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Randomised Controlled Study

Effects of Kinesio Taping on postural balance in patients with low back pain, a randomized controlled trial

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Purpose: to identify postural balance changes in subjects with low back pain after the application of Kinesio Taping, which is then compared to a no treatment control group, using baropodometric evaluation. Methods: This randomized controlled trial was carried out on 50 individuals (both sexes) with chronic low back pain. They were then randomized into two groups: an experimental group - EG (treated with Kinesio Taping in the lumbar region) and a control group - CG (no intervention). Both groups underwent a baropodometric evaluation (mean plantar pressure, peak plantar pressure, plantar surface, mass distribution on right foot and left foot, mass distribution on forefoot and rear foot and base width) at four different moments: pre-intervention, 10 minutes, 48 hours, and 10 days after the intervention on the EG. The level of statistical significance was established at 5%. Results: Significant changes were observed in the EG compared to the CG. In the EG, peak pressure reduced on both right and left foot after Kinesio Taping application; the right base width was reduced, and the mass distribution between the forefoot and the rear foot normalized towards the ideal 50% distribution. These changes happened 48 hours after the Kinesio Taping application, with effects lasting up to 10 days. Conclusion: The use of Kinesio Taping in the lumbar region of subjects with chronic low back pain improved postural balance. This is proved by changes in peak plantar pressure, plantar surface, and mass distribution 48 h after Kinesio Taping application, with effects lasting up to 10 days.

1. Introduction

Low back pain is a clinical condition characterized by moderate to severe pain in the lower region of the spine (Deyo, 2017). People with low back pain experience changes in postural balance and develop compensatory postural patterns (Métréau et al., 2016). Cumulatively, it results in changes in the biomechanical behavior of the trunk musculature, imbalance of muscle relationships in the pelvis, and the presence of muscle contractures in the region (Jean, 2011; Roussouly and Pinheiro-Franco, 2011; Williams et al., 2013; Wong et al., 2017). Lumbo-pelvic muscular imbalance is a predictor of postural imbalance, which is common in people with low back pain. Such imbalances compromise the anticipatory postural adjustment in fast movements due to low back pain (Jacobs et al., 2017). In addition, postural control deficits may play a role in the recurrence of low back pain (Tsao et al., 2008). Therefore, postural balance recovery is very important for low back pain treatment (Gatti et al., 2011; Roussouly and Pinheiro-Franco, 2011; Cavanilles-Walker et al., 2014; Jacobs et al., 2016).

The Kinesio Taping technique involves applying an elastic tape on the skin to correct the underlying function of muscle by increasing proprioceptive stimulation via adjacent mechanoreceptors (Halseth et al., 2004; Long et al., 2017). Beyond the proprioceptive mechanism, it is reported Kinesio Taping is useful to reduce the negative effects of fatigue on postural control (Akbari et al., 2017). This technique is gaining popularity around the world, and the number of studies conducted to evaluate its application for low back pain treatment are increasing, although results are contradictory (Zajt-Kwiatkowska et al., 2007; Weber-Rajek et al., 2011; Bae et al., 2013; Álvarez-Álvarez et al., 2014; Miquelutti and Cecatti, 2017; Trobec and Peršolja, 2017; Araujo

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et al., 2018). A systematic review showed the need for further studies with larger samples to prove the efficacy of Kinesio Taping in patients with low back pain (Nelson, 2016). In addition, studies evaluating the effect of Kinesio Taping on postural balance of patients with chronic low back pain were not found. Only one study investigated the effect of Kinesio Taping on postural control by analyzing variables related to the center of pressure by force platform in patients with low back pain (Abbasi et al., 2018). However, this study only evaluated the immediate effect of Kinesio Taping and 24 h after application, without any comparison to the control group. The lack of studies shows the need for further research on the effects of Kinesio Taping on variables related to postural balance in individuals with low back pain.

Postural imbalance can be evaluated through electronic baropodometry, a procedure that measures several variables related to foot positioning and weight-bearing that characterize postural changes (Giacomozzi et al., 2014; Pineda-Lopez et al., 2016).

In this study, the purpose of the Kinesio Taping technique used was to activate muscle relaxation in individuals with low back pain, which, it is hypothesized, will change the parameters measured in the baropodometry examination. The baropodometer is a reliable instrument for evaluation of parameters related to postural balance (Giacomozzi et al., 2014; Pineda-Lopez et al., 2016). The purpose of this study was to identify changes in the postural balance of subjects with low back pain after Kinesio Taping application compared to a no treatment control group, using baropodometric evaluation.

2. Methods

This study is a randomized, evaluator-blinded, controlled trial.

During the three months (August, September and October), all patients referred by the physician to undergo physical therapy treatment for chronic low back pain at the Rehabilitation Clinic of the Municipal Government in Mafra, Santa Catarina, Brazil, were invited to voluntarily participate in this study. The criteria for inclusion were the following: the subject must be 20–60 years of age; not practicing physical activity regularly; presenting low back pain with at least three months of duration diagnosed by a physician; The criteria for subject exclusion included: undergoing some type of non-medicated treatment for low back pain; the presence of bone tumors or bone tuberculosis; existing neurological, orthopedic or metabolic alterations that prevent or hinder patients' movements; previous lumbar spine surgery less than six months ago; an existing allergy to Kinesio Taping; pregnancy; accumulated absences from work due to low back pain.

Fifty patients of both sexes with chronic low back, between the ages of 42 and 66 years old and low back pain intensity of $8{,}08 \pm 1{,}57$ in the Visual Analogue Scale (VAS), were randomly divided into two groups: the Experimental Group - EG (composed of 25 subjects who received the Kinesio Taping application) and Control Group - CG (composed of 25 subjects who did not receive treatment), using sequentially numbered containers. The study was initiated after approval by the Research Ethics Committee of the Pontifical Catholic University of Paraná (protocol number 55884), and all participants provided written informed consent.

The Physical Therapy Clinical School of the University of the Contestado in Mafra city, Santa Catarina, Brazil, performed four baropodmetric evaluations on each subject of the EG and CG, and the Kinesio Taping application on the EG subjects. The evaluation phases are shown in Fig. 1 and described below.

For the randomization process, all participants were instructed to pick up, from a basket containing 50 sealed envelopes (25 for each group), one envelope indicating which group they were assigned to.

Two physiotherapist researchers conducted all the protocol. Researcher A - non-blinded: applied the Kinesio Taping to all EG subjects and was not present during baropodometric evaluations; Researcher B - blinded: performed all baropodometric assessments, did not know the randomization process, and was not present when Kinesio Taping was applied to the EG.

In the first baropodometric evaluation (pre), before application of Kinesio Taping to the EG, all the subjects were instructed to remain barefoot and to stand naturally with their arms down by their sides. Once the subject was comfortable in this posture, the baropodometer collected data for 10 s.

The following assessed variables considering values for each foot were: Mean plantar pressure (kg/f) – mean pressure exerted on the platform; Peak plantar pressure (kg/f) – peak pressure exerted on the platform; Plantar surface (sq-cm) – foot area in contact with the platform; Base width (cm) – distance between the body mass center and the mass center of the right and left foot; and mass distribution between right foot and left foot (percentage) - considering that the ideal is 50% of the mass distributed on each foot (Rosário, 2014). The variable mass distribution between forefoot and rear foot (percentage) – was assessed considering the joint value of both forefoot and rear foot, considering that the ideal is 50% of the mass distributed on forefoot and rear foot (Rosário, 2014).

The subjects of the EG had Kinesio Taping applied to them by researcher A, immediately after the first evaluation and all CG and EG subjects had a new baropodometric evaluation 10 min after applying Kinesio Taping to the EG. All participants (EG and CG) were reassessed after 48 h and 10 days after the intervention in the EG. During the last three baropodometric evaluations, the subjects wore a wide T-shirt so that researcher B did not see who was with or without Kinesio Taping.

The Kinesio Taping was applied as follows: the length of the subject's flexed lumbar region determined the cut of two I-shaped strips. The paper adhering to the tape was removed from the ends of both strips to form the 'base' and the 'anchors'. With the subject seated with the trunk upright, the evaluator placed the bases of the strips laterally to the gluteal line, parallel to each other, on the sacroiliac joint. Each subject flexed the trunk as far as possible, and the evaluator applied strips, without tension, along the *erector spinae* muscles on both sides. The subject then returned to the standing position and the other end of the tape, or 'anchors', were fixed. At this point, the bands created small elevations in the skin, as described in the literature. The objective of this procedure was to relax the *erector spinae* muscles. After the application of this part is completed, three new I-shaped strips were placed on the lower lumbar area in the form of an asterisk. The center formed by these strips coincided with the middle of the lumbar spine and had no tension, while the tension of the extremities of the asterisk were almost to the maximum. This technique, called 'space opening', aims to decompress the central area of the strips (Sijmonsma, 2007) (Fig. 2). The Kinesio Taping remained in place until it naturally detached itself, with no further application.

2.1. Statistical analysis

The sex of the subjects, being a categorical variable, was described in absolute and relative frequency. The age and all baropodometric variables, being numerical, were described in mean, standard deviation, median, minimum and maximum. The data normality evaluation was tested using the Shapiro-Wilks test. As some of them did not present normal distribution, a non-parametric approach was used to analyze the data. The non-parametric Mann-Whitney test compared the variables evaluated in the pre-intervention; 10 min after; 48 h after and 10 days after intervention moments as well as the absolute differences (Δ)

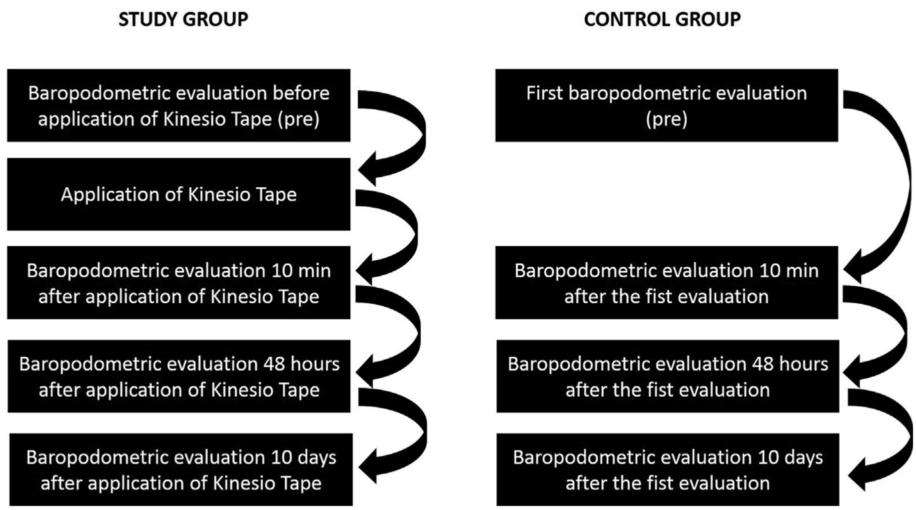

Fig. 1. Phases of the Kinesio Taping evaluation process.

Fig. 2. Application of the Kinesio Taping using the ‘space opening’ technique.

between the pre-intervention moment and the after intervention moments between EG and CG. The non-parametric Friedman test to compare four evaluation moments (pre, 10 min after, 48 h after and 10 days after) within each group was used. Only variables that showed a significant difference in the Friedman test had the evaluation moments tested two to two by the non-parametric Wilcoxon test with level of significance corrected by Bonferroni. The significance statistical level was stipulated in 5% ($p = 0{,}05$). The data were analyzed with the statistical software Statistica v.8.0.

3. Results

All 25 subjects in the Experimental Group (EG) completed the study, and 15 out of the 25 subjects initially in the Control Group (CG) completed the study. The sample loss was due to the 10 CG patients not returning for the evaluation 10 days after the first one. The EG was composed of eight males and seventeen females with the following baseline characteristics: mean age of 54.9 ± 11 years and mean pain intensity of 8.0 ± 1.7 in the VAS. The CG was composed of four males and eleven females with the following baseline characteristics: mean age of 51.5 ± 12 years and mean pain intensity of $8.1 \pm 1{,}4$. The results of baropodometric evaluations were show in Tables 1–3, and described separately for each variable:

3.1. Mean plantar pressure

The mean plantar pressure did not significantly change between the four moments, neither within the EG ($p = 0.489$ for the right and $p = 0.193$ for the left foot), nor within the CG ($p = 0.172$ for the right and $p = 0.891$ for the left foot) (Table 1). There was also no significant difference in this variable when EG was compared with CG for both the right and left foot, as shown in Table 3.

3.2. Peak plantar pressure

Within the EG, the peak plantar pressure was significantly different between moments on the right foot ($p < 0.001$) compared to the left foot ($p = 0.037$). On the right foot, there was a significant reduction from 10 min after the intervention to 48 h after (1.8%, $p = 0.015$). On the left foot, there was a significant reduction from pre-intervention to 48 h after the intervention (12.36%, $p < 0.001$) and from 10 min after the intervention to 48 h after (4.4%, $p < 0.001$). In contrast, no significant changes were seen in the CG (Tables 1 and 2).

There was no significant difference between the groups for the peak plantar pressure variable when the absolute values of each evaluation moment were compared. However, when compared, the variations of peak plantar pressure occurred within each group over time, there were significant differences between the groups. For the right foot, when compared to the values of variation from pre-intervention to 10 min after ($p = 0.008$), to 48 h after ($p = 0.002$), and to 10 days after ($p = 0.028$); and for the left foot when compared to the values of variation from pre-intervention to 10 days after ($p = 0.049$) (Table 3). In the descriptive values (Table 1), it can be observed that the peak plantar pressure in the EG reduced over time for both feet, while the CG values increased.

3.3. Plantar surface

The right foot contact area of plantar surface did not differ significantly in each acquisition for both CG ($p = 0.564$) and EG ($p = 0.782$); the same was shown for the left foot of the EG subjects ($p = 0.066$). However, the left foot contact area was significantly different for CG ($p = 0.039$), specifically a 0.49% increase in the 48 h to 10 days measurements ($p = 0.004$) (Tables 1 and 2). There was also no significant difference between the groups for both right and left foot, as shown in Table 3.

Table 1
Descriptive results of plantar pressures (kg/f), peak plantar pressure (kg/f), plantar surface (sq-cm), of mass distribution (%) in the plantar surface, mass distribution (%) in the forefoot and rearfoot, and base width (cm), and value of comparison at each evaluation moment within each group.

Variable	Group	Moment	n	Foot	Mean ± SD	Median (Min-Max)	*p* value	Foot	Mean ± SD	Median (Min-Max)	*p* value
Mean plantar pressure (kg/f)	EG	pre	25	**right**	47.60 ± 14.1	46.98 (22.5–91.8)	0.489	**left**	54.28 ± 14.7	49.91 (26.7–93.8)	0.193
		10min	25		48.14 ± 13.4	46.31 (23.0–91.8)			54.29 ± 14.0	51.44 (27.9–93.8)	
		48 h	25		47.89 ± 12.2	46.25 (24.6–90.3)			52.92 ± 13.2	50.13 (29.2–92.9)	
		10d	25		48.39 ± 11.9	46.39 (28.6–90.5)			52.91 ± 13.1	49.43 (29.1–92.3)	
	CG	pre	15		50.58 ± 11.8	46.82 (36.8–81.5)	0.172		56.75 ± 12.9	53.41 (39–83.4)	0.891
		10min	15		51.52 ± 11.5	48.44 (37.3–83.1)			56.27 ± 13.5	51.15 (40.4–83.9)	
		48 h	15		51.83 ± 11.7	49.11 (37.7–83.3)			56.37 ± 13.1	52.1 (40.2–82.7)	
		10d	15		50.96 ± 11.2	47.42 (37.4–83)			56.22 ± 13.8	51.79 (39.2–83.1)	
Peak plantar pressure (kg/f)	EG	pre	25	**right**	170.21 ± 54.2	165.9 (82.1–304.3)	0.001*	**left**	214.45 ± 75.3	183.89 (129.7–376.8)	0.037*
		10min	25		165.99 ± 54.3	162.76 (81.4–302)			211.11 ± 67.1	194.77 (129.1–349.5)	
		48 h	25		163.00 ± 48.6	161.29 (84.2–298.1)			201.82 ± 64.0	182.06 (116.9–346.1)	
		10d	25		167.75 ± 48.0	164.75 (92.8–299)			201.37 ± 64.9	181.99 (109.5–351)	
	CG	pre	15		168.38 ± 40.6	163.27 (123.3–284.7)	0.050		195.64 ± 63.8	179.85 (126.3–350.3)	0.204
		10min	15		171.58 ± 39.9	156.12 (129.9–283.9)			190.71 ± 62.0	168.33 (129.7–351.2)	
		48 h	15		173.25 ± 41.6	160.23 (127.8–289.6)			188.95 ± 60.9	167.29 (126.9–350.8)	
		10d	15		172.40 ± 41.3	159.3 (127.7–287.4)			188.74 ± 61.3	167.3 (127.5–351.5)	
Plantar surface (sq-cm)	EG	pre	25	**right**	149.54 ± 16.9	155.44 (114–172.8)	0.782	**left**	151.22 ± 15.0	153.7 (119.8–177.2)	0.066
		10min	25		149.79 ± 16.6	154.11 (117.4–179.2)			151.14 ± 15.1	154.91 (121.3–182.7)	
		48 h	25		149.23 ± 15.5	155.43 (120.8–171.7)			151.76 ± 17.1	153.76 (122.4–203.6)	
		10d	25		149.27 ± 16.0	156.44 (114.6–172.1)			150.86 ± 14.2	153.87 (122.6–177)	
	CG	pre	15		147.15 ± 12.7	151.98 (126.6–172.1)	0.564		151.53 ± 11.8	153.16 (135.2–178)	0.039*
		10min	15		147.12 ± 12.7	151.34 (127.2–173)			151.21 ± 11.9	153.56 (134.9–177.2)	
		48 h	15		147.31 ± 12.7	152.03 (126.9–172.2)			150.70 ± 13.0	153.44 (125.7–176.9)	
		10d	15		147.37 ± 13.0	151.4 (126.6–173.9)			151.45 ± 12.4	154.08 (129.9–177.1)	
base width (cm)	EG	pre	25	**right**	10.58 ± 2.3	10.03 (7.6–17.7)	<0.001*	**left**	9.77 ± 2.7	9.95 (3.5–16.1)	0.668
		10min	25		10.5 ± 2.1	9.88 (7.1–16.6)			9.58 ± 2.3	10.05 (4.2–15)	
		48 h	25		9.51 ± 1.4	9.48 (7.3–13.4)			9.07 ± 1.6	9.07 (5.1–11.5)	
		10d	25		9.67 ± 1.4	9.33 (7.6–14)			9.25 ± 1.5	9.17 (5.6–12.5)	
	CG	pre	15		11.31 ± 2.4	11.03 (7.1–14.9)	0.615		9.71 ± 1.7	9.55 (7.2–12.8)	0.114
		10min	15		11.49 ± 2.0	11.14 (8.2–15)			9.92 ± 1.7	9.77 (7.1–13.8)	
		48 h	15		11.38 ± 2.2	11.12 (8.2–14.9)			10.21 ± 1.7	10.06 (7–13.8)	
		10d	15		11.15 ± 2.1	11 (7.5–14.2)			10.05 ± 1.8	10.03 (7.1–13)	
mass distribution (%)	EG	pre	25	**right**	47.40 ± 9.7	48 (24–64)	0.329	**left**	52.6 ± 9.7	52 (36–76)	0.141
		post	25		47.44 ± 8.1	48 (27–60)			52.96 ± 8.0	52 (40–73)	
		48 h	25		48.64 ± 4.5	50 (37–54)			51.36 ± 4.5	50 (46–63)	
		10d	25		49.04 ± 4.5	50 (36–55)			50.88 ± 4.7	50 (43–64)	
	CG	pre	15		47.33 ± 5.1	47 (39–56)	0.515		52.67 ± 5.1	53 (44–61)	0.380
		10min	15		47.33 ± 5.4	48 (34–56)			52.67 ± 5.4	52 (44–66)	
		48 h	15		47.6 ± 5.7	47 (35–57)			52.40 ± 5.7	53 (43–65)	
		10d	15		48.07 ± 5.6	48 (37–57)			51.87 ± 5.6	52 (43–63)	
mass distribution (%)	EG	pre	25	**forefoot**	53.28 ± 5.4	53 (43–69)	0.006*	**rear foot**	46.68 ± 5.4	47 (31–57)	0.006*
		10min	25		52.44 ± 4.3	53 (44–62)			47.52 ± 4.4	47 (38–56)	
		48 h	25		50.96 ± 1.4	51 (48–54)			49.04 ± 1.4	49 (46–52)	
		10d	25		50.76 ± 2.8	51 (41–56)			49.24 ± 2.8	49 (44–59)	
	CG	pre	15		50.93 ± 4.2	51 (45–60)	0.247		49.07 ± 4.2	49 (40–55)	0.338
		10min	15		50.73 ± 4.5	51 (45–61)			49.27 ± 4.5	49 (39–55)	
		48 h	15		51.60 ± 4.1	52 (45–59)			48.47 ± 4.1	48 (41–55)	
		10d	15		51.47 ± 4.4	52 (45–61)			48.53 ± 4.4	48 (39–55)	

Friedman test significance level, $p < 0.05$.

Table 2
Significance of comparison intragroup moments two to two for the variables that presented statistical significance in the comparison of evaluation moments in Table 1.

	Group		*p* value of comparison of intragroup moments two to two					
			pre x 10min	pre x 48 h	pre x 10d	10 min × 48 h	10 min × 10 d	48 h × 10d
Peak plantar pressure (kg/f)	EG	rigth	0.294	0.162	0.483	0.015	0.081	0.483
		left	0.625	<0.001*	0.017	<0.001*	0.054	0.090
Plantar surface (sq-cm)	CG	left	0.548	0.103	0.180	0.296	0.056	0.004*
Mass distribution (%)	EG	fore	0.328	0.003*	0.003*	0.040	0.040	0.999
		rear	0.328	0.003*	0.004*	0.039	0.040	0.999
Base width (cm)	EG	rigth	0.618	<0.001*	0.001*	<0.001*	0.004*	0.003*

Wilcoxon test significance level, $p < 0.012$ according to the Bonferroni correction.

Table 3
Significance of comparison between EG and CG at each moment of evaluation and in relation to the variation between the moments of evaluation with the *at the pre-intervention* assessment, for all study variables.

		p value of the comparison between the EG and CG						
		Moments				Variation between moments		
		pre	Post	48 h	10d	10min - pre	48 h - pre	10 h - pre
Mean plantar pressure (kg/f)	rigth	0,679	0455	0,376	0525	0,581	0292	0,934
	left	0,525	0679	0,406	0525	0,659	0255	0,173
Peak plantar pressure (kg/f)	rigth	0,847	0868	0,543	0868	0,008*	0,002*	0,028*
	left	0,489	0346	0,507	0525	0,133	0053*	0,049*
Plantar surface (sq-cm)	rigth	0,376	0391	0,455	0376	0,659	0825	0,720
	left	0,912	0934	1	0,890	0847	0,912	0292
Mass distribution (%)	rigth	0,422	0699	0,489	0422	0,699	0581	0,659
	left	0,422	0912	0,489	0472	0,639	0581	0,581
Mass distribution (%)	fore	0,133	0148	0,192	0406	0,439	0008*	0,004*
	rear	0,125	0148	0,233	0406	0,439	0008*	0,004*
Base width (cm)	rigth	0,280	0069	0,009	0030	0,173	0001*	0,038*
	left	0,934	0847	0,078	0148	0,361	0061	0,376

Mann-Whitney significance level, $p < 0.05$.

3.4. Base widths

There was no significant difference in the base widths at each evaluation moments for right foot ($p = 0.615$) and left foot ($p = 0.114$) of CG, and for left foot ($p = 0.668$) of EG. However, the results showed significant approximation of the right foot of EG to the center of pressure ($p < 0.001$) over time (Table 1). There was significant base width reduction from pre-intervention to 48 h after ($p < 0.001$), from pre-intervention to 10 days after ($p = 0.001$), from 10 min after to 48 h after ($p < 0.001$), from 10 min after to 10 days after ($p = 0.004$), and from 48 h after to 10 days after ($p = 0.003$) (Table 2).

In the comparison between groups, there was a significant reduction of the values of the pre-intervention moment to the moments 48 h after ($p = 0.001$) and 10 days after ($p = 0.038$) in the EG compared to CG on the rigth foot base widths (Table 3).

3.5. Mass distribution between right foot and left foot

The mass distribution along the plantar surface did not significantly change between four moments neither within the EG ($p = 0.329$ for the right and $p = 0.141$ for the left foot), nor within the CG ($p = 0.515$ for the right and $p = 0.380$ for the left foot) (Table 1). However, in the right and the left foot of the EG, the mass distribution normalized toward the ideal 50% for the last two evaluations (48 h and 10 days). This did not happen with CG (Table 1), although, there was also no significant difference between the groups (Table 3).

3.6. Mass distribution between forefoot and rear foot

Table 1 shows that in the CG the mass distribution values remained away from balance (the ideal 50% on each part of the foot), without significant changes for the forefoot ($p = 0.247$) and for the rear foot ($p = 0.338$). In contrast, the EG converged significantly towards balance ($p = 0.006$ on the forefoot and $p = 0.006$ on the rear foot). There was a significant reduction on the mass distribution on the forefoot in the EG from pre-intervention to 48 h after ($p = 0.003$) and to 10 days after ($p = 0.003$). This reduction had values close to the parameters of normality (50%), and a significant increase in the percentage of mass distribution on the rear foot from pre-intervention to 48 h after ($p = 0.003$) and to 10 days after ($p = 0.004$) (Table 2), also tending to the ideal. These changes show a mass redistribution towards postural rebalancing in the EG patients. In contrast, CG, although without a significant difference of values, shows inverse results in the descriptive data (i.e., an increase of the percentage of mass distribution on the forefoot and a decrease of the percentage of mass distribution on rear foot) moving away from the 50% equilibrium over time.

The comparison between groups showed a significant difference in the mass distribution variation of each group in the forefoot and the rear foot from pre-intervention to 48 h after ($p = 0.008$) and to 10 days after ($p = 0.004$) (Table 3).

4. Discussion

Sufficient evidence has not yet been established on the effect of Kinesio Taping in postural control and balance on populations with chronic low back pain (Nelson, 2016). Therefore, the discussion explored theoretical studies on postural balance in patients with low back pain as a way of correlating the findings.

The mean and peak plantar pressure exerted by the foot support on both feet and the pressure distributed on the plantar surface provide information on postural control for both healthy and non-healthy individuals (Mehlhorn et al., 2017; Vieira et al., 2017; Yildirim and Ersoy, 2017). Baropodometry is used as a diagnostic tool for conditions such as Parkinson's disease, fibromyalgia, osteoarthritis, low back pain, stroke, chronic pelvic pain, and diabetic foot ulcers (Valentini et al., 2011; Furnari et al., 2014; Giacomozzi, 2014; Rosário, 2014). In this study, there were no significant inter- or intragroup differences in the mean plantar pressure values. However, there was a statistically significant reduction in the peak plantar pressures of the right and left foot supports ($p = 0.001$ and $p = 0.037$, respectively) for the EG.

The maximum plantar pressure considered normal is below 263 kPa in standing position (Imamura et al., 2002). The plantar pressures of both sides remained within normal values for most participants of both groups. However, the reduction of the plantar pressure on both sides of the EG subjects was significantly higher than in the CG when evaluated at 48 h and at 10 days after the tape application. This indicates a better distribution of plantar pressure for those treated with Kinesio Taping, which is a positive outcome, since high peak plantar pressures predispose an individual to certain injuries, such as calcaneal osteophytes or painful metatarsus. These findings suggest that modifications on the proprioceptive mechanism relates to Kinesio Taping use, that reduces the negative effects of fatigue on postural control (Akbari et al., 2017).

Such muscular fatigue is often due to postural imbalance that removes the body from the center of the “cone of economy”, a concept introduced by Dubousset (1994). Therefore, even facing imbalances, the body uses compensatory postural mechanisms to maintain an upright posture, which reflects in the displacement of the center of mass, center of gravity and center of body pressure, apart from affecting the sagittal balance. Such postural changes are incapacitating and relate closely to imbalances and dysfunctions in the lumbopelvic region, often found in patients with low back pain (Jean, 2011; Roussouly and Pinheiro-Franco, 2011; Cavanilles-Walker et al., 2014; Ozer et al., 2014). Furthermore, in patients with low back pain, neuromuscular adaptation may reduce force and cause tissue deformation in the lumbar region (Shojaei et al., 2017).

When comparing postural parameters of individuals with and without low back pain through a force platform, previous studies have found that coordination of postural control is impaired in individuals with low back pain. These individuals present significant displacement of the center of pressure in the antero-posterior direction and in the medial-lateral direction (Lafond et al., 2009; Mann et al., 2010; Abbasi et al., 2018).

The present study also demonstrated a higher percentage of mass distribution on the forefoot than on the rear foot of the patients of both groups at the pre-intervention assessment. However, EG presented mass redistribution in the plantar surface, in the anterior-posterior direction, after 48 h and after 10 days of Kinesio Taping application, with a significant decrease in the percentage of mass distribution in the forefoot and consequent significant increase in the rear foot.

A lot of the reference values are 50% of mass in the forefoot and 50% in the rear foot, considering the bipodal support since each forefoot and rear foot should support 25% of the corporal mass (Rosário, 2014). Meanwhile, in the control group there was a progressive departure from the reference value, increasing the imbalance in the mass distribution, in the anteroposterior direction, with an increase in the percentage of mass distribution in the forefoot and reduction in the rearfoot. There was no significant change in the mass distribution of the treated group 10 min after application, in which evidence is provided in another study (Abbasi et al., 2018).

The mass distribution percentage may be an estimator of the center of mass. A higher pressure in the forefoot indicates a larger anterior projection of the center of mass. This leads to a compensatory postural imbalance increasing the low back physiological curvature, one of the reasons for chronic degenerative mechanical low back pain. (Barrey et al., 2007; Jean, 2011; Roussouly and Pinheiro-Franco, 2011; Cavanilles-Walker et al., 2014; Ozer et al., 2014). In the present study the EG converged significantly towards balance between forefoot and rear foot, i.e. a significant reduction on the mass distribution on the forefoot and a significant increase in the percentage of mass distribution on the rear foot from pre-intervention to 48 h after and to 10 days after. These changes show a mass redistribution towards postural rebalancing in the EG patients, which may contribute reducing the facet impact and also the pain, contributing in the process of rehabilitation (Cavanilles-Walker et al., 2014; Rosário, 2014).

While presenting significant improvements in the parameters that indicate postural balance of EG patients compared to CG subjects, results showed a reduction of the base width of both sides (i.e. bringing both feet closer to the body's center of pressure). This reduction was significant on the right side at 48 h after and 10 days after Kinesio Taping application.

The measurement of the right and left bases' width distance (cm) converge with one another in the treated group. The increased width may relate to a balance deficit. The discrepancy between the right and left side values relate to postural changes and/or lower limb injuries. Therefore, it is recommended that the width of the base needs to be equal on both sides (Rosário, 2014).

The reduction of plantar pressure peak values, the improvement in the mass distribution on the plantar surface, and the reduction in base width that occurred in the EG subjects could be considered as evidence of the positive influence of Kinesio Taping on postural balance.

One possible explanation is that such postural changes may result from the anticipatory contraction of the lumbopelvic stabilizing muscles at times of balance disturbance caused by the use of Kinesio Taping on the lumbar region (Bae et al., 2013).

One could observe that all significant results regarding the effects of Kinesio Taping on the analyzed variables were evident after 48 h and after 10 days of application of Kinesio Taping and were evident in the variation values between the evaluations done before and after 48 h and 10 days. These effects show evidence that after 48 h it could be justified that the physiological effectiveness of Kinesio Taping lasts approximately 96 h (Álvarez-Álvarez et al., 2014; Halseth et al., 2004; Kahanov, 2007; Zajt-Kwiatkowska et al., 2007).

The present study verified the effect of Kinesio Taping, even when it did not exist on the skin (evaluations 10 days after application). A similar effect was described in a study that showed the benefits after the tape was removed (Kelle et al., 2015). Contrastingly, another study did not show the effects of Kinesio Taping on a six month follow up (Araujo et al., 2018). Furthermore, a systematic review of the effect of Kinesio Taping on pain suggests short-term beneficial effects, and the authors proclaim that there is still no evidence that these effects can be prolonged (Artioli and Bertolini, 2014).

There were no statistically significant differences in the plantar surface measurements on the right side; however, a significant difference was observed on the left side ($p = 0.039$) for the CG between 48 h and 10 days after treatment.

Table 1 shows a high similarity in the left foot support. No significant differences were observed for this variable as the plantar area remained essentially unchanged in both groups. The reference value for normal biomechanical mass distribution is 50% for each side, allowing a homogeneous distribution as a result.

The variables of plantar surface and mass distribution between the right and left foot did not come into consideration due to the absence of studies with baropodometry evaluating the effects of Kinesio Taping applied to the lumbar region.

Limitations of the study include the lack of inclusion of any pain variables, no use of a placebo group, and the loss by attrition of 10 control group subjects.

The 10 subjects who dropped out were contacted and showed disinterest in remaining in the study because of the lack of motivation in not receiving the treatment, even if, at the end of the study, they would have received the same treatment as the experimental group received. This sample loss could probably have led to non-rejection of the null hypothesis as a result of some statistical tests.

It is expected that highlighting these limitations may improve the quality of evidence to be obtained in future studies.

5. Conclusion

The group treated with Kinesio Taping had a significant improvement in the mass distribution between the forefoot and rear foot towards rebalancing (50%). There was also a significant reduction in the peak of plantar pressure on both feet and a reduction in the width of the base of corporal sustentation; in particular, the reduction on the right foot was significant. These changes were not observed in the control group. The improvements in EG were more evident 48 h and 10 days after the application of Kinesio Taping.

In conclusion, the use of Kinesio Taping in the lumbar region of subjects with chronic low back pain improved postural balance, as proved by changes in peak pressure plantar, plantar surface, and mass distribution 48 h after Kinesio Taping application, with lasting effects up to 10 days.

Further studies are needed to complement the findings of the present study and to advance in the knowledge of the influence of the Kinesio Taping application in the changes postural balance of subjects with low back pain.

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