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Reducing Lumbar Flexion in a Repetitive Lifting Task: Comparison of Leukotape and Kinesio Tape and Their Effect on Lumbar Proprioception

Kim Grütters [1], Susanne Narciss [1,2], Shawn M. Beaudette [3] and Luca Oppici [4,*]

1 Psychology of Learning and Instruction, Department of Psychology, School of Science, Technische Universität Dresden, 01069 Dresden, Germany
2 Centre for Tactile Internet with Human-in-the-Loop (CeTI), Technische Universität Dresden, 01069 Dresden, Germany
3 Department of Kinesiology, Faculty of Applied Health Sciences, Brock University, 1812 Sir Isaac Brock Way, St. Catharines, ON L2S 3A1, Canada
4 The Department of Teacher Education and Outdoor Studies, Norwegian School of Sport Sciences, 0863 Oslo, Norway
* Correspondence: lucao@nih.no

Abstract: Rigid leukotape applied to the skin of the trunk dorsum, superficial to the lumbar paraspinals, has been shown to reduce lumbar flexion in repetitive lifting, with the potential to reduce the risk of injury in jobs requiring the handling of material. It is unclear which mechanism underpins this reduction, and whether a tape with more elastic properties (i.e., kinesio tape) can yield similar results. In this study, twelve participants were randomly allocated into two groups, and practiced a repetitive lifting task with either leukotape or kinesio tape applied to the skin of their trunk dorsum. The participants also performed a sagittal plane repositioning task to assess changes in lumbar proprioception. The results showed a small reduction in lumbar flexion in the kinesio tape group and a moderate reduction in the leukotape group, and suggested a reduction in repositioning errors in the kinesio tape group only. We suggest that leukotape may correct the movement and improve performance during a flexion-based task, while kinesio tape may improve lumbar proprioception and promote learning. These results have implications for the choice and use of wearable textiles aiming to reduce injury risks in the manual handling industry.

Keywords: augmented feedback; tactile feedback; practice design; low back; spine

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1. Introduction

Low back pain is one of the most common health conditions and the leading cause of years lived with physical disabilities [1]. One of the main risk factors related to low back injury and pain is the frequent and excessive bending of the spine during lifting movements (e.g., lifting a box from the ground) [2–4]. An appropriate sense of the position and movement of the spine (proprioception), especially in the lumbar area, is crucial to avoid (or at least reduce) flexion and maintain the spine in a neutral and safe position. Lumbar proprioception has been shown to decrease in flexed trunk postures [5], which typically occur during lifting, making it difficult for individuals to adjust the position of their lumbar spine during periods of elevated spine flexion. Augmented feedback can be used to provide additional sensory information on the degree of spine flexion during lifting, supplementing the information that is naturally available to the senses (i.e., intrinsic feedback) [6]. It can direct an individual's attention to lumbar proprioceptive information, in turn facilitating a reduction in lumbar flexion during lifting.

A promising and straightforward strategy is to provide tactile feedback directly on the lumbar area through the application of tape to the skin [7]. The application of tape with mechanical properties differing from those of the skin facilitates the activation of specialized mechanoreceptors (slowly adapting type 2, Ruffini corpuscle) sensitive to tensile strain, which have been postulated to play a critical role in proprioception [8]. Further, in flexed spine postures, skin stretch sensitivity thresholds decrease in the longitudinal direction [9]. This suggests that a flexed posture can cause the skin to "pre-stretch", lowering the threshold of mechanically sensitive afferents to sense an additional stretch [10]. The improvement of stretch sensitivity can be used for the design of a tactile feedback strategy. Specifically, a tape can be applied to the skin parallel to the spine to augment skin stretching, providing supplemental sensory information about spine flexion, particularly in high-flexion postures. Based on this, two studies have recently shown that a rigid sport leukotape applied to the lumbar extensor muscles reduced lumbar flexion during lifting [7,11]. Yet, it remains unclear which mechanism underpinned this reduction, and if tape with differing elastic properties may modulate this effect. Examining the mechanism that underlies a feedback effect is not a trivial issue in motor learning [12]. Feedback can promote a short-term improvement in performance by guiding movement, or promote a lasting learning effect by directing a learner's attention to critical goal-related sensory information. In the former, the effect reduces when the feedback is removed (i.e., feedback dependency), while it persists in the latter [13]. Knowing which mechanism a feedback strategy promotes is critical for the design of a training or re-training intervention.

Previous research suggested two potential mechanisms for the effect of leukotape on reducing lumbar spine flexion. Pinto et al. [7] showed that participants retained reduced lumbar flexion when the tape was removed, suggesting that leukotape could improve body awareness (i.e., lumbar proprioception) by making sensory information more accessible. Supporting this explanation, McNair and Heine [14] revealed small improvements in proprioception in a trunk repositioning task when participants wore a lumbar brace. However, Pinto et al. [7] also stated that the leukotape may have acted as a mechanical barrier (some participants reported this). In fact, the second explanation for a reduced lumbar angle is that leukotape could act as position control, limiting participants' movement and preventing them from flexing their spine. Oppici et al. [11] found some indication that participants became dependent on the feedback provided. These authors argued that the tape initially restricted participants in flexing their spine, and this effect decreased once the tape was removed. In short, there was an improvement in performance, but not learning. The fact that leukotape reduced lumbar flexion but with potential feedback dependency raises the question of whether a tape with more elastic properties may yield similar results in reducing lumbar flexion but without feedback dependency.

A more flexible tape could provide proprioceptive information on lumbar flexion without constraining the movement. An example of a more flexible tape that is commonly used in clinical practice is kinesio tape. Kinesio tape has been shown to elicit mechanical deformation of the skin superficial to the paraspinals [15]. This suggests that kinesio tape activates cutaneous mechanoreceptors, and thus it enhances proprioception [16,17]. In addition, pre-stretching the tape before its application might even further stimulate mechanoreceptors through the deformation of the skin [18], potentially further augmenting skin stretching [9]. As such, kinesio tape may reduce lumbar flexion during lifting through an improvement in proprioception, and consequently promote learning. Yet, to our knowledge, very few studies have investigated the effects of kinesio tape on lumbar proprioception. Previous work by Ruggiero et al. [19] noted that kinesio tape had no effect on the lumbar flexion relaxation phenomenon, and differential effects on trunk position sense and postural control. Others have proposed that kinesio tape applied to the lumbar extensor muscles could improve postural control through an enhancement in proprioception; however, there is no evidence for this assumption, and improved postural control could also be a result of muscle strengthening or pain reduction [20]. In summary, leukotape seems to be effective in reducing lumbar flexion during lifting. However, it is not yet understood which mechanism underpins this reduction, and it has been suggested that the tape may restrict movement, lead to feedback dependency, and have a reduced effect on learning. A more elastic tape applied to the skin of the trunk dorsum may similarly reduce spine bending through an improvement in spine proprioception rather than restricting movement, and consequently promote learning.

The aim of the current work was two-fold: (1) to assess the utility of leukotape- and kinesio-tape-derived sensory cues as a means to limit peak lumbar flexion during a lifting task, and (2) to assess the effects of leukotape- and kinesio-tape-derived sensory cues on gross lumbar proprioception (i.e., position sense). The ultimate aim was to examine how different tapes influence the performance and learning of a safe lifting movement with reduced spine flexion. The participants were randomly assigned to a leukotape and a kinesio tape group. Leukotape was attached to the participants' lower back in one group, while kinesio tape was used in the other group. Both groups performed the same repetitive lifting task, and lumbar flexion was measured during lifting. Before and after this lifting training, the participants performed a repositioning task to measure their proprioceptive ability. It was hypothesized that both tapes would reduce lumbar flexion from baseline to retention, and that the repositioning error would decrease from baseline to retention in the kinesio tape group but not in the leukotape group. Due to the small sample, the data collected and presented here can be used as a pilot for designing the investigation of mechanisms underpinning the effect of tape-mediated tactile feedback.

2. Materials and Methods

2.1. Participants

Twelve healthy participants (23 ± 3 years old, 1.71 ± 0.06 m, 63 ± 10 kg, 83% female) were recruited from a university student population. The participants were randomly assigned to a leukotape and a kinesio tape group using a number generator. The two groups did not differ significantly in age, height, or weight. Exclusion criteria were applied: back injury or pain in the past year, undergone spinal surgery, musculoskeletal conditions, allergies to adhesives, pregnancy, and performing lifting and squatting movements regularly or previous professional training. The research team's university ethics committee approved the procedure of this study (rSR-EK-74022020), and the participants voluntarily provided their written informed consent to participate.

2.2. Experimental Design

The study design comprised a repeated lifting task and a repositioning task. Both groups performed the same tasks and followed the same procedure. In total, the lifting task consisted of eight lifting blocks with ten repetitions each. The participants executed one lifting block without any feedback, which was considered as a baseline measurement. After that, six more lifting blocks were performed with tape applied to the participants' lumbar extensor muscles. After each block, there was a short one-minute break, to mitigate any effects of neuromuscular fatigue. At the end of the experiment, the last lifting block was executed without any additional feedback, which was considered as a retention measurement. The repositioning task was performed at two different measurement times (before the baseline and after the sixth lifting block). The task was executed under two different target angle conditions (30 degrees and 60 degrees) (for a detailed overview of the procedure, see Figure 1).

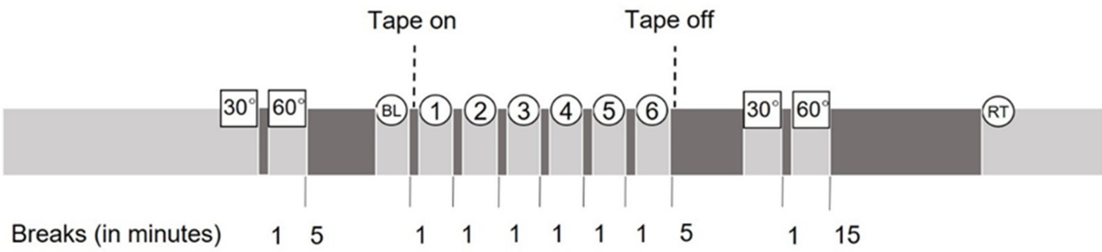

Figure 1. Experimental procedure. Circles represent lifting blocks, and rectangles represent repositioning tasks (BL = baseline assessment; 1–6 = lifting blocks with feedback; RT = retention).

2.3. Experimental Tasks

2.3.1. Lifting Task

The lifting task was consistent with Oppici et al.'s [11] lifting task. The participants lifted an empty 1.5 kg box with their two hands from the ground to knuckle height and placed it back on the ground. For consistency within and between participants, lines on the floor were used to mark the positions of the toes. The box was positioned 10 cm away from the participants' toes, and it had two handles (25 cm above the floor). An auditory metronome (20 beats per minute) indicated when to lift and when to lower the box such that 10 lifting repetitions were performed per minute. The movement started with a standing position and consisted of two phases: (1) bend down, grab the box handles, and lift the box; (2) lower the box, place it back on the ground, and stand back up.

2.3.2. Repositioning Task

For the repositioning task, the participants sat on a stool in a standardized position (angle of 130 degrees between the thighs and trunk) with both feet on the ground, knees and feet apart, and an anterior pelvic tilt, which causes an inward curve of the lumbar spine. This position allowed the participants to maintain the normal physiological curvature of the spine [21]. The participants were instructed to keep both arms crossed in front of their chest on their contralateral shoulder and to bend forward to a target position of the torso angle (segment between S1 and T12) in the sagittal plane. The task was performed with a 30- and a 60-degree target angle position. Similar to Hidalgo et al. [21], the participants were instructed to (1) begin each movement in the standardized seated position, (2) maintain the lumbar angle from the seated position throughout the movement, (3) move at their own pace, (4) aim for the target position, (5) maintain this posture for 3 **s** (count to three) and try to memorize it, and (6) go back to the starting position. In the first trial, the participants were guided to the target position by a visual display. After that, the visual display was removed, and five more repetitions of the task were performed.

2.4. Feedback Conditions

In both groups, the tape provided the participants with continuous tactile feedback on their spine flexion by augmenting skin stretching. While leukotape (altapharma sport tape, Rossmann GmbH, Burgwedel, Germany) was applied to the participants' back in one group, kinesio tape (altapharma kinesio tape, Rossmann GmbH, Burgwedel, Germany) was used in the other group. The tape was applied superficial to the participants' left and right lumbar extensor muscles on the lower back, from the 12th thoracic to the 1st sacral vertebra. During the application of the tape, the participants were asked to remain in a standing position with a neutral spine. While the length of the tape corresponded to the distance between the two vertebrae in the leukotape group, two centimeters was subtracted from this distance in the kinesio tape group, and the tape was stretched to apply it from T12 to S1, thereby representing an approximate 10–15% baseline stretch. As leukotape tended to peel off in previous studies [7,11], it was re-applied after each lifting block. To prevent the tape from loosening the reflective markers on the lower back and pelvis, the width of both tapes was halved. The participants in both groups were given the following instruction: "You will feel the tape stretching if you bend your back. If you feel your skin pulling, use this as a cue to limit spine flexion where possible". This instruction was consistent with previously published procedures [7].

2.5. Outcome Measures

An eleven-camera motion capture system (Qualisys AB, Gothenburg, Sweden), with proven excellent reliability [22], recorded 3D kinematics, sampling at 100 Hz. A specific arrangement of 11 lightweight, retroreflective spherical markers was attached to the participants' bodies. Importantly, five markers were placed at the height of the vertebrae CV7 (7th cervical vertebra), TV7 (7th thoracic vertebra), TV12 (12th thoracic vertebra), L3 (3rd lumbar vertebra), and S1 (sacrum) to track spine flexion (SF). The pelvis was defined by six additional markers, and one marker was applied to the box. Data were exported for analysis to Visual 3D software (C-Motion, Inc., Boyds, MD, USA), and they were low-pass-filtered using a bidirectional low-pass filter with a cut-off frequency of 15 Hz before computing the outcomes of interest.

For the lifting task, the lumbar angle was computed as a planar angle (YZ) at each frame between the TV12-L3 and L3-S1 segments, using the pelvis as a reference. The angle was normalized by the lumbar angle recorded during the static pose, in which the participants adopted a neutral standing position. The start and the end of each lift were defined by the box marker's vertical position. Peak angles were extracted as the maximum lumbar angles between the beginning and the end of the lift.

For the repositioning task, we were interested in the torso angle. Consistent with previous research, the segment between S1 (proximal) and TV12 (distal) was considered rigid and homogenous. The torso angle was calculated as the angle of the S1-T12 segment on the sagittal plane (YZ). The laboratory's coordinate system was chosen as a reference for the calculation of the torso angle.

As a measure of gross lumbar proprioception, repositioning errors were computed as the difference in torso angular displacements between the target position (i.e., 30 or 60 degrees) and the orientation of the torso adopted by the participant in their perception of this target position using the following formula, adapted from [14,21,23–26]:

$$|\mathrm{RE}| = \mathrm{RPi} - \mathrm{TP}$$

where RP is the reached position, i is the number of trials (n = 5), TP is the target position, and RE is the repositioning error. RE refers to the number of errors and indicates the accuracy, regardless of the direction.

2.6. Statistical Analysis

All statistical analyses were completed in SPSS (version 27.0. Armonk, NY, USA: IBM Corp.). Unless otherwise stated, a critical alpha level of 0.05 was assumed for all analyses.

2.6.1. Lifting Task

For the lumbar angle, a generalized linear mixed model (GLMM) was computed with log transformation of the target variable and robust covariances; measurement time (baseline, retention) was considered as a repeated and fixed factor, and group was considered as a fixed factor. In the model, the participants and their intercepts were not considered as random factors, as they caused the model not to converge. The residuals had the following distribution: skewness of 1.53 (SE = 0.49) and kurtosis of 2.29 (SE = 0.95). Post hoc comparisons were computed using Bonferroni adjustment for multiple comparisons.

For a more exploratory analysis, effect sizes were estimated based on the means and standard deviations from the raw data.

2.6.2. Repositioning Task

The GLMM was computed with log transformation of the target variable and robust covariances. It was computed on repositioning errors (RE) from target positions of 30 and 60 degrees to analyze differences between the groups (group 1: leukotape; group 2: kinesio tape), measurement times (pre- and post-test), repetitions (1–5), and interactions between these factors. The participants were considered as a random factor, groups as a fixed factor, and measurement time and repetitions as repeated and fixed factors. The participants' intercepts were not included because they caused the model not to converge. The residuals had the following distribution: skewness of 0.44 (SE = 0.22) and kurtosis of 0.07 (SE = 0.44) in the 30-degree target position, and skewness of 0.29 (SE = 0.22) and kurtosis of −0.54 (SE = 0.44) in the 60-degree target position.

In both the lifting and repositioning tasks, post hoc comparisons were computed using Bonferroni adjustment for multiple comparisons (*p*-values were adjusted). Cohen's d was calculated based on the raw data. The effect magnitude was classified as trivial (d < 0.2), small (0.2 < d < 0.5), moderate (0.5 < d < 0.8), or large (d > 0.8).

3. Results

3.1. Lifting Task

Eleven participants were included in the analysis. One participant from the kinesio tape group had to be excluded because the retroreflective markers were not tracked properly.

There was a significant group effect (F [1,18] = 12.53, $p = 0.02$), but there was no significant effect of the measurement time (baseline, retention) (F [1,18] = 2.86, $p = 0.11$) and no interaction effect between the measurement time and group (F [1,18] = 0.38, $p = 0.55$). Post hoc tests revealed that lumbar flexion was significantly higher (baseline and retention sessions combined) in the kinesio tape group compared to the leukotape group ($p = 0.02$). The estimation of the effect sizes revealed a small reduction from baseline to retention in the kinesio tape group (d = 0.31), and a moderate reduction in the leukotape group (d = 0.60) (Table 1, Figure 2).

Table 1. Descriptive statistics for the peak lumbar flexion angles and estimation of effect sizes (baseline vs. retention; d).

			Confidence Interval (95%)		
	Mean	**Standard Error**	**Lower Limit**	**Upper Limit**	**d**
Leukotape (n = 6)					0.60
Baseline	11.3	3.1	3.1	19.4	
Retention	7.7	1.7	3.3	12.1	
Kinesio tape (n = 5)					0.31
Baseline	28.1	6.4	10.5	45.7	
Retention	23.4	7.1	3.8	43.0	

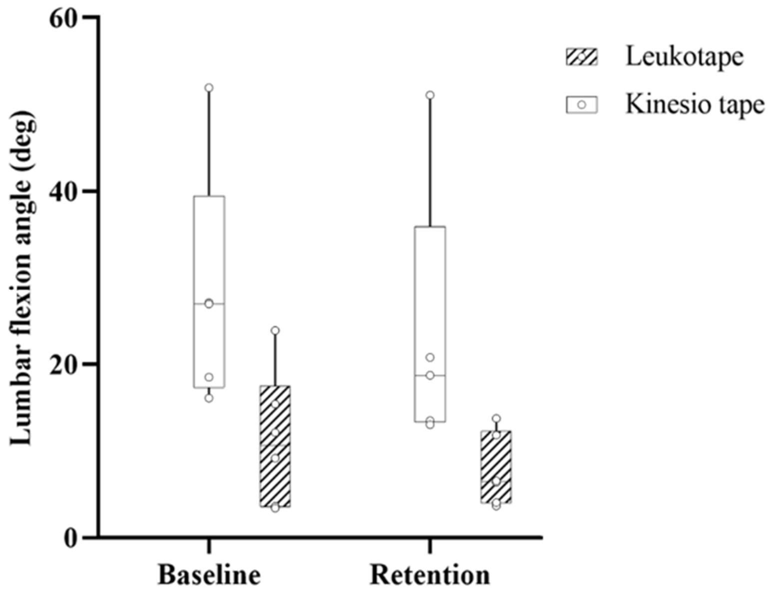

Figure 2. Mean peak lumbar angle at baseline and retention measurement in the lifting task. Small circles show the mean peak flexion angles for each participant at baseline and retention. The lower limit of each box represents the first quartile, the middle line shows the median, and upper line represents the third quartile.

3.2. Repositioning Task

3.2.1. Repositioning Error (Target Position 30 Degrees)

All 12 participants were included in the analysis. The results showed a significant main effect of the tape type (F [1,100] = 8.27, $p < 0.01$), a significant repetition effect (F [4,100] = 16.81, $p < 0.01$), and a significant interaction effect of the measurement time, repetition, and tape type (F [10,100] = 17.85, $p < 0.01$). The effect of the measurement time (F [1,100] = 3.27, $p = 0.07$) and the two-way interaction between the tape type and measurement time (F [1,100] = 1.07, $p = 0.30$) were not statistically significant. The post hoc tests revealed that RE was significantly higher in the leukotape group compared to the kinesio tape group ($p = 0.01$), and lower in the first repetition compared to the other repetitions ($p < 0.01$). RE was significantly higher in the first measurement (pre-lifting) compared to the second measurement (post-lifting) in the fifth repetition in the kinesio tape group ($p < 0.05$). The estimation of the effect sizes revealed a small-to-moderate reduction from pre-lifting to post-lifting in the kinesio tape group at the 30-degree target position (d = 0.47), while no such effect was found in the leukotape group (d = 0.10) (Table 2, Figure 3).

Table 2. Descriptive statistics for torso angle repositioning errors and estimation of effect sizes (pre vs. post; d).

			Confidence Interval (95%)		
	Mean	**Standard Error**	**Lower Limit**	**Upper Limit**	**d**
30-degree target					
Leukotape					0.10
Pre-lifting	8.4	2.0	3.2	13.6	
Post-lifting	8.1	1.1	5.2	10.93	
Kinesio tape					0.47
Pre-lifting	5.4	1.4	1.9	9.0	
Post-lifting	3.9	1.4	0.4	7.3	
60-degree target					
Leukotape					0.30
Pre-lifting	5.7	1.5	1.8	9.5	
Post-lifting	4.7	1.1	1.8	7.6	
Kinesio tape					0.17
Pre-lifting	3.4	1.0	1.0	5.9	
Post-lifting	3.8	0.8	1.1	5.9	

3.2.2. Repositioning Error (Target Position 60 Degrees)

All 12 participants were included in the analysis. The results revealed that the effects of the tape type (F [1,100] = 1.66, $p = 0.21$), measurement time (F [1,100] = 0.12, $p = 0.72$), and repetition (F [4,100] = 1.86, $p = 0.12$), as well as the interaction between the measurement time and group (F [1,100] = 0.60, $p = 0.44$), were statistically non-significant.

Within the groups, a significant interaction effect of the measurement time and repetition was found (F [10,100] = 4.32, $p < 0.01$). However, the post hoc tests revealed no significant differences between measurement times at different repetitions. The estimation of the effect sizes revealed a small reduction from pre-lifting to post-lifting in the leukotape group at the 60-degree target position (d = 0.30), while no such effect was found in the kinesio tape group (d = 0.17) (Table 2, Figure 4).

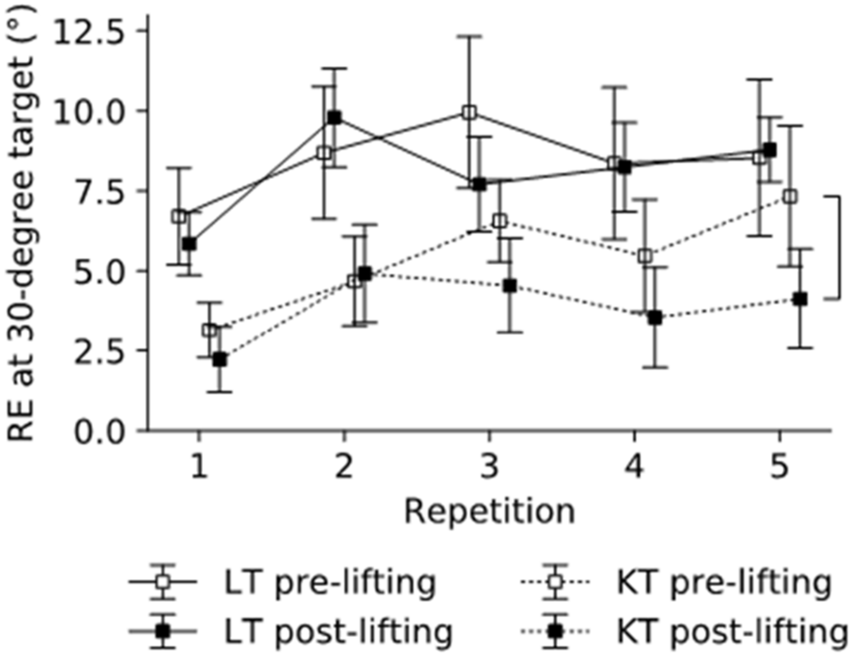

Figure 3. Repositioning error from 30-degree target position over measurement times and repetitions. The difference was significant between pre- and post-lifting at repetition five in the kinesio tape group (LT = leukotape group; KT = kinesio tape group). * indicates statistically significant differences.

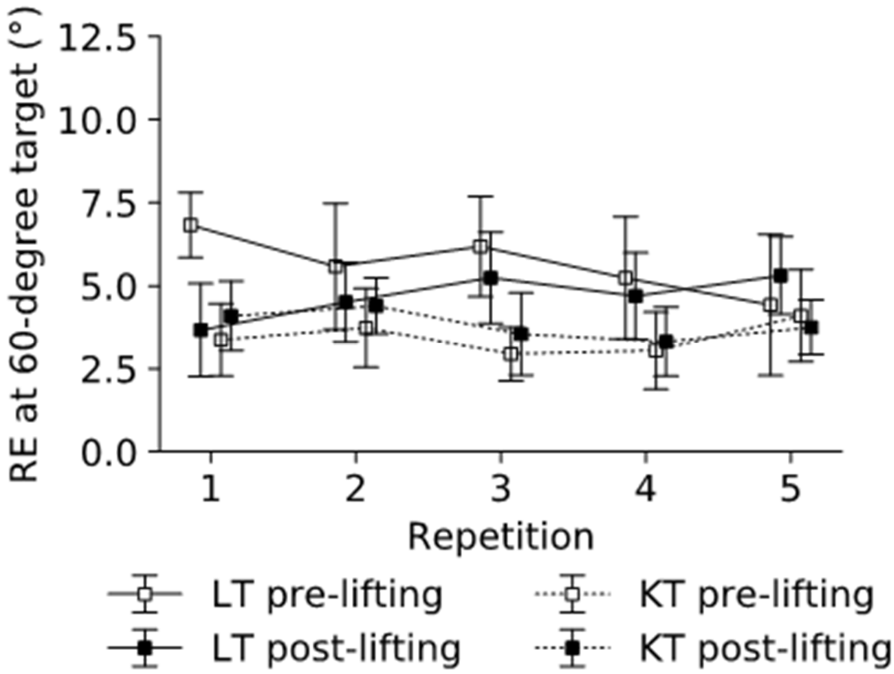

Figure 4. Repositioning error from 60-degree target position over measurement times and repetitions (LT = leukotape group; KT = kinesio tape group).

4. Discussion

This pilot study compared the effects of lifting with two adhesive tapes affixed to the trunk dorsum with different elastic properties (i.e., leukotape vs. kinesio tape) on the peak lumbar flexion angle and lumbar proprioception. It was hypothesized that both tapes would reduce lumbar flexion from baseline to retention, and that the participants in the kinesio tape group would also improve lumbar proprioception. The small sample had low statistical power; hence, we interpret the statistical results along with the effect sizes. Arguably, in such a small sample, effect sizes are more meaningful than statistical testing. The results showed that, despite not being statistically significant, both groups reduced lumbar flexion from baseline to retention (moderate reduction in the leukotape group, and small reduction in the kinesio tape group) (Table 1, Figure 2). Furthermore, the kinesio tape group had a small-to-moderate reduction in the repositioning error in the 30-degree repositioning task, and the leukotape group had a small reduction in the repositioning error in the 60-degree repositioning task (Table 2, Figures 3 and 4).

The participants in both groups reduced their lumbar flexion angle. These results are in line with previous research that investigated the effect of leukotape as a tactile feedback strategy during lifting [7,11]. Even though kinesio tape has more elastic properties than leukotape, the stimulus provided by the kinesio tape seems to have been strong enough to activate stretch sensitivity thresholds (due to reduced stretch sensitivity thresholds in flexed spine postures, see Beaudette et al. [9]), allowing the participants to adjust the position of their lumbar spine. Importantly, we observed results with both tapes cut in half, and the effect could be stronger when the full tape is applied. The lower effect size in the kinesio tape group was driven by high standard errors. In addition, there was a significant difference in lumbar flexion between both groups. Thus, it remains unclear whether one tape is more effective than the other. Importantly, the results indicate that both tapes seem to be effective in reducing lumbar flexion during lifting.

This study employed a repositioning task to measure participants' proprioceptive ability before and after the lifting trials with supplementary tactile feedback. The aim was to gain further insights into the mechanisms that underlie the effects of tactile feedback with tapes of different elastic properties. In the 60-degree task, the effect sizes indicate a higher reduction in the leukotape group compared to the kinesio tape group. However, this task might not be ideal to assess lumbar proprioception. Several participants stated that they felt uncomfortable when performing this task because they had to bend forward so much that they had to concentrate on not falling over. In addition, it was difficult for some participants to see the visual feedback, and thus they had to extend their necks to see the display. Furthermore, anecdotally, this task seemed quite far off from the lifting movement. These problems did not occur in the 30-degree repositioning task, and therefore we consider this task as a more appropriate measurement of lumbar proprioception. The effect sizes suggest that kinesio tape reduced the repositioning error in the 30-degree task, and the difference between the pre- and post-lifting measurements was significant in the fifth trial. Differences between the pre- and post-lifting measurements became larger over the trials (Figure 4); thus, it can be argued that training with kinesio tape seems to reduce repositioning errors over the trials, on average. In conclusion, as also noted by [20], these results suggest that kinesio tape improved lumbar proprioception.

This pilot study is the first to measure the effect of lifting trials with supplementary tactile feedback on lumbar proprioception, and therefore it provides new insights into the different mechanisms that underpin the effects of the two tapes. As proprioception did not improve in the leukotape group, the assumption that leukotape acts as a mechanical barrier [11] is further supported. Previous research has demonstrated that position control strategies are likely to promote passive behavior, which can result in feedback dependency and interfere with motor learning [27,28]. Contrarily, kinesio tape seemed to have promoted an increased perception of intrinsic feedback (proprioception), which should result in motor learning. Therefore, leukotape may be suitable for improving immediate performance, while kinesio tape is more likely to lead to lasting learning effects.

In conclusion, the results of this pilot study suggest that training with kinesio tape seems to improve lumbar proprioception, while lumbar proprioception might not improve when training with leukotape. Therefore, it can be argued that a more elastic tape (i.e., kinesio tape) could increase the availability of task-intrinsic feedback without creating a mechanical barrier.

Limitations and Implications for Further Research

This pilot study has several limitations: Due to COVID-19 pandemic restrictions, we were not able to complete data collection, hence the small sample (n = 12) and the lack of statistical power. As such, this study can be considered a pilot study for integrating a systematic assessment of mechanisms underpinning feedback effects. It is possible that inter-individual differences in anthropometrics, muscle tension, or spinal mobility may have impacted our results. Therefore, even though interpretations must be taken with caution, we paved the way for an interesting research avenue. Importantly, we only included a short-term retention test, and long-term retention tests are necessary to better investigate learning effects. Future research should focus on increasing the sample, targeting workers or subjects with back pain, who can directly benefit from such an intervention. Long-term retention tests should also be included to evaluate learning. Further, the repositioning task should be further developed, i.e., displacements from a lumbar angle target could be assessed instead of the torso angle target that was used in this study. Importantly, any future investigation should further emphasize the mechanisms that underlie the effects of tapes with different elastic properties and differentiate between performance and learning effects, as the reductions in the lumbar range of motion noted in this work may have been generated due to a variety of interacting and intersecting phenomena (supplementary sensory feedback, mechanical limits imposed by stiffer tape, changes in the stretching of the muscles imposed by tape applications, etc.)

5. Conclusions

The results of this study suggest that leukotape and kinesio tape reduced lumbar flexion during lifting, and that the mechanisms through which they reduced lumbar flexion might be different. Kinesio tape seems to have improved lumbar proprioception, while leukotape seems to have acted as a mechanical barrier, thereby restricting movement. Therefore, kinesio tape could be more suitable to promote motor learning, while leukotape might improve lumbar flexion in the short term. Further studies with larger samples that include long-term retention tests are needed to prove these assumptions.

This pilot study has practical implications as it provides insights into the mechanisms through which different tapes can reduce lumbar flexion. The results showed that kinesio tape might be a more promising strategy to train individuals, while leukotape could rather be used for movement correction. It is therefore important to choose an appropriate feedback technique based on a given goal (i.e., promotion of learning vs. movement correction). For instance, workers recovering from a back injury may be encouraged to initially use a firm leukotape to mechanically limit spine flexion and reduce the risk of re-injury; then, at a later stage, they may switch to kinesio tape to improve their proprioception and postural control during lifting, reducing their risk of future injuries. Further, workers that perform manual lifting daily may use kinesio tape to learn safe movements with long-term benefits, while workers that perform manual lifting seldomly may decide to use leukotape during those instances to reduce their risk of injury. From a practical perspective, in some working contexts, kinesio tape could be a viable alternative for providing tactile feedback to workers as it is more firmly attached to the skin compared to leukotape, which easily peels off during flexion [7]. Therefore, a continuous re-application of the tape is not required, making this feedback method easier to use in practice.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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