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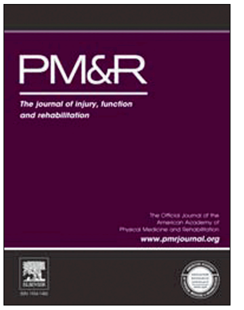

Immediate and Short-Term Effects of Kinesio Taping Tightness in Mechanical Low Back Pain: A Randomized Controlled Trial.

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Immediate and Short-Term Effects of Kinesio Taping Tightness in Mechanical Low Back Pain: A Randomized Controlled Trial.

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Abstract

Background: There is controversy regarding Kinesio® Tex taping (KT) best technique of application, and the theory supporting that skin convolutions may explain its efficacy has been recently challenged.

Objective: To compare the immediate and short-term effectiveness of KT tightness on mechanosensitivity and spinal mobility in non-specific low-back pain (LBP), and to observe the influence of gender in the outcome measures.

Design: Randomized, double-blinded, controlled trial.

Setting: University-based clinical research centre.

Participants: 75 subjects, with a mean age of 33 years (± 7.4) (60% females), with non-specific LBP, were recruited and randomly assigned to one study group; Standard KT tension (n=26), Increased KT tension (n=25), and No KT tension (n=24).

Interventions: All participants received a two I-strip taping over the paravertebral muscles for 24 hours. Paper-off tension (15%-25% of the available stretch) was used in the Standard KT group, which was increased to 40% in the Increased KT tension group. The rest of participants received a taping procedure with no KT tension. Measurements were taken at baseline, immediately and 24-hours after the taping, and after KT removal.

Main outcome measures: The primary outcome included pressure pain thresholds over erector spinae and gluteus medius muscles. Secondary outcome was lumbar mobility (assessed with a digital inclinometer, and back-saver sit-and-reach, finger-to-floor and sit-and-reach tests).

Results: In the between-groups analysis of the mean score changes after baseline assessment, no significant differences were found for any of the outcome measures (*P* >.05), except for the left back-saver sit-and-reach test (P = .03). A statistically significant interaction group x gender x time was only observed for mechanosensitivity values (P = .02 for gluteus, and P = .01 for erector spinae).

Conclusion: KT tightness does not seem to influence results on pain sensitivity and lumbar mobility in chronic LBP in an immediate and short terms.

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Introduction

It is expected that around 60-84% of population of industrialized countries will suffer at least one episode of severe mechanical low-back pain (LBP) throughout their lives [1], with substantial functional limitation, prolonged time of recovery before return to work, and frequent health care use, which leads to a high socioeconomic burden [2].

The decrease in strength and endurance of the back extensor muscles has been linked with an overload of the lumbar spine soft tissue, becoming a common risk factor in the occurrence and recurrence of non-specific LBP [3,4]. This change on back muscles strength an endurance is also related to an increased muscle tone, postural changes, and the activation of myofascial trigger points, being the source of pain and dysfunction [5,6].

The European guidelines for the management of chronic non-specific LBP recommend the use of therapeutic exercise in order to increase muscular flexibility and endurance [7]. Non-invasive and low-cost therapies, such as electrotherapy, manual therapy, and/or soft tissue techniques are only purported to have a moderate positive impact on LBP [7,8]. Therefore, more effective treatments are needed for LBP [7].

The use of Kinesio Taping (KT) has steadily increased in the clinical practice among physical therapists, and its effectiveness has been recently assessed in acute and/or chronic non-specific LBP [9-11]. KT is an inexpensive, and easy-to-use treatment method, due to its ease and speed of application [11]. On the one hand, according to the creators of this technique, KT may relieve pain, decrease soft-tissue inflammation, relax muscle tension, and

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accelerate the physiological healing process [12]. On the other hand, previous research has concluded a slight positive impact of KT on pain perception and mobility both in acute whiplash injury [13], and also in non-specific LBP when combined with stretching and strengthening exercises [14]. Therefore, the clinical meaning of these findings is arguable [13], and the impact of KT in the clinical setting still remains controversial [15]. Likewise, there are few high-quality and randomized studies about its efficacy over the lower back muscles in subjects with LBP.

According to the literature, KT needs to be applied with a specific percentage of tape tension to generate a mechanical and physiological effect [12,16]. The stretching capacity of the KT linked with its application over a stretched muscle may modify the pressure in the skin mechanoreceptors and decrease nociceptive stimuli [12]. It has been hypothesized that creating skin convolutions may explain some of the benefits attributed to KT [12]. However, a recent study found no differences in pain perception between a standard KT application (10-15% of taping tension), and KT applied with no tension (creating no convolutions) in subjects with chronic LBP [17]. These findings challenge the mechanisms that underpin KT. Nevertheless, no previous study has assessed if results may be different when assessing low-back mobility or when using increased KT tightness to create more convolutions.

The main aim of the present trial was to assess the immediate and short-term effectiveness of KT tightness on spinal range of motion and muscular mechanosensitivity in non-specific LBP. As a secondary aim, due to gender

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differences in pain perception in LBP [18], this study has observed the influence of gender in the outcome measures.

Methods

Study Design

A controlled, randomized and double-blinded clinical trial was carried out. Participants and evaluators who collected data remained unaware of the number of study groups and the treatment allocation group in order to ensure participant blinding and outcome assessor blinding respectively. The study protocol was designed according to the Institutional Review Board, was approved by the Ethics Committee of the Regional Government, and was registered in the Australian and New Zealand Clinical Trials Registry with registration number ACTRN 12612000267853.

Randomization and Sample Size

The randomization sequence was made using a randomized number table designed by the Epidat 3.1 program (Consellería de Sanidade, Xunta de Galicia, Spain and and Pan-American Health Organization). An external assistant safeguarded the sequence for those participating in the study. The sample size was calculated using the ENE 2.0 software (GlaxoSmithKline, London, UK and Universidad Autónoma de Barcelona, Spain), following previous research [19], and being the pressure pain threshold (PPT) the main outcome measure. It was taking into account a score difference in PPT values after intervention of 0.5 kg/cm^2, (standard deviation of 0.5 kg/cm^2 at post-intervention data). For an α level of .05, a two-tailed test, a desired power of 80%, and an allocation ratio of 1:1:1 between the study groups, 25 participants per group were necessary to complete the study.

Patient Selection

Participants were screened for eligibility in a University-based clinical research centre from November 2012 to February 2013. Based on former guidelines [3], the inclusion criteria were: (a) age between 18 and 45 years old; (b) history of LBP for more than 6 weeks before the study, or had on-and-off spinal pain having suffered at least 3 episodes of LBP during the year before the study, each lasting more than a week [20]. The exclusion criteria were: (a) previous spinal surgery; (b) a history of spinal or pelvic fracture; (c) a severe trauma and/or injuries related to a car crash accident; (d) osteoarthritis and/or fractures of the lower extremities; (e) degenerative, systemic, rheumatic and/or tumoral disorders; (f) having received manual therapy within eight weeks before data collection or during the study; (g) having received KT as an intervention procedure for LBP; (h) being under pharmacological treatment to relieve pain; (i) LBP associated with radicular pain and/or radiculopathy with presence of neurologic signs [21]; and (j) having any allergies that would prevent the placement of a bandage;

Measurement Protocol

After baseline allocation, the subject gave verbal and written informed consent, as established by the Declaration of Helsinki. Then, participants were randomly assigned to one group: Standard KT tension, Increased KT tension, and No KT tension. Outcome measures were collected at four different times: 1) baseline assessment, 2) 10 minutes after taping, 3) 24-hours after KT application, and 4) immediately after KT removal (around 25 hours after the application). The interventor and the evaluator were senior physical therapists with a long clinical experience (over 10 years). The evaluator was previously trained in the use of the evaluation tools.

Outcome Measures

The pressure pain threshold (PPT) was measured with a pressure algometer (Force dial ™ FDK 20, Wagner Instruments, USA) of a 1cm^2 rubber disk, and using a rate of 1 kg/cm^2/second. Pressure algometry was evaluated over the area described to locate tense bands on the erector espinae and gluteus medius muscles [22]. PPT was applied in a pseudo-randomized order in the different spots, with a resting period of 30-45 seconds between measurements. The average of three measurements was used as the reference value. Subjects were familiarized with the evaluation tool by using non-painful ranges to relieve potential anxiety. The reliability of this procedure has been observed in previous studies [23].

Low-back mobility was measured indirectly [3,5], by assessing trunk flexion range of motion using four different tools: 1) finger-to-floor test, 2) double

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inclinometer, 3) sit-and-reach test, and 4) back-saver sit-and-reach test. All the different tests were performed in a randomized order.

Trunk flexion is a complex movement involving lumbar, thoracic and hip regions. Due to the discrepancy among studies on the validity and reliability of the possible different methods to evaluate spinal range of motion, [24] a combined use of several tools was chosen in the present protocol.

The finger-to-floor test establishes the maximum range of lumbar spine flexion and is a possible indicator of functional limitation [25]. The patient stood on a footstool with arms in a neutral position and with feet 15 cm apart. Subjects were asked to bend forward to their maximal extent, with knees and arms straight, and fingers fully straight. The vertical distance between the tip of third finger and the floor was determined with a tape measure. Subjects were asked to maintain this position for 2 seconds before the measurement was held. This test has shown a high level of interexaminer reliability (r 0.96–0.98) [26].

The sit-and-reach, and back-saver sit-and-reach tests were evaluated using the baseline standard flexibility tester [27]. Subjects sat with extended knees and feet flat against the sit-and-reach box. They were told to bend forward slowly, sliding the right hand over the left along the board. The test was repeated three times and the best record was taken for statistical analysis [28]. For the back-saver sit-and-reach test, one leg was flexed 90º, while the other was extended against the box. This procedure has shown high criterion-related validity [29]. The standard error of measurement (SEM) for these tests has been observed around 3 cm [30].

Finally, the double inclinometer method uses two hand-held, circular fluid-filled disk devices, with an adjustable scale to permit zeroing (Baseline Acuangle^{R} inclinometer A360, Japan). Subjects were standing, with feet 15 cm apart. The evaluator marked T12-L1 and S1 spinal levels. One inclinometer was placed at T12-L1, while the other was located over the sacrum [31]. Then, the subject was asked to bend forward, keeping the knees straight. Maximum values in both inclinometers were recorded. Lumbar flexion was calculated by subtracting the records from S1 from the device placed over T12-L1. This method has shown to be valid and reliable [31].

Treatment Groups

A KT (Kinesio Tex Gold Tape ®, Kinesio, USA), with 5 cm width and 0.5 mm thickness, was used in all groups. A two I-strip KT procedure over the paravertebral muscles [17], was used for all participants. Patients were required to stand straight while the first part of a strip was attached with no tension over the sacroespinalis origin. The rest of the procedure continued depending on the group. For the Standard KT tension group, participants were asked to bend forward gradually, while the rest of the strip was applied until T12 spinal level, as it came off of the paper backing (paper-off tension). The same procedure was followed with the other strip, with paper-off tension meaning around 15-25% of the available stretch [12]. In the Increased KT tension group, the KT strips were placed until the T12 level, but, in this case, the paper-off tension was increased until around 40% of the available stretch. Finally, for participants in the No KT tension group, the KT was placed over the lower spine with no

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tension. Then, subjects were asked to bend forward after both strips were completely placed.

Statistical Analysis

The statistical package PASW Advanced Statistics 19.0 (SPSS Inc., Chicago, USA) was used for processing the data. Distribution normality of the study variables was evaluated using the Shapiro-Wilk test. According to this and the characteristics of the variables, ANOVA, Kruskal-Wallis or Chi-square tests were used to compare baseline demographic and clinical characteristics of the study groups. A repeated measures analysis of variance (ANOVA) was used to observe the interactions of between-subject factors GROUP (standard tension vs. increased tension vs. no tension) and GENDER (men vs. women), and the within-subjects factors TIME (between the four assessment times). ANOVA results were adjusted by using Bonferroni corrections for post-hoc comparisons. Significance level was set at $P < .05$.

Results

A total of 93 subjects with non-specific LBP were selected from November 2012 to February 2013. The final sample included 75 subjects, 45 females and 30 males, with a mean age of 33 years (± 7.4) (18-48). The flow chart diagram of the participants during the selection, follow-up and analysis phases is listed in figure 1. No losses to follow-up were recorded during data collection and analysis phases.

In the baseline comparison between-groups, no differences were found for the physical and clinical characteristics of participants (*P* <.05) (table 1). Table 2 shows the mean scores of pressure algometry and lumbar mobility in the four different assessments, while table 3 lists the statistical significance of the between-groups comparison of the mean score changes after baseline. No differences were found for pressure algometry when considering the whole sample (*P* >.05). However, taking into account gender differences, a significant main interaction gender [F (2,64) = 7.081, *P* = .002], indicating higher pain thresholds in men than in women was observed over the gluteus medius muscle. Likewise, a statistically significant interaction group x gender x time was found in both assessed muscles [F (6,61) = 2.046, *P* = .02 for gluteus; and F (6,61) = 2.232, *P* = .01 for erector spinae].

Concerning lumbar mobility, a significant difference was only observed between those who underwent an increased KT tension treatment, and the No tension group in the evaluation after 24 hours, for the left back-saver sit-and-reach test (*P* = .03). No statistical significance was found in the main effects group or gender or time in the different interactions for the rest of the lumbar mobility tests (*P* >.05 in all cases) (table 3). In the double inclinometry evaluation, neither the main effects time [F (3,66) = .594, *P* = .52], group [F (2,68) = .741, *P* = .48] nor gender [F (1,65) = .761, *P* = .38] were statistically significant.

Discussion

The present findings showed that KT tightness has no immediate influence on pain sensitivity and lumbar mobility in chronic LBP after a single application of KT over a 24-hour period. Gender differences were found for pain sensitivity, but not for lumbar mobility.

As concluded in previous research [17], the present results call into question the theory that KT tightness and the presence of convolutions may explain some of the results attributed to its effectiveness [12]. Our findings suggest that other aspects, such as the potential Hawthorne effect, the influence of tests's repetitions [32] and/or the placebo effect [33,34], may better explain some of the clinical results of KT in the everyday practice. The mere contact of the tape with the skin is a sufficient proprioceptive stimulus to generate cutaneous mechanoreceptors inputs to the central nervous system. This may decrease the nociceptive inputs (according to the gate control pain theory) and activate descending pain inhibitory systems [35,36]. It has even been proposed that KT may increase muscle blood circulation and reduce edema, which may impact the interstitial pressure and decompress subcutaneous nociceptors, leading to a decreased pain perception [35-37]. However, the underlying mechanisms explaining these effects remain unknown.

The observed changes in pain sensitivity appeared to be highly influenced by gender at the different tension groups. Although the underlying reasons remain unclear, female gender is significantly associated with musculoskeletal pain [38], and gender differences have been found in response to mechanically induced pain [39]. This may help to explain the fact that, in the present study, gender observed a higher interaction with pain perception than the use of a specific KT tension protocol. Therefore, from a biopsychosocial perspective, the characteristics of the study sample need also to be taken into account when assessing effectiveness of treatment provision and clinical decision-making in LBP [40].

Our findings are consistent with previous studies on chronic LBP, in which no between-groups differences were observed when assessing standard KT and KT with no convolutions [17,41], or when comparing KT with sham taping [11]. Even though the use of KT alone may help to reduce pain and disability, the clinical impact of these changes remains controversial [11]. Current scientific literature does not support the use of KT over any other intervention, although it remains commonly used in clinical practice [15].

Concerning mobility, KT has been suggested to improve spinal range of motion in different musculoskeletal disorders [11,42,43]. This improvement has been attributed to a greater recruitment of motor units in spinal erectors muscles [14], because of the cutaneous and proprioceptive stimulation caused by the pressure and stretching exerted by KT [44]. A decrease in pain perception after the use of KT has been purported as a plausible explanation to understand an enhanced back muscles performance during isometric endurance tests (probably because KT may help to achieve greater muscle awareness), allowing a subsequent increased in range of motion [11].

In the present trial, statistical significance was only found when increased KT tension was compared to no KT tension. The economy of effort, time and number of treatment sessions might suggest KT as an optimal adjunctive treatment to improve functionality in chronic LBP, although this is still a matter of discussion [11]. Our trial did not specifically evaluate KT physiological mechanisms and we can only speculate on this topic.

Study Limitations

First, although 75 participants were recruited, this can be considered as a small sample size for the study purposes. Second, the trial only evaluated immediate and short-term effects, and the participants all had minimal disability (less than 20 points on the Oswestry Disability Scale), so the external validity to patient populations may be compromised. Third, the lack of a control group with no KT intervention makes impossible to assess the real placebo effect. Fourth, self-perceived low-back pain was only evaluated at baseline, but not in the subsequent assessments. Fifth, even though the evaluator was not informed of the study aims and was not told either that different KT tension procedures were used, it is arguable if an experienced therapist could notice that different taping tensions were performed. Finally, the results were evaluated after a single application of KT, which was not combined with any other interventions. This protocol may differ from what it is done in real clinical practice, where several treatment methods are often combined.

Conclusion

The use of different percentages of KT tension does not seem to influence its impact on pain sensitivity and lumbar mobility in chronic LBP. In the study sample, gender differences were only observed for pain sensitivity, but not for lumbar range of motion.

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Figure Legends

Figure 1 Flowchart diagram of the study sample

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Table 1 Baseline characteristics of participants in the study group

	Standard KT Tension (n=26)	Increased KT Tension (n=25)	No KT Tension (n=24)	P-value
Age (years)	33 (±8.4)	32 (±6.3)	35 (±8.2)	.42
Gender				
Female, n (%)	10 (±38.4)	10 (±40)	10 (±41.6)	.97
Male, n (%)	16 (±61.5)	15 (±60)	14 (±58.3)	
Height (m)	1.67 (±0.9)	1.67 (±0.1)	1.69 (±0.8)	.89
Weight (kg)	69.4 (±11.4)	66.1 (±15.7)	71.7 (±14.8)	.38
Visual Analogue Scale	4.30 (±2.86)	4.50 (±3.11)	4.22 (±2.83)	.95
Body Mass Index (kg/cm^2)	24.7 (±3.2)	23.4 (±3.8)	25.2 (±4.9)	.12
Oswestry Disability Index (%)	11.7 (±6.7)	16.5 (±14.2)	11.5 (±7.8)	.26

Data are expressed as mean (± standard deviation) or as percentage (%); KT, kinesio taping; *P*, statistical significance of the between-groups difference

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Table 2 Mechanosensitivity and lumbar mobility values in the study sample

Outcome measures	Groups	Baseline	10 minutes post-KT	24-hours post-KT	After KT removal
PPT- right erector spinae	Standard KT	2.36 (±0.9)	2.53 (±1.0)	2.44 (±1.0)	2.21 (±0.8)
	Increased KT	2.23 (±1.0)	2.42 (±1.0)	2.38 (±1.1)	2.32 (±1.0)
	No tension KT	1.72 (±1.2)	2.0 (±1.5)	2.0 (±1.5)	1.98 (±1.4)
PPT- left erector spinae	Standard KT	2.22 (±1.0)	2.25 (±0.9)	2.56 (±1.0)	2.49 (±1.1)
	Increased KT	2.32 (±1.2)	2.46 (±1.2)	2.44 (±1.2)	2.20 (±1.1)
	No tension KT	2.23 (±1.3)	2.45 (±0.9)	2.52 (±1.1)	2.60 (±1.3)
PPT- right gluteus medius	Standard KT	1.82 (±0.7)	1.78 (±0.5)	1.90 (±0.4)	1.99 (±0.4)
	Increased KT	1.92 (±0.8)	2.18 (±0.6)	2.21 (±0.7)	2.23 (±0.6)
	No tension KT	2.08 (±0.8)	2.22 (±0.9)	2.18 (±0.8)	2.29 (±0.9)
PPT- left gluteus medius	Standard KT	1.96 (±0.7)	2.10 (±0.8)	2.23 (±0.9)	2.31 (±0.7)
	Increased KT	2.18 (±0.8)	2.36 (±0.7)	2.15 (±0.6)	2.35 (±0.6)
	No tension KT	2.08 (±0.7)	2.36 (±0.9)	2.21 (±0.9)	2.53 (±0.9)
Sit-and-Reach test (cm)	Standard KT	27.48 (±9.6)	28.61 (±9.2)	29.15 (±8.8)	30.29 (±8.6)
	Increased KT	27.68 (±8.5)	29.43 (±8.4)	30.03 (±8.1)	29.22 (±9.8)
	No tension KT	29.10 (±9.2)	30.48 (±8.4)	30.91 (±8.1)	31.27 (±7.9)
Finger-to-floor test (cm)	Standard KT	21.91 (±6.4)	22.46 (±5.8)	23.26 (±5.9)	23.96 (±5.8)
	Increased KT	21.52 (±4.8)	25.42 (±1.5)	23.45 (±5.4)	23.48 (±5.1)
	No tension KT	22.24 (±5.3)	22.91 (±5.1)	22.82 (±4.3)	23.36 (±4.8)
Inclinometry (º)	Standard KT	38.42 (±24.6)	41.92 (±12.8)	38.5 (±13.4)	44.37 (±14.2)

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	Increased KT	36.92 (±23.2)	38.28 (±11.7)	42.08 (±11.7)	40.47 (±14.0)
	No tension KT	44.08 (±12.7)	46.54 (±14.3)	43.75 (±18.0)	42.04 (±15.9)
Right back-saver sit-and-reach test (cm)	Standard KT	27.05 (±9.1)	27.83 (±8.5)	29.25 (±8.7)	30.29 (±8)
	Increased KT	26.73 (±6.9)	28.54 (±7.5)	30.29 (±7.1)	30.73 (±7.8)
	No tension KT	27.06 (±7.6)	28.52 (±7.5)	28.65 (±6.7)	29.74 (±7.15)
Left back-saver sit-and-reach test (cm)	Standard KT	26.63 (±8.9)	27.70 (±8.3)	28.83 (±7.9)	30.03 (±7.6)
	Increased KT	25.4 (±6.8)	28.23 (±7.3)	29.85 (±7.7)	30.31 (±7.1)
	No tension KT	27.75 (±7.5)	29.06 (±7.3)	29.11 (±6.9)	30.21 (±7.7)

Data are expressed as mean (± standard deviation); KT, kinesio taping; PPT, pressure pain threshold (kg/cm^2).

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Table 3 Statistical significance of the between-groups pairwise comparison of the mean score changes between baseline and the rest of assessments.

Outcome measures		Baseline – 10 minutes post KT	Baseline – 24 hours post KT	Baseline – final assessment
PPT- right erector spinae	Standard vs Increased KT	>.99	>.99	.27
	Standard vs No tension KT	>.99	.66	.12
	Increased vs No tension KT	>.99	>.99	>.99
PPT- left erector spinae	Standard vs Increased KT	>.99	>.99	.30
	Standard vs No tension KT	>.99	>.99	>.99
	Increased vs No tension KT	>.99	>.99	.12
PPT- right gluteus medius	Standard vs Increased KT	.32	.32	.33
	Standard vs No tension KT	>.99	.29	.30
	Increased vs No tension KT	>.99	>.99	>.99
PPT- left gluteus medius	Standard vs Increased KT	>.99	.25	.30
	Standard vs No tension KT	>.99	.27	.31
	Increased vs No tension KT	>.99	>.99	>.99
Sit-and-reach test (cm)	Standard vs Increased KT	>.99	>.99	.50
	Standard vs No tension KT	>.99	>.99	>.99
	Increased vs No tension KT	>.99	>.99	>.99
Finger-to-floor test (cm)	Standard vs Increased KT	.40	>.99	>.99
	Standard vs No tension KT	>.99	.56	.44
	Increased vs No tension KT	.47	.28	>.99
Double inclinometry (º)	Standard vs Increased KT	>.99	>.99	>.99

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	Standard vs No tension KT	>.99	>.99	.70
	Increased vs No tension KT	>.99	>.99	>.99
Right back-saver sit-and-reach test (cm)	Standard vs Increased KT	.77	>.99	>.99
	Standard vs No tension KT	>.99	>.99	>.99
	Increased vs No tension KT	>.99	.44	>.99
Left back-saver sit-and-reach test (cm)	Standard vs Increased KT	.19	.63	>.99
	Standard vs No tension KT	>.99	.58	.64
	Increased vs No tension KT	.35	.03*	.47

KT, kinesio taping; PPT, pressure pain threshold (kg/cm^2)

* Statistical significance of the between-groups analysis

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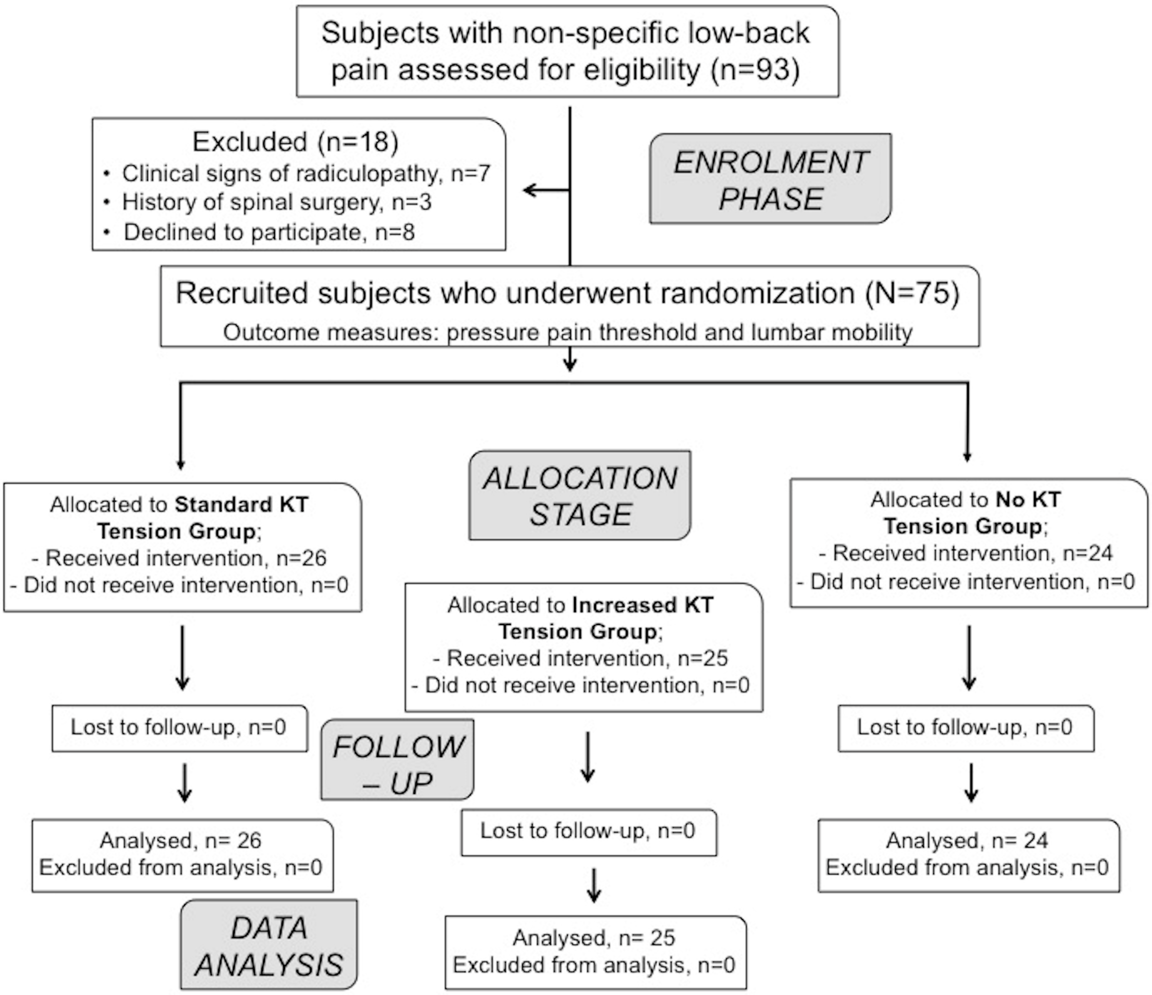

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