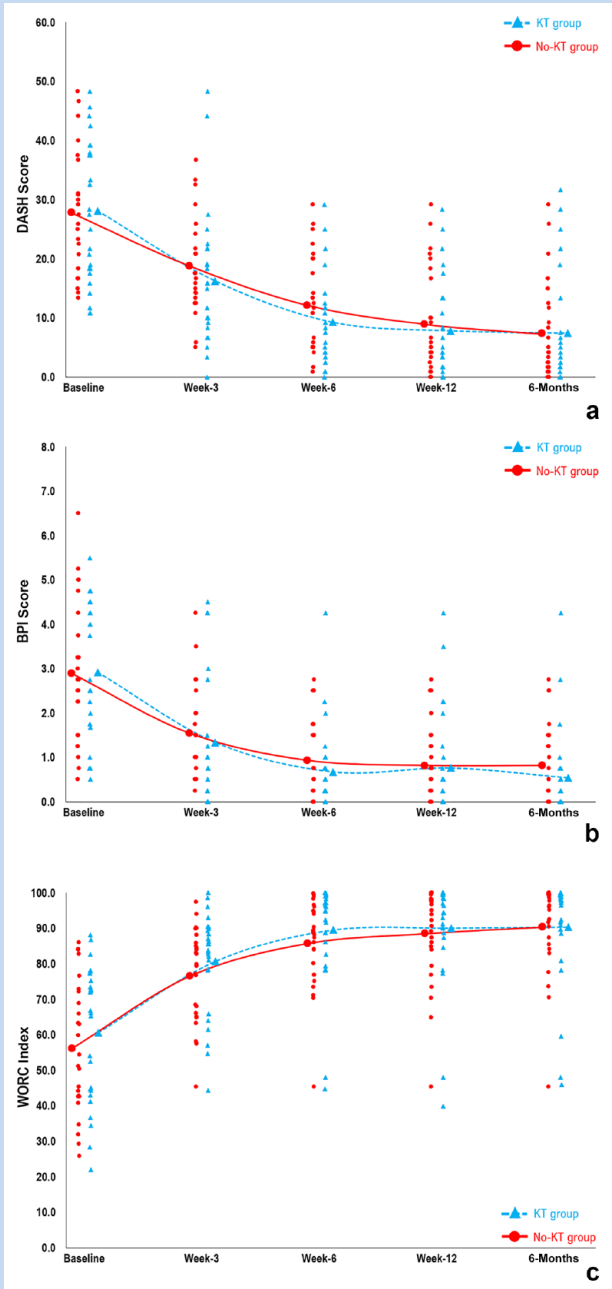

Figure 3. Mean group scores for symptoms and functional limitations: (a) Disabilities of the Arm, Shoulder and Hand questionnaire (DASH); (b) Brief Pain Inventory (BPI); and (c) Western Ontario Rotator Cuff (WORC) index. In all 3 questionnaires, statistically significant time effects were observed in the pooled group (N = 52) (see Table 4). KT, kinesiotaping.

20.2% [95% CI, 15.1 to 25.4], respectively) and from week 3 to week 6 (−0.6 mm [95% CI, −0.9 to 0.1] and 9.0% [95% CI, 6.4 to 11.6], respectively); and did not significantly change thereafter (Figure 3, b and c). Mean WORC score changes reached the MCID (17.5%)[45] at week 3, and changes in the BPI score reached the CID (2 mm)[14] at week 6.

Pain-free ROM abduction ($P < 0.0001$) and flexion ($P < 0.0001$) and full ROM abduction ($P < 0.0001$) increased significantly from baseline to week 6. Finally, the AHD at 60° of abduction increased from baseline to week 6 (0.38 ± 1.11 mm; $P = 0.017$) (Table 4).

DISCUSSION

This RCT assessed the effectiveness of KT when added to a conventional rehabilitation program for individuals with RCRSP. Despite no group × time interaction, both groups improved significantly with regard to their symptoms and functional limitations. Notwithstanding, our hypothesis was not confirmed; similar improvement in both the KT and no-KT groups suggests that KT did not provide incremental effects in the midterm (week 6 and week 12) or long term (6 months).

One of the possible explanations for the absence of additional benefits is that the KT technique used in this study may have acted on the same outcomes targeted by the exercise-based rehabilitation program. Indeed, therapeutic exercises have been evidenced to be effective with improving muscular recruitment and the restoration of shoulder motor control.[16,25,28,39,48] Therefore, if KT had any effect, it is likely that the effects of the rehabilitation program have surpassed, or masked, the benefits provided by the KT. An alternative hypothesis could be, however, that KT may not have produced any mid- or long-term effects.

One meta-analysis[9] and 2 systematic reviews[31,38] have examined the clinical efficacy of KT on RCRSP and reported conflicting results. Desjardins-Charbonneau et al[9] analyzed 10 trials, including 6 RCTs,[11,18,21,41,44,50] and concluded that KT may provide an immediate effect on pain-free flexion and abduction ROM in the short term, but they presented inconclusive evidence on its efficacy on overall pain reduction or the improvement of function. McLaren et al[31] reviewed 5 trials and found moderate evidence that KT may improve pain and function in the short term, whereas Saracoglu et al[38] examined 3 KT-related trials[11,22,44] that combined KT plus interventions such as electrotherapy, manual therapy, and strengthening and concluded that these combinations may be effective for improving pain, function, and ROM, again in the short term. Most studies included in these reviews, however, presented a high risk of bias, assessed only the immediate- or short-term KT effects, or tested KT alone instead of in addition to physical therapy treatments.

Few studies have investigated KT as an adjunct resource for treating RCRSP to allow for a parallel comparison with our data. Kaya et al[21] compared the effects of KT with manual therapy, both combined with exercises (stretching, strengthening, and re-education of scapular stabilizers and rotator cuff muscles), and obtained comparable results with those of the current study: similar improvements were observed in both groups after 6 weeks. In contrast, Şimşek et al[44] compared rotator cuff and scapular strengthening exercises with KT versus the same

exercises plus sham KT, and they found that KT was more effective in improving pain, function, and pain-free abduction ROM in the short term (5 and 12 days). Djordjevic et al[11] compared KT plus mobilization with movement (MWM) to exercises on active pain-free ROM and muscle strength. They concluded that, in the short term (5 and 10 days), KT plus MWM was superior to exercises in improving pain-free ROM. Different factors may explain the discrepancies between our results and those from studies that have concluded that KT is superior. However, the main factor might be the rehabilitation program, as our program was centered on sensorimotor training for the restoration of proper shoulder neuromuscular control.

It is worth highlighting other differences between our study and previous ones, such as the length of follow-up and the KT technique used. In most studies, only the short-term effect was explored, whereas ours evaluated the participants up to 6 months. There was also a lack of standardization regarding the protocol for KT application. Although all studies used a Y-shape KT surrounding the deltoid muscles, which hypothetically inhibits deltoid activation,[19,20] other studies also employed additional strips over the acromioclavicular[21,44] or glenohumeral joint[7,11,21,42,50] or over the supraspinatus[11,21,42,44,50] or lower trapezius muscles.[42] These differences may explain the contrasting results.

Limitations

The first limitation of the current study is the absence of a sham-KT group (placebo). However, a sham taping application could have been problematic since KT applied over the skin may drive proprioceptive stimuli, which could act as a confounding factor.[24] Another limitation is the loss to follow-up at 12 weeks (13.5%) and 6 months (19.2%), suggesting an attrition bias, which may have limited the evaluation of the continued effects of the treatment. However, this attrition could be classified as low, as the sample size was calculated with consideration of a possible withdrawal of up to 18.2% of participants. Therefore, the treatment effect reported in this study was likely not influenced by this attrition. In addition, as KT was applied only until the week 6 evaluation, changes were mostly expected within the first 6 weeks (period of treatment), during which the participants were assiduous (attrition of 7.5%). Finally, some individuals with RCRSP may benefit more from the KT than others. However, subgroup analyses were not performed, as the number of patients was insufficient to keep a strong statistical power.

Clinical Implications

Clinicians should not expect additional benefits from the KT in the mid or long term if an exercise-based physical therapy program is also provided to individuals with RCRSP.

CONCLUSION

Whereas symptoms, functional limitations, ROM, and the AHD improved in both groups, no between-group differences in the mid and long term were observed. Therefore, KT did not provide incremental effects to a 6-week rehabilitation program for individuals with RCRSP to improve symptoms and functional limitations.

REFERENCES

1. Alqunaee M, Galvin R, Fahey T. Diagnostic accuracy of clinical tests for subacromial impingement syndrome: a systematic review and meta-analysis. *Arch Phys Med Rehabil.* 2012;93:229-236.
2. Andersen LL, Vinstrup J, Jakobsen MD, Sundstrup E. Validity and reliability of elastic resistance bands for measuring shoulder muscle strength. *Scand J Med Sci Sports.* 2017;27:887-894.
3. Burfeind SM, Chimera N. Randomized control trial investigating the effects of kinesiology tape on shoulder proprioception. *J Sport Rehabil.* 2015;24:405-412.
4. Chard MD, Hazleman R, Hazleman BL, King RH, Reiss BB. Shoulder disorders in the elderly: a community survey. *Arthritis Rheum.* 1991;34:766-769.
5. de Oliveira FCL, Bouyer LJ, Ager AL, Roy JS. Electromyographic analysis of rotator cuff muscles in patients with rotator cuff tendinopathy: a systematic review. *J Electromyogr Kinesiol.* 2017;35:100-114.
6. de Oliveira FCL, de Fontenay BP, Bouyer LJ, Desmeules F, Roy JS. Effects of kinesiotaping added to a rehabilitation programme for patients with rotator cuff tendinopathy: protocol for a single-blind, randomised controlled trial addressing symptoms, functional limitations and underlying deficits. *BMJ Open.* 2017;7(9):e017951.
7. de Oliveira FCL, de Fontenay BP, Bouyer LJ, Roy JS. Kinesiotaping increases the acromiohumeral distance in individuals with symptomatic rotator cuff tendinopathy. *J Orthop Sports Phys Ther.* 2018;48(1):A99.
8. de Oliveira FCL, Pairot de Fontenay B, Bouyer LJ, Roy JS. Immediate effects of kinesiotaping on acromiohumeral distance and shoulder proprioception in individuals with symptomatic rotator cuff tendinopathy. *Clin Biomech (Bristol, Avon).* 2019;61:16-21.
9. Desjardins-Charbonneau A, Roy JS, Dionne CE, Desmeules F. The efficacy of taping for rotator cuff tendinopathy: a systematic review and meta-analysis. *Int J Sports Phys Ther.* 2015;10:420-433.
10. Desmeules F, Minville L, Riederer B, Cote CH, Fremont P. Acromio-humeral distance variation measured by ultrasonography and its association with the outcome of rehabilitation for shoulder impingement syndrome. *Clin J Sport Med.* 2004;14:197-205.
11. Djordjevic OC, Vukicevic D, Katunac L, Jovic S. Mobilization with movement and kinesiotaping compared with a supervised exercise program for painful shoulder: results of a clinical trial. *J Manipulative Physiol Ther.* 2012;35:454-463.
12. Drouin JL, McAlpine CT, Primak KA, Kissel J. The effects of kinesiotape on athletic-based performance outcomes in healthy, active individuals: a literature synthesis. *J Can Chiropr Assoc.* 2013;57:356-365.
13. Durand MJ, Vachon B, Hong QN, Loisel P. The cross-cultural adaptation of the DASH questionnaire in Canadian French. *J Hand Ther.* 2005;18:34-39.
14. Farrar JT, Young JP Jr, LaMoreaux L, Werth JL, Poole RM. Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. *Pain.* 2001;94:149-158.
15. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods.* 2007;39:175-191.
16. Hanratty CE, McVeigh JG, Kerr DP, et al. The effectiveness of physiotherapy exercises in subacromial impingement syndrome: a systematic review and meta-analysis. *Semin Arthritis Rheum.* 2012;42:297-316.
17. Hertel R, Ballmer FT, Lombert SM, Gerber C. Lag signs in the diagnosis of rotator cuff rupture. *J Shoulder Elbow Surg.* 1996;5:307-313.
18. Hsu YH, Chen WY, Lin HC, Wang WT, Shih YF. The effects of taping on scapular kinematics and muscle performance in baseball players with shoulder impingement syndrome. *J Electromyogr Kinesiol.* 2009;19:1092-1099.
19. Kase K, Tatyusuki H, Tomoki O. *Kinesio™ Taping Perfect Manual.* 2nd ed. Ken Ikai; 1996.
20. Kase K, Wallis J, Kase T. *Clinical Therapeutic Applications of the Kinesio Taping Method.* 1st ed. Ken Ikai; 2003.
21. Kaya DO, Baltaci G, Toprak U, Atay AO. The clinical and sonographic effects of kinesiotaping and exercise in comparison with manual therapy and exercise for patients with subacromial impingement syndrome: a preliminary trial. *J Manipulative Physiol Ther.* 2014;37:422-432.
22. Kaya E, Zinnuroglu M, Tugcu I. Kinesio taping compared to physical therapy modalities for the treatment of shoulder impingement syndrome. *Clin Rheumatol.* 2011;30:201-207.

23. Kirkley A, Alvarez C, Griffin S. The development and evaluation of a disease-specific quality-of-life questionnaire for disorders of the rotator cuff: the Western Ontario Rotator Cuff Index. *Clin J Sport Med*. 2003;13:84-92.
24. Lin JJ, Hung CJ, Yang PL. The effects of scapular taping on electromyographic muscle activity and proprioception feedback in healthy shoulders. *J Orthop Res*. 2011;29:53-57.
25. Littlewood C, Ashton J, Chance-Larsen K, May S, Sturrock B. Exercise for rotator cuff tendinopathy: a systematic review. *Physiotherapy*. 2012;98:101-109.
26. Luime JJ, Koes BW, Hendriksen IJ, et al. Prevalence and incidence of shoulder pain in the general population; a systematic review. *Scand J Rheumatol*. 2004;33:73-81.
27. Matts JP, Lachin JM. Properties of permuted-block randomization in clinical trials. *Control Clin Trials*. 1988;9:327-344.
28. McClure PW, Bialker J, Neff N, Williams G, Karduna A. Shoulder function and 3-dimensional kinematics in people with shoulder impingement syndrome before and after a 6-week exercise program. *Phys Ther*. 2004;84:832-848.
29. McClure PW, Michener LA, Karduna AR. Shoulder function and 3-dimensional scapular kinematics in people with and without shoulder impingement syndrome. *Phys Ther*. 2006;86:1075-1090.
30. McCreesh KM, Anjum S, Crotty JM, Lewis JS. Ultrasound measures of supraspinatus tendon thickness and acromiohumeral distance in rotator cuff tendinopathy are reliable. *J Clin Ultrasound*. 2016;44:159-166.
31. McLaren C, Colman Z, Rix A, Sullohern C. The effectiveness of scapular taping on pain and function in people with subacromial impingement syndrome: a systematic review. *International Musculoskeletal Medicine*. 2016;38:81-89.
32. Michener LA, Walsworth MK, Doukas WC, Murphy KP. Reliability and diagnostic accuracy of 5 physical examination tests and combination of tests for subacromial impingement. *Arch Phys Med Rehabil*. 2009;90:1898-1903.
33. Miller CA, Forrester GA, Lewis JS. The validity of the lag signs in diagnosing full-thickness tears of the rotator cuff: a preliminary investigation. *Arch Phys Med Rehabil*. 2008;89:1162-1168.
34. Mottram SL. Dynamic stability of the scapula. *Man Ther*. 1997;2:123-131.
35. Noguchi K, Gel YR, Brunner E, Konietschke F. nparLD: an R software package for the nonparametric analysis of longitudinal data in factorial experiments. *J Stat Softw*. 2012;50(12):1-23.
36. Roy JS, MacDermid JC, Woodhouse LJ. Measuring shoulder function: a systematic review of four questionnaires. *Arthritis Rheum*. 2009;61:623-632.
37. Roy JS, Moffet H, Hebert LJ, Lirette R. Effect of motor control and strengthening exercises on shoulder function in persons with impingement syndrome: a single-subject study design. *Man Ther*. 2009;14:180-188.
38. Saracoglu I, Emuk Y, Taspinar F. Does taping in addition to physiotherapy improve the outcomes in subacromial impingement syndrome? A systematic review. *Physiother Theory Pract*. 2018;34:251-263.
39. Savoie A, Mercier C, Desmeules F, Fremont P, Roy JS. Effects of a movement training oriented rehabilitation program on symptoms, functional limitations and acromiohumeral distance in individuals with subacromial pain syndrome. *Man Ther*. 2015;20:703-708.
40. Seo HD, Kim MY, Choi JE, et al. Effects of Kinesio taping on joint position sense of the ankle. *J Phys Ther Sci*. 2016;28:1158-1160.
41. Shakeri H, Keshavarz R, Arab AM, Ebrahimi I. Clinical effectiveness of kinesiological taping on pain and pain-free shoulder range of motion in patients with shoulder impingement syndrome: a randomized, double blinded, placebo-controlled trial. *Int J Sports Phys Ther*. 2013;8:800-810.
42. Shakeri H, Keshavarz R, Arab AM, Ebrahimi I. Therapeutic effect of Kinesio-taping on Disability of Arm, Shoulder, and Hand in patients with subacromial impingement syndrome: a randomized clinical trial. *J Nov Physiother*. 2013;3(4):1-5.
43. Siegel LB, Cohen NJ, Gall EP. Adhesive capsulitis: a sticky issue. *Am Fam Physician*. 1999;59:1843-1852.
44. Şimşek HH, Balki S, Keklik SS, Ozturk H, Elden H. Does Kinesio taping in addition to exercise therapy improve the outcomes in subacromial impingement syndrome? A randomized, double-blind, controlled clinical trial. *Acta Orthop Traumatol Turc*. 2013;47:104-110.
45. St-Pierre C, Dionne CE, Desmeules F, Roy JS. Reliability, validity, and responsiveness of a Canadian French adaptation of the Western Ontario Rotator Cuff (WORC) index. *J Hand Ther*. 2015;28:292-298.
46. Steuri R, Sattelmayer M, Elsig S, et al. Effectiveness of conservative interventions including exercise, manual therapy and medical management in adults with shoulder impingement: a systematic review and meta-analysis of RCTs. *Br J Sports Med*. 2017;51:1340-1347.
47. Tan G, Jensen MP, Thornby JI, Shanti BF. Validation of the Brief Pain Inventory for chronic nonmalignant pain. *J Pain*. 2004;5:133-137.
48. Tate AR, McClure PW, Young IA, Salvatori R, Michener LA. Comprehensive impairment-based exercise and manual therapy intervention for patients with subacromial impingement syndrome: a case series. *J Orthop Sports Phys Ther*. 2010;40:474-493.
49. Tatham B, Smith J, Cheifetz O, et al. The efficacy of exercise therapy in reducing shoulder pain related to breast cancer: a systematic review. *Physiother Can*. 2013;65:321-330.
50. Thelen MD, Dauber JA, Stoneman PD. The clinical efficacy of kinesio tape for shoulder pain: a randomized, double-blinded, clinical trial. *J Orthop Sports Phys Ther*. 2008;38:389-395.
51. Urwin M, Symmons D, Allison T, et al. Estimating the burden of musculoskeletal disorders in the community: the comparative prevalence of symptoms at different anatomical sites, and the relation to social deprivation. *Ann Rheum Dis*. 1998;57:649-655.
52. van der Heijden GJ. Shoulder disorders: a state-of-the-art review. *Baillieres Clin Rheumatol*. 1999;13:287-309.
53. Williams S, Whatman C, Hume PA, Sheerin K. Kinesio taping in treatment and prevention of sports injuries: a meta-analysis of the evidence for its effectiveness. *Sports Med*. 2012;42:153-164.