ELSEVIER

Physiotherapy 105 (2019) 65–75

Physiotherapy

Kinesio Taping reduces pain and improves disability in low back pain patients: a randomised controlled trial

Liane de Brito Macedo [a], Jim Richards [b], Daniel Tezoni Borges [a], Samara Alencar Melo [a], Jamilson Simões Brasileiro [a,*]

[a] Physiotherapy Department, Federal University of Rio Grande do Norte, Natal, Brazil
[b] Allied Health Research Unit, University of Central Lancashire, Preston, United Kingdom

Abstract

Objective To investigate the effects of Kinesio Taping® (KT) on chronic non-specific low back pain (LBP).
Design Randomised controlled trial with intention-to-treat analysis.
Setting University laboratory.
Participants One hundred and eight women with chronic non-specific LBP underwent an evaluation pre, 3 and 10 days after intervention.
Interventions After randomisation, participants were assigned to four groups: KT with tension group (KTT) applied KT® with tension in the region of the erector spinae muscles; KT no tension group (KTNT) applied KT® with no tension in the same region; Micropore group (MP) applied Micropore® tape on the erector spinae muscles; and control group (CG) did not receive any intervention.
Main outcome measures The primary outcome was pain sensation, measured by numerical pain rating scale. Secondary outcomes were: disability (Roland Morris Disability questionnaire), trunk range of motion (inclinometry), strength (dynamometry) and electromyographic amplitude (electromyography).
Results Improved pain relief was observed for KTT group (mean difference 2.0; 95% CI 0.5 to 3.4; $P = 0.003$) and KTNT group [mean difference (MD) 1.9; 95% CI 0.5 to 3.4; $P = 0.004$] compared with CG at 3 days after application of the tape. For disability, there was a difference between CG and KTT group at 3 days (MD 3.5; 95% CI 0.8 to 6.1; $P = 0.004$) and 10 days (MD 32; 95% CI 0.4 to 6.0; $P = 0.016$). For all the other variables, there were no differences between groups.
Conclusion KT with or without tension reduces pain 3 days after its application. Additionally, when applied with tension, it improves disability after 3 and 10 days in patients with LBP.

Trial registration NCT02550457 (clinicaltrials.gov).

Keywords: Spine; Back muscles; Bandage; Electromyography

Introduction

The high incidence of low back pain (LBP) is burdensome in the world population and causes more disability than any other condition [1]. It is associated with psychological, social and biophysical factors that impair function, social participation, job satisfaction and socioeconomic status [2]. Numerous treatments for LBP have been studied [1,3], and recently the use of Kinesio Taping® (KT) has become a popular treatment option for many conditions, including LBP [4].

* Corresponding author at: Universidade Federal do Rio Grande do Norte – Departamento de Fisioterapia, Av. Senador Salgado Filho, 3000, Campus Universitário – Lagoa Nova, Natal, RN, CEP: 59.078-970, Brazil.
E-mail addresses: lianebm@hotmail.com, lianebmacedo@yahoo.com.br (L.d.B. Macedo), JRichards@uclan.ac.uk (J. Richards), daniel.borges.t@hotmail.com (D.T. Borges), samara_alencar@hotmail.com (S.A. Melo), brasileiro@ufrnet.br, brasileiroj@bol.com.br (J.S. Brasileiro).

https://doi.org/10.1016/j.physio.2018.07.005
0031-9406/

Fig. 1. Application of the tape with tension (A) and without tension (B) in the region of erector spinae muscles.

KT was developed in 1973 by the Japanese chiropractor Kenzo Kase [5]. This technique uses an extremely thin functional elastic bandage, approximately the same thickness as the epidermis. It can be longitudinally extended up to 120 to 140% of its original length, having similar elasticity to the skin [6,7]. KT has been reported to be able to increase blood and lymph circulation, improve muscle performance, reduce pain, realign joints, reduce muscle tension [7–9] and change motor unit recruitment [10]. However, the mechanism by which KT achieves this is not clear. It has been suggested that its application to the skin activates cutaneous mechanoreceptors, which results in pain relief through the pain gate theory [10]. Furthermore, KT has been reported to provide an increase of the interstitial space, permitting improved blood and lymph flow due to its elastic and adhesive characteristics [7,9]. Regarding the hypothesis of increased muscle activity, this could be due to neurofacilitation, with a suggested mechanism that the tactile stimulation provided by the bandage activates cutaneous receptors provoking stimulation of alpha motoneurons [11,12]. However, detailed studies relating to the efficacy and effectiveness of KT are still limited and controversial.

Recent studies on LBP have shown an improvement in pain [8,10], disability [8], range of motion (ROM) of lower trunk [13] and lumbar muscle activation [10] in subjects who underwent treatment with KT, while others have shown no such differences with the application of KT or placebo taping [14,15]. For example, several authors analysed pain and disability and showed good results related to these variables in patients using tape [8,10,16–18]; however, other authors have shown no superiority of its effects compared with placebo treatments [14,19–21], or similar or slightly superior effects [22,23].

There are few studies that have analysed the effect of KT on ROM and electromyography (EMG) [12,13]. Despite EMG being suggested as a useful tool in the assessment of muscle dysfunction associated with LBP [24], little work has been published identifying changes due to taping, with the majority of studies being conducted using healthy subjects [25,26] or lower limb injuries [27]. Patients with LBP have been shown to demonstrate different EMG patterns compared with healthy subjects [28,29]; however, variations EMG between static to dynamic tasks have been observed due to high tension or inhibitory mechanism of pain, and demonstrate greater asymmetry in muscle activation and higher fatigability [24], making the comparison of studies difficult.

Considering the lack of consensus in the literature and the increasing use of KT, it is pertinent to question its effects in individuals Kinesio Taping® in individuals with LBP. Thus, this study aims to evaluate the isolated effect of KT on pain, disability, ROM, strength and muscle activity in individuals with chronic non-specific LBP.

Method

Design

This was an assessor blinded prospective randomised controlled trial. The study was conducted at the University Laboratory of Federal University of Rio Grande do Norte.

Ethics

This study was approved by the research ethics committee of the local university under the Protocol Number 1.213.864, registered on the clinicaltrials.gov website (NCT02550457), and is in accordance with CONSORT recommendations. All volunteers were informed about the objectives of the study and signed the consent form.

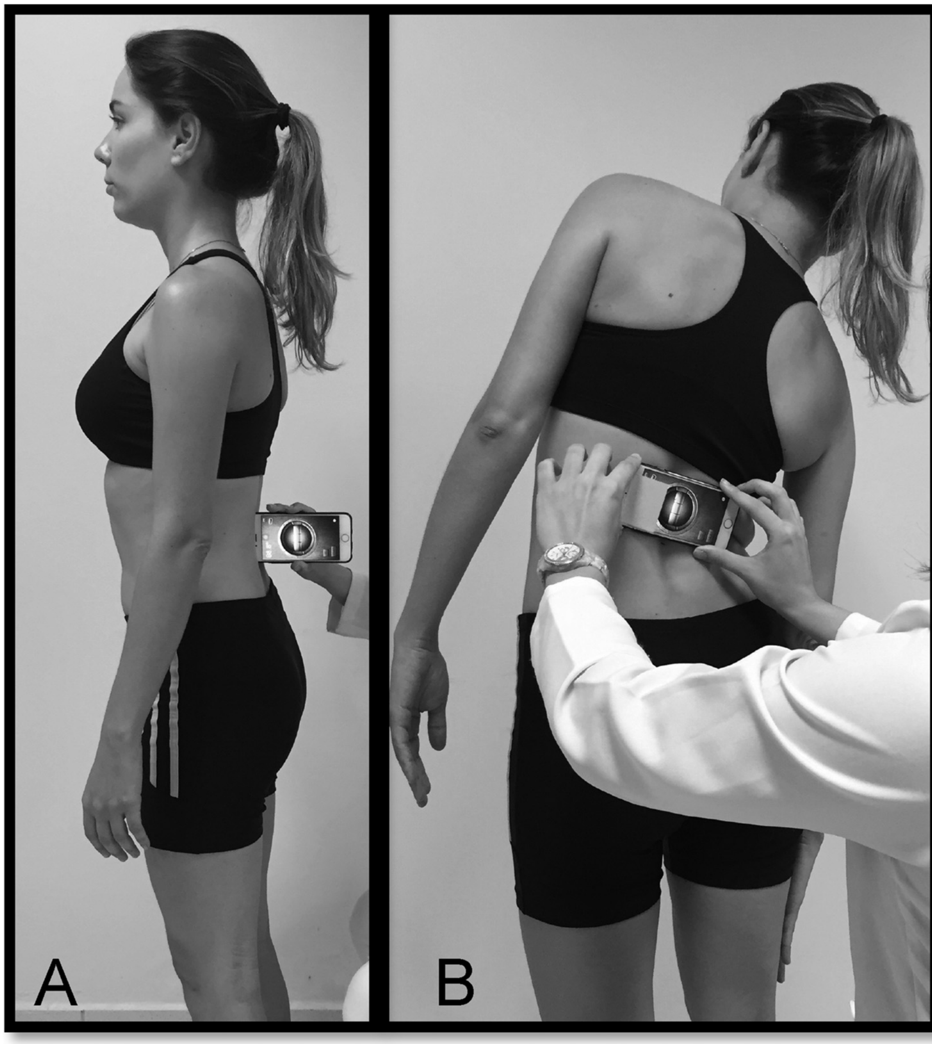

Fig. 2. Position of the device to measure flexion and extension (A) and lateral flexion (B) of the spine.

Subjects

One hundred and eight females with a mean age of 25 [standard deviation (SD) 5] and a mean body mass index (BMI) of 22.8 (SD 2.9) kg/m^2, were recruited to the study from the community, orthopaedics and rheumatology clinics, and Pilates and fitness centres through verbal and printed advertising. Inclusion criteria were: age between 18 and 50 years old and having chronic non-specific LBP for more than 3 months. Exclusion criteria were: diagnosis of fractures or tumours in the spine, ankylosing spondylitis, disc herniation, spondylolisthesis with neurological involvement, lumbar stenosis, previous spinal surgery, fibromyalgia and any central or peripheral neurological diseases. Volunteers were also excluded from the study if they were pregnant, were on their menstrual cycle or the premenstrual period, had BMI over 30, had NPRS less than 2 in the last 24 hours of the first evaluation, or if they had used corticosteroids in the last 2 weeks or any anti-inflammatory medication in the last 24 hours. They were also excluded if they presented signs of allergy/intolerance to KT during a test conducted before the initial evaluation, or had undergone prior treatment with this technique in the lumbar region. Furthermore, volunteers were excluded if they demonstrated a lack of understanding of the instructions in the proposed protocol and/or inadequate performance of the evaluations.

Procedure

Block randomisation was performed by an independent researcher, and the order of the participants was determined using numbers sealed in opaque envelopes. Participants were allocated to four different groups: control group (CG), KT with tension group (KTT), KT no tension group (KTNT) and Micropore® group (MP). Separate researchers performed the assessment (researcher 1), intervention (researcher 2) and data analysis (researcher 3) to minimise potential sources of bias. The initial assessment was carried out and data recorded before the envelopes were opened.

Table 1
Mean (standard deviation) of age, body mass index (BMI), pain, disability, range of motion for flexion, extension, right lateral flexion, left lateral flexion, root mean square RMS of right longuissimus muscle (right RMS — normalised by the peak of the signal), RMS of left longuissimus muscle (left RMS — normalised by the peak of the signal) and strength (normalised by body weight) of the erector spinae muscles for the four groups at baseline.

Variable	CG ($n = 27$)	KTT ($n = 27$)	KTNT ($n = 27$)	MP ($n = 27$)	P-value
Age (years)	24 (4)	25 (6)	24 (5)	25 (5)	0.747
BMI (kg/m^2)	23.2 (2.7)	23.2 (3.2)	22.1 (3.2)	22.7 (2.6)	0.516
Pain (0 to 10)	4.9 (1.6)	4.9 (1.9)	4.9 (1.8)	5.1 (1.7)	0.977
Disability (0 to 24)	8 (3)	7 (3)	8 (4)	7 (3)	0.221
Flexion (degree)	88 (19)	92 (18)	89 (22)	89 (16)	0.892
Extension (degree)	25 (8)	24 (14)	27 (13)	24 (12)	0.794
Right lateral flexion (degree)	29 (5)	32 (7)	30 (6)	29 (5)	0.113
Left lateral flexion (degree)	28 (6)	31 (7)	30 (5)	28 (5)	0.189
Right RMS (%)	58.5 (7)	59.7 (7)	58.0 (6)	58.7 (6)	0.798
Left RMS (%)	57.7 (7)	57.8 (6)	57.6 (5)	57.9 (6)	0.998
Strength (%)	196.5 (87)	212.5 (53)	196.0 (56)	191.6 (69)	0.686

CG: control group; KTT: Kinesio Taping with tension group; KTNT: Kinesio Taping no tension group; MP: Micropore group.

Fig. 3. Position of the dynamometer to evaluate trunk extensor strength.

Due to the presence of a group without tape, it was not possible for the participants and researchers 1 and 2 to be blinded to the treatment. However, before any analysis was performed, the data were coded by researcher 2, so the statistical analysis performed by researcher 3 was blinded.

Intervention

The KTT group received KT that was positioned in the form of "I" over the erector spinae muscles bilaterally [14]. The tape was applied with the participants seated, with the spine in anatomical position for the application of the anchor, which was positioned in the sacral region (S1) without tension [30]. The participants were then asked to perform trunk flexion and rotation to the opposite side to the application of the tape with a slight stretch of approximately 10 to 15%, which was then repeated on the opposite side [30]. The tape was fixed with tension from the posterior superior iliac spine to T12 with a final anchor point fixed directly above T12 with 0% of tension [30] (Fig. 1A).

For the participants in the KTNT group, KT was applied in a similar way as the previous group, except they were asked to hold a neutral pose and no tension was applied to the tape (Fig. 1B). Finally, the participants in MP group received the application in the same way as KTT group. The participants of CG did not receive any intervention.

Participants in the experimental groups were instructed to leave the tape applied to the area for 3 days until re-evaluation, the time usually recommended in clinical practice and in accordance with Kase *et al.* [7], after which the KT can start to become detached from the skin.

Outcome measures

Assessments were taken at baseline (pre), 3 and 10 days after the intervention. On completion of the tests during the re-evaluation at 3 days, the tape was removed and the participant was asked to return to the laboratory 1 week later for the final evaluation, 10 days after the first assessment, which was performed on the same day of the week and time as the second evaluation.

Assessment comprised of pain intensity, disability, trunk range of motion, strength and electromyographic amplitude. The assessment of pain intensity was the primary outcome evaluated using a numerical pain rating scale across a range of 11, with 0 being described as 'no pain' and 10 as 'worst possible pain'. Participants were instructed to report the level of pain intensity based on the last 24 hours [30].

Functional status was assessed using the Roland Morris Disability Questionnaire which provides a score on 24 items that describes daily tasks, where 0 represents no disability and 24 represents serious disabilities. Participants were instructed to complete the items that actually apply to them over the last 24 hours [30].

In addition, the trunk range of motion was assessed using an iPhone® (iPhone® model 6, Apple Inc., California) application *iHandy level®*, which was first calibrated on a level surface and worked as a gravity inclinometer. This application has previously been found to be reliable and has been

Table 2
Mean (standard deviation) for the analysed variables at three time points.

Variables	CG ($n = 27$)			KTT ($n = 27$)			KTNT ($n = 27$)			MP ($n = 27$)		
	Pre	3 days	10 days	Pre	3 days	10 days	Pre	3 days	10 days	Pre	3 days	10 days
Pain (0 to 10)	4.9 (1.6)	4.4 (2.3)	4.6 (2.5)	4.9 (1.9)	2.5 (1.7)	3.4 (1.9)	4.9 (1.8)	2.5 (1.9)	3.2 (2.6)	5.1 (1.7)	3.8 (2.0)	3.4 (2.4)
Disability (0 to 24)	8 (3)	7 (3)	7 (4)	7 (3)	4 (3)	4 (3)	8 (4)	5 (5)	6 (6)	7 (3)	5 (3)	4 (3)
Flexion (degree)	88 (19)	87 (18)	86 (15)	92 (18)	95 (18)	94 (19)	89 (22)	90 (21)	90 (22)	89 (16)	88 (17)	86 (16)
Extension (degree)	25 (8)	25 (9)	27 (9)	24 (14)	28 (13)	30 (14)	27 (13)	28 (13)	29 (15)	24 (12)	26 (13)	26 (13)
Right lateral flexion (degree)	29 (5)	29 (5)	29 (7)	32 (7)	34 (7)	34 (7)	30 (6)	31 (7)	32 (6)	29 (5)	30 (5)	29 (5)
Left lateral flexion (degree)	28 (6)	28 (6)	29 (6)	31 (7)	31 (7)	32 (7)	30 (5)	29 (5)	30 (5)	28 (5)	30 (6)	28 (5)
Right RMS (%)	58.5 (7)	62.2 (16)	59.2 (13)	59.7 (7)	67.2 (16)	65.8 (17)	58.0 (6)	62.4 (14)	63.1 (15)	58.7 (6)	62.7 (13)	64.1 (17)
Left RMS (%)	57.7 (7)	61.5 (16)	58.5 (17)	57.8 (6)	64.1 (17)	63.8 (20)	57.6 (5)	63.1 (15)	64.1 (17)	57.9 (6)	62.9 (17)	66.5 (23)
Strength (%)	196.5 (87)	212.1 (101)	216.5 (98)	212.5 (53)	238.9 (85)	235.2 (59)	196.0 (56)	215.9 (55)	218.2 (57)	191.6 (69)	214.9 (63)	212.4 (75)

CG: control group; KTT: Kinesio Taping with tension group; KTNT: Kinesio Taping no tension group; MP: Micropore group; RMS: root mean square.

validated by several studies [31,32]. This was used to measure the movements of flexion, extension, and lateral flexion to the left and right of the spine, according to the guideline established by Waddell *et al.* [33].

To measure flexion, the device was positioned horizontally with its upper edge in contact with the skin of the participant, while the central region of this edge was placed at the level of T12-L1 (Fig. 2). The participants were asked to flex their trunk moving until the limit of their ROM and hold the position while the angle was recorded. The same procedure was performed for extension, however, for this movement, participants were asked to support their hands on the lower back at L4 to L5 to facilitate their balance [31]. For lateral flexion, the device was positioned horizontally parallel to the ground with the display directed to the investigator at the level of T9 to T12 (Fig. 2). Participants were asked to slide their hand down the side of the leg as far as possible while maintaining trunk and head facing forward whilst keeping both feet on the ground, first moving to the right and then to the left. To ensure the reliability of test-retest, the position and orientation of the iPhone was marked out with a dermographic pen using the spinous processes as a reference. Each movement task was repeated twice with 30-second interval between trials, and a familiarisation was allowed before trials. The repetition with greater amplitude was used in the analysis.

An EMG assessment was performed using a Telemyo direct transmission system and eight-channel wireless system (Noraxon®, USA) with 16-bit resolution and common mode rejection >100 db. Signals were captured with a sampling frequency of 1500 Hz, amplified 1000 times and filtered with a bandpass of 10 to 500 Hz. The signals were captured using passive self-adhesive surface electrodes (4 × 2.2 cm) in a bipolar arrangement, with an inter-electrode distance of 2 cm. Before attaching the electrodes, the participant's skin was shaved and cleaned with alcohol 70%. The electrodes were placed bilaterally in the longissimus muscles, in accordance with the SENIAM guidelines [34]. The analysis software used was the MyoResearch 3.8 (Noraxon®, USA).

A dynamometric evaluation of the trunk extensor strength was performed using a portable hand held dynamometer (Lafayette Instrument®, model 01165, USA). Participants were positioned in prone on a plinth with their hands clasped behind their neck [35] and then guided to conduct trunk extension for 2 seconds for familiarization (Fig. 3). After 1-minute rest, two maximum voluntary isometric contractions (MVIC) were performed for 5 seconds each, with a 2-minutes interval. The dynamometer was positioned centrally between the two lower edges of the shoulder blades and fixed by a band. Two other bands were used to stabilise the participant, positioned above the popliteal line and above the lateral malleolus. During the two contractions, the maximum extensor strength (Newtons) and the root mean square (RMS) of the longissimus muscle were recorded. The electromyographic data (in microvolts) was normalised by the peak of the signal recorded during the MVIC, and strength was normalised to body weight (kg) [35].

Statistical analysis

A sample size of 108 participants, 27 in each group, was identified as sufficient to detect a two-point clinically significant difference [36] between groups in the pain intensity outcome, measured by the NPRS. This assumed a standard deviation of 2.5 points, estimated from a previous pilot study, with a statistical power of 80%, alpha of 5% and a loss rate of 10% [37].

All statistical analyses were conducted following the principles of intention to treat using the Statistical Package for the Social Science software (SPSS) Version 20.0. A mixed methods analysis of variance (ANOVA) (4 × 3) was used to analyse the differences between the four groups (CG, KTT, KTNT, MP) over the three time points (pre, 3 days, 10 days) and group/time interactions. In addition, the effect size was calculated using ηp^2 which reports the proportion of the total variance within the dependent variables. The homogeneity of variance was verified by the Levene test. When the assumption of sphericity was violated, significance was adjusted using Greenhouse–Geisser. When the effect of the test was significant, post hoc pairwise comparisons were performed using a Bonferroni adjustment for multiple comparisons with a 0.05 significance level.

Results

Flow of participants through the study

The design of the study is shown as a Consort diagram (Fig. 4). One hundred and thirty-two volunteers were selected by inclusion. Twenty-four (18%) were excluded in accordance with the eligibility criteria, seven had NPRS less than 2, one had history of fracture on lumbar spine, one had spondylolisthesis with neurological involvement, one was submitted to a previous back surgery, one had used KT on lumbar region previously, two had BMI over 30 kg/m2, three were over 50 years of age, two were men and six declined to participate. In total, 108 participants were included and randomly allocated to one of four groups: CG $n = 27$, mean age 24 (SD 4) years; KTT $n = 27$, mean age 25 (SD 6) years; KTNT $n = 27$, mean age 24 (SD 5) years; and MP $n = 27$, mean age 25 (SD 5) years. Ten data sets were lost in total (9%), one of which was in CG (withdrew), three in KTT group (one volunteer abandoned the study and two where the tape fell off), two in KTNT group (where tape fell off) and four in MP group (all due to the tape falling off).

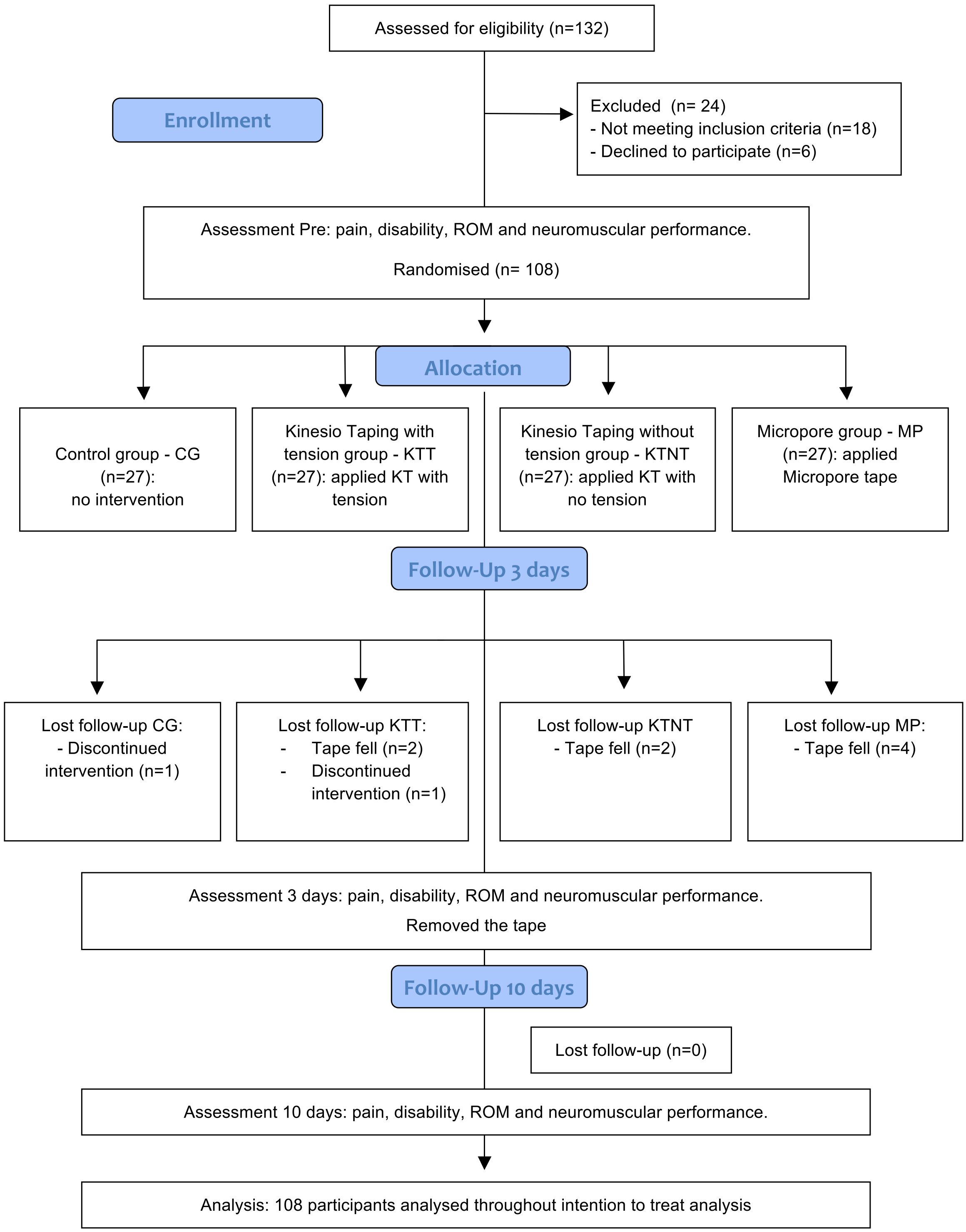

Fig. 4. Study flow diagram. Abbreviation: CG: control group; KTT: Kinesio Taping with tension group; KTNT: Kinesio Taping no tension group; MP: Micropore group; RMS: root mean square.

Analysed variables

The sample homogeneity between groups at baseline for age, BMI, pain, disability, range of motion, RMS and strength are shown on Table 1 as mean (SD).

Table 2 shows the mean values (SD) of all analysed variables, for the four groups, at the three time points of evaluation.

Mixed methods ANOVAs showed significant differences between groups for pain ($P = 0.036$, $\eta p^2 = 0.079$) and disability ($P = 0.010$, $\eta p^2 = 0.102$). Specifically, there was an

Table 3
Mean differences between groups [95% confidence interval (CI) and *P*-value at pre, 3 days and 10 days after intervention for pain and disability variables.

Time	Groups	Pain (NRS 0 to 10)		Disability (RMDQ 0 to 24)	
		Mean difference (95% CI)	*P*-value	Mean difference (95% CI)	*P*-value
Pre	CG × KTT	0.1 (−1.2 to 1.4)	1.000	0.9 (−1.6 to 3.3)	1.000
	CG × KTNT	0.4 (−1.2 to 1.4)	1.000	−0.5 (−2.9 to 2.1)	1.000
	CG × MP	−0.2 (−1.5 to 1.1)	1.000	1.3 (−1.2 to 3.8)	0.918
	KTT × KTNT	0 (−1.3 to 1.3)	1.000	1.3 (−1.2 to 3.7)	0.99
	KTT × MP	−0.2 (−1.5 to 1.1)	1.000	0.4 (−2 to 2.9)	1.000
	KTNT × MP	−0.2 (−1.5 to 1.1)	1.000	1.7 (−0.8 to 4.2)	0.368
3 days	CG × KTT	2* (0.5 to 3.5)	0.003	3.5* (0.9 to 6.2)	0.004
	CG × KTNT	2* (0.5 to 3.4)	0.004	2 (−0.7 to 4.7)	0.297
	CG × MP	0.6 (−0.9 to 2.1)	1.000	2.6 (−0.1 to 5.3)	0.06
	KTT × KTNT	0.1 (−1.5 to 1.5)	1.000	1.6 (−1.2 to 4.2)	0.763
	KTT × MP	−1.4 (−2.8 to 0.1)	0.087	−0.9 (−3.6 to 1.8)	1.000
	KTNT × MP	−1.4 (−2.8 to 0.2)	0.104	0.6 (−2.1 to 3.3)	1.000
10 days	CG × KTT	1.1 (−0.6 to 2.9)	0.527	3.2* (0.4 to 6)	0.016
	CG × KTNT	1.3 (−0.4 to 3.1)	0.247	0.6 (−2.3 to 3.4)	1.000
	CG × MP	1.2 (−0.6 to 2.9)	0.485	2.6 (−0.3 to 5.4)	0.092
	KTT × KTNT	−0.2 (−2 to 1.5)	1.000	2.7 (−0.1 to 5.5)	0.069
	KTT × MP	0.1 (−1.8 to 1.8)	1.000	−0.6 (−3.4 to 2.2)	1.000
	KTNT × MP	−0.2 (−1.9 to 1.6)	1.000	2.1 (−0.8 to 4.9)	0.314

CG: control group; KTT: Kinesio Taping with tension group; KTNT: Kinesio Taping no tension group; MP: Micropore group.
* Significant difference: $P < 0.05$.

improvement between KTT and KTNT groups compared with CG for NPRS 3 days after intervention. For disability, there was an improvement between KTT group and CG group at 3 and 10 days (Table 3).

A significant interaction was seen between group and time ($P = 0.016$) for pain. Further pairwise comparisons showed a mean difference of 2.4 ($P < 0.001$) and 1.5 ($P = 0.011$) in pain between pre intervention and 3 days and between pre intervention and 10 days, respectively, for KTT group. For KTNT group, a mean difference of 2.4 between pre vs 3 days ($P < 0.001$) and 1.7 between pre vs 10 days ($P = 0.003$) was observed. For MP group, a mean difference of it was observed a mean difference of 1.3 ($P = 0.022$) and 1.7 ($P = 0.003$) between pre vs 3 days and between pre vs 10 days, respectively. These changes should be considered on the basis of Ostelo *et al.* [36] who reported values over two points in NPRS to be a clinically important change.

The same effect was seen for disability with a significant interaction between group and time ($P = 0.018$). Further pairwise comparisons showed an improvement between pre vs 3 days ($P < 0.001$, mean difference of 3.2) and pre vs 10 days ($P < 0.001$, mean difference of 3.4) for KTT group; pre vs 3 days ($P < 0.001$, mean difference of 2.9) and pre vs 10 days ($P = 0.009$, mean difference of 1.9) for KTNT group; and pre vs 3 days ($P = 0.005$, mean difference of 1.8) and pre vs 10 days ($P = 0.002$, mean difference of 2.3) for MP group. All the values between time points for KTT group and between pre vs 3 days for KTNT group showed more than 30% of improvement, which also could be considered as a clinically important change [36].

Mixed methods ANOVAs showed significant differences between time points; for extension ($P < 0.001$, $\eta p^2 = 0.090$), a difference was seen between pre vs 3 days (mean difference of −1.8) and pre vs 10 days (mean difference of −2.8); for right lateral flexion ($P = 0.008$, $\eta p^2 = 0.045$), there was difference between both pre vs 3 days (mean difference of −0.9) and pre vs 10 days (mean difference of −1.0); for right RMS ($P = 0.001$, $\eta p^2 = 0.065$), differences were observed between pre vs 3 days (mean difference of −4.9) and pre vs 10 days (mean difference of −4.3); for left RMS ($P < 0.001$, $\eta p^2 = 0.081$) a difference was observed for both pre vs 3 days (mean difference of −5.1) and pre vs 10 days (mean difference of −5.4); and for strength ($P < 0.001$, $\eta p^2 = 0.180$), differences were observed between for pre vs 3 days (mean difference of −20) and pre vs 10 days (mean difference of −20). However, there was no significance difference between groups and no interaction between group and time.

Discussion

This study aimed to evaluate the effect of KT on individuals with non-specific LBP using outcomes of pain, disability, ROM, strength and electromyographic amplitude. To the authors' knowledge, this is the first study to analyse these variables together with a view of comparing the effects of different tapes and the application of different techniques. The results showed reduced pain after 3 days in both KT groups (with and without tension). In addition, disability showed an improvement at 3 and 10 days for KTT group alone. All other statistical comparisons between groups did not show any statistical significance, indicating improvements only in the groups who underwent KT.

These results corroborate the work of previous authors who found a reduction in pain after KT application [8,10]. Paoloni *et al.* [10] observed pain relief shortly after tape application and also after 4 weeks of intervention. They evaluated the effects of the tape vs tape combined with exercise and exercise alone; however, they did not find any significant differences between groups, although pain between time points showed clinically important differences. The same was seen in our results, which showed changes greater than those considered to be minimal clinically importance changes in pain [36] for KTT and KTNT at 3 days of evaluation. Castro-Sánchez *et al.* [8] found a greater improvement of pain for the experimental group, which applied KT over the lumbar spine, at 7 days of treatment and 4 weeks after the intervention. Nevertheless, these findings did not pass the threshold of what can be considered clinically important.

Previous studies [14,38] found reductions in pain after treatment which reached the threshold for a clinically important change [36]; however, these authors did not support its use as no differences were seen between groups. It is important to highlight that these studies did not use a CG without intervention.

Kelle *et al.* [18] and Luz Júnior *et al.* [20] analysed the effects of KT compared with a non-intervention group in LBP and both found a statistically significant difference between the experimental and control group. However, the results of Luz Júnior *et al.* [20] did not reach the threshold for a clinically important change. Moreover, they found the same results for Micropore tape, arguing that this demonstrates a placebo effect. However, the current study did not find differences between CG and MP group, and no statistical difference between Micropore tape and Kinesio tape was seen.

The potential mechanism by which KT reduces pain is beyond the scope of this study; however, one hypothesis that has been suggested is the gate control theory of pain [8,10,22], which suggests that the mechanical stimulus provided by the tape would act through the large-diameter non-nociceptive fibres resulting in pain inhibition and relief. The analgesia ceases, however, as soon as the stimulus is removed. This is in agreement with the present, which showed reduction of the pain at 3 days, while the tape was applied. However, due to the lack of differences between MP group and the groups that applied KT, the hypothesis of a placebo mechanism must also be considered.

In terms of disability, the present results showed a clinically important improvement up to 10 days in the KTT group alone. In contrast, Parreira *et al.* [14], despite observing an improvement of disability in patients who received tape with and without tension, showed no significances between groups. Other authors [8,18,20,38] also observed significant improvement for disability, but with differing evaluation time points, varying between 48 hours to 5 weeks of intervention. None of the studies showed improvement after a follow-up period without tape. However, the variation in these findings could be due to the different protocols used.

Besides the face that disability has a direct relationship with pain, its genesis in chronic conditions is generally multifactorial and may have a different clinical presentation [39]. It can be suggested that the tension provided by the tape can enhance proprioceptive feedback and facilitate correct posture and movement, even after its removal. Some authors [40,41] agree that this improvement in proprioception may provide feedback to achieve and maintain preferred body alignment, and give patients more awareness of back movements, hence reducing detrimental movements [8].

Edin [42] suggested that joint motions are associated with predictable patterns of changing strain in the surrounding skin. The application of the tape would therefore stimulate the skin and change the strain, stimulating cutaneous receptors and improving the movement control.

Although the tape provided improvements in pain and disability, no significant differences were seen between groups for ROM assessed by inclinometry this study. An improvement was detected for extension and right lateral flexion with time, but without an interaction between group and time. Previous studies used clinical tests or instruments as fleximeters [8,13,15,43,44] and analysed different movements in patient populations, making interpretation difficult.

With regards to neuromuscular performance, literature shows that KT does not alter strength or EMG [25–27,45]. Paoloni *et al.* [10] used EMG to determine the effect of the tape on back pain. However, they analysed flexion-relaxation during trunk flexion, whereas the present study also included extension and lateral flexion. The aim of the present study was to verify if KT would improve strength, increase electromyographic amplitude and enhance strength through the stimulation of cutaneous receptors [46]. However, although there was an increase in RMS and strength in relation to time, there was no difference between groups or group and time, concluding that this technique is not able to improve the performance of back muscles.

Finally, it is suggested that KT is capable of reducing pain when applied with or without tension, and improving disability, even after its withdrawal, when applied with tension. However, no effect was seen on ROM, EMG activity or strength. Although improvements were observed in the subjective measures, these showed no superiority of the results of KT group compared with MP group, so a potential placebo effect should be considered. It is important to note that these findings are limited to young women with chronic non-specific LBP and the tape was applied on a single occasion with a short follow-up of 10 days.

Acknowledgements

For the financial assistance granted for this study, we are grateful to Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES).

Ethical approval: The Ethics Committee of Federal Univer-

Key messages

- Kinesio Taping reduces pain and disability in patients with chronic non-specific low back pain.
- There is no difference between the use of Kinesio Taping with or without tension for pain.
- The Micropore group showed no differences compared with the Kinesio tape or control groups.
- No alterations in physical measures were observed.

sity of Rio Grande do Norte approved this study (protocol number 1.213.864).

Funding: This work was supported by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES).

Conflict of interest: None declared.

References

[1] Hoy D, March L, Brooks P, Blyth F, Woolf A, Bain C, *et al.* The global burden of low back pain: estimates from the Global Burden Disease 2010 study. Ann Rheum Dis 2014;73:968–74.

[2] Hartvigsen J, Hancock MJ, Kongsted A, Louw Q, Ferreira ML, Genevay S, *et al.* What low back pain is and why we need to pay attention. Lancet 2018;391:2356–67.

[3] Foster NE, Anema JR, Cherkin D, Chou R, Cohen SP, Gross DP, *et al.* Prevention and treatment of low back pain: evidence, challenges, and promising directions. Lancet 2018;391:2368–83.

[4] Parreira PCS, Costa LCM, Hespanhol Junior LC, Lopes AD, Costa LOP. Current evidence do not support the use of Kinesio Taping in clinical practice: a systematic review. J Physiother 2014;60:31–9.

[5] Kase K, Lemos TV, Dias EM. Kinesio Taping: Introdução ao método e aplicações neuromusculares. 1st ed. São Paulo: Andreoli; 2013.

[6] Kase K, Tatsuyuki H, Tomoko O. Development of Kinesio tape. Kinesio Taping perfect manual. Kinesio Taping Association; 1996.

[7] Kase K, Wallis J, Kase T. Clinical therapeutic applications of the kinesio taping method. 2nd ed. Kinesio Taping Association; 2003.

[8] Castro-Sánchez AM, Lara-Palomo IC, Matarán-Peñarrocha GA, Fernández-Sánchez M, Sánchez-Labraca N, Arroyo-Morales M. Kinesio Taping reduces disability and pain slightly in chronic non-specific low back pain: a randomised trial. J Physiother 2012;58:89–95.

[9] Thelen M, Dauber J, Stoneman P. The clinical efficacy of kinesio tape for shoulder pain: a randomized, double-blinded, clinical trial. J Orthop Sport Phys Ther 2008;38:389–95.

[10] Paoloni M, Bernetti A, Fratocchi G, Mangone M, Parrinello L, Cooper MDP, *et al.* Kinesio Taping applied to lumbar muscles influences clinical and electromyographic characteristics in chronic low back pain patients. Eur J Phys Rehabil Med 2011;47:237–44.

[11] Halseth T, McChesney JW, DeBeliso M, Vaughn R, Lien J. The effects of Kinesio taping on proprioception at the ankle. J Sports Sci Med 2004;3:1–7.

[12] Macgregor K, Gerlach S, Mellor R, Hodges PW. Cutaneous stimulation from patella tape causes a differential increase in vasti muscle activity in people with patellofemoral pain. J Orthop Res 2005;23:351–8.

[13] Yoshida A, Kahanov L. The effect of kinesio taping on lower trunk range of motions. Res Sports Med 2007;15:103–12.

[14] Parreira PCS, Costa LCM, Takahashi R, Hespanhol Junior LC, Luz Junior MA, Silva TM, *et al.* Kinesio Taping to generate skin convolutions is not better than sham taping for people with chronic non-specific low back pain: a randomised trial. J Physiother 2014;60:90–6.

[15] Salvat IS, Salvat AS. Efectos inmediatos del kinesio taping en la flexión lumbar. Fisioterapia 2010;32:57–65.

[16] AlBahel F, Hafez AR, Zakaria AR, Al-Ahaideb A, Buragadda S, Melam GR. Kinesio taping for the treatment of mechanical low back pain. World Appl Sci J 2013;22:78–84.

[17] Kaplan Ş, Alpayci M, Karaman E, Çetin O, Özkan Y, İlter S, *et al.* Short-term effects of Kinesio taping in women with pregnancy-related low back pain: a randomized controlled clinical trial. Med Monit 2016;22:1297–301.

[18] Kelle B, Güzel R, Sakalli H. The effect of Kinesio taping application for acute non-specific low back pain: a randomized controlled clinical trial. Clin Rehab 2016;30:997–1003.

[19] Parreira PCS, Costa LCM, Takahashi R, Hespanhol Junior LC, Luz Junior MA, Silva TM, *et al.* Kinesio Taping to generate skin convolutions is not better than sham taping for people with chronic non-specific low back pain: a randomised trial. J Physiother 2014;60:90–6.

[20] Luz Júnior MA, Sousa MV, Neves LA, Cezar AA, Costa LO. Kinesio Taping® is not better than placebo in reducing pain and disability in patients with chronic non-specific low back pain: a randomized controlled trial. Braz J Phys Ther 2015;19:482–90.

[21] Vanti C, Bertozzi L, Gardenghi I, Turoni F, Guccione AA, Pillastrini P. Effect of taping on spinal pain and disability: systematic review and meta-analysis of randomized trials. Phys Ther 2015;95:493–506.

[22] Artioli DP, Bertolini GRF. Kinesio taping: application and results on pain: systematic review. Phys Ther Res 2014;21:94–9.

[23] Lim ECW, Tay MGX. Kinesio taping in musculoskeletal pain and disability that lasts for more than 4 weeks: is it time to peel off the tape and throw it out with the sweat? A systematic review with meta-analysis focused on pain and also methods of tape application. Br J Sports Med 2015;0:1–10.

[24] Alschuler KN, Neblett R, Wiggert E, Haig AJ, Geisser ME. Flexion-relaxation and clinical features associated with chronic low back pain: a comparison of different methods of quantifying flexion-relaxation. Clin J Pain 2009;25:760–6.

[25] Lins CAA, Locks Neto FL, Amorim ABC, Macedo LB, Brasileiro JS. Kinesio Taping® does not alter neuromuscular performance of femoral quadriceps or lower limb function in healthy subjects: randomized, blind, controlled, clinical trial. Man Ther 2013;18:41–5.

[26] Lins CA, Borges DT, Macedo LB, Costa KS, Brasileiro JS. Delayed effect of Kinesio Taping on neuromuscular performance, balance, and lower limb function in healthy individuals: a randomized controlled trial. Braz J Phys Ther 2016;20:231–9.

[27] Oliveira AKA, Borges DT, Lins CAA, Cavalcanti RL, Macedo LB, Brasileiro JS. Immediate effects of Kinesio Taping on neuromuscular performance of quadriceps and balance in individuals submitted to anterior cruciate ligament reconstruction: a randomized clinical trial. J Sci Med Sport 2016;19:2–6.

[28] Roy SH, De Luca CJ, Casavant DA. Lumbar muscle fatigue and chronic lower back pain. Spine 1989;14:992–1001.

[29] Heydari A, Nargol AV, Jones AP, Humphrey AR, Greenough CG. EMG analysis of lumbar paraspinal muscles as a predictor of the risk of low-back pain. Eur Spine J 2010;19:1145–52.

[30] Added MAN, Costa LOP, Fukuda TY, Freitas DG, Salomão EC, Monteiro RL, *et al.* Efficacy of adding the Kinesio Taping method to guideline-endorsed conventional physiotherapy in patients with chronic nonspecific low back pain: a randomised controlled trial. BMC Musculoskelet Disord 2013;14:301.

[31] Kolber MJ, Pizzini M, Robinson A, Yanez D, Hanney WJ. The reliability and concurrent validity of measurements used to quantify lumbar spine mobility: an analysis of an Iphone® application and gravity based inclinometry. Int J Sports Phys Ther 2013;8:129–37.

[32] Salamh PA, Kolber M. The reliability, minimal detectable change and concurrent validity of a gravity-based bubble inclinometer and iphone application for measuring standing lumbar lordosis. Physiother Theory Pract 2014;30:62–7.

[33] Waddell G, Somerville D, Henderson I, Newton M. Objective clinical evaluation of physical impairment in chronic low back pain. Spine 1992;17:617–28.
[34] Hermens HJ, Freriks B, Disselhorst-Klug C, Rau G. Development of recommendations for SEMG sensors and sensor placement procedures. J Electromyogr Kinesiol 2000;10:361–74.
[35] Nakagawa TH, Maciel CD, Serrão FV. Trunk biomechanics and its association with hip and knee kinematics in patients with and without patellofemoral pain. Man Ther 2015;20:189–93.
[36] Ostelo RWJG, Deyo RA, Stratford P, Wanddell G, Croft P, Von Korff M. Interpreting change scores for pain and functional status in low back pain: towards international consensus regarding minimal important change. Spine 2008;33:90–4.
[37] Sakpal TV. Sample size estimation in clinical trial. Perspect Clin Res 2010;1:67–9.
[38] Added MAN, Costa LOP, Freitas DG, Fukuda TY, Monteiro RL, Salomão EC, *et al.* Kinesio Taping does not provide additional benefits in patients with chronic low back pain who receive exercise and manual therapy: a randomized controlled trial. JOSPT 2016;46:506–13.
[39] Weigl M, Cieza A, Cantista P, Reinhardt JD, Stucki G. Determinants of disability in chronic musculoskeletal health conditions: a literature review. Eur J Phys Rehabil Med 2008;44:67–79.
[40] Osterhues JD. The use of Kinesio Taping in the management of traumatic patella dislocation. A case study. Physiother Theory Pract 2004;20:267–70.
[41] Jaraczewska E, Long C. Kinesio taping in stroke: improving functional use of the upper extremity in hemiplegia. Top Stroke Rehab 2006;13:31–42.
[42] Edin BE. Cutaneous afferents provide information about knee joint movements in humans. J Physiol 2001;531:289–97.
[43] Preece H, White P. Does kinesiology tape increase trunk forward flexion? J Bodyw Mov Ther 2017;21:618–25.
[44] Lemos TV, Albino ACG, Matheus JPC, Barbosa AM. The effect of kinesio taping in forward bending of the lumbar spine. J Phys Ther Sci 2014;26:1371–5.
[45] Csapo R, Alegre LM. Effects of Kinesio® taping on skeletal muscle strength—a meta-analysis of current evidence. J Sci Med Sport 2015;18:450–6.
[46] Konishi Y. Tactile stimulation with Kinesiology tape alleviates muscle weakness attributable to attenuation of Ia afferents. J Sci Med Sport 2013;16:45–8.