KNEE TAPING AND GROUND REACTION FORCES IN A SIT TO STAND, SQUAT, AND VERTICAL JUMPING TASKS

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This study examined the effect of no tape compared to Kinesiotape, Leukotape, and placebo (type of tape) on resultant ground reaction forces (GRF) in a sit to stand, full squat, and vertical jumping task (functional task). Ten participants completed four testing sessions with different taping techniques. Mean resultant GRF was measured using an AMTI force platform for three trials of each task. There was no significant main effect for resultant GRF by type of tape and functional task ($F(6, 108)=.003$, $p=1.0$). There was a significant main effect for resultant GRF by functional task ($F(2, 117)=145$, $p=.0005$); sit to stand GRF were significantly lower than the GRF for squatting or vertical jumping. Knee taping may affect resultant GRF but may depend on the functional task being performed.

KEY WORDS: Kinesiotape, Leukotape, placebo, no tape, functional task

INTRODUCTION: Patellofemoral pain syndrome (PFPS) is a common clinical disorder resulting in knee pain, crepitus, and functional restrictions (Rothermich, Glaviano, Li, & Hart, 2015). The signs and symptoms associated with this disorder often result in healthcare costs related to assessment and treatment, lost time in the work setting, as well as functional and sport related restrictions (De oliveira Silva et al., 2015). The exact etiology and pathophysiology of this disorder is unknown. Currently theories centre on the malpositioning and misalignment of the patella resulting in increased joint compression of the posterior aspect of the patellar facets. Longstanding and prolonged patellofemoral joint compression may result in progression to include degenerative changes and chondromalacia patellae and increased pain, weakness, and functional loss. The misalignment may be related to muscular imbalances related to length tension and inflexibility in the hamstrings, iliotibial band, and gastrocnemius, weakness in the gluteus medius and vastus lateralis muscles, or increased patellofemoral joint capsular tightness contributing to excessive joint compressive forces and subsequent pain (Rothermich et al., 2015). The proposed treatments for knee pain secondary to PFPS can vary from conservative measures including electrotherapeutic modalities to active stretching and strengthening exercises, bracing, and therapeutic taping (Rothermich et al., 2015).

Therapeutic taping is commonly used to treat PFPS with the intent of mechanically realigning the patella, facilitating and increasing quadriceps muscle activation and function, and reducing compression and, subsequently, pain (Crossley, Cowan, Bennell, & McConnell, 2000). Despite its increased use, popularity, media exposure associated with various high profile sporting events such as the Olympic Games, and the vibrant colours of the different tapes themselves, the number of high quality studies examining the effects of therapeutic taping on joint reaction forces is limited. Therefore, the purpose of this pilot study was to examine the effect of no tape compared to Kinesiotape, Leukotape, and placebo tape on the resultant ground reaction forces (GRF) of the knee in a sit to stand, full squat, and vertical jumping task in normal healthy individuals.

METHODS: The design of this pilot study was a one group pre-test post-test design. Participants included 10 normal healthy individuals (Table 1).

Table 1. Participant Characteristics

Age (years)	M=24.1, SD=7.1
Height (cm)	M=176.1, SD=12.2
Weight (kg)	M=72.8, SD=15.8
Gender	6 males; 4 females

After ethical approval was obtained from the academic institution and participants provided informed consent, each individual completed four testing sessions under different taping conditions. The different taping conditions included a baseline test session without the application of any tape followed by randomly ordered taping techniques applied to the patellofemoral joint. The colour of the tape was also controlled for as each tape utilized a beige coloured tape. The application of the McConnell medial glide and tilt technique using Leukotape, a patellar corrective procedure using Kinesiotape, and a placebo technique using zinc oxide tape applied to the anterior aspect of the patella without the application of any tension and/or compression was used (Figure 1-A). Participants wore the tape for 5 minutes to allow them to become accustomed to the sensation of having it on. For the Leukotape procedure, one end of the beige coloured Leukotape was secured to the lateral border of the patella. A medial glide and tilt was then applied to the patella while maintaining tension in the tape. The Leukotape was then firmly anchored to the medial aspect of the knee and soft tissue insuring that the medial tissue was lifted and folds were present in the tape. The folds in the tape allowed for expansion and lengthening of the Leukotape (Figure 1-B). Again, the tape was worn for 5 minutes prior to the commencement of further testing. For the Kinesiotape technique, a patellar correction procedure was used with two pieces of beige coloured Kinesiotape (Figure 1-C). The length of the first piece of Kinesiotape extended from the medial condyle of the femur diagonally over the patella up to the lateral margin of the patella. For the second piece of Kinesiotape, the tape was anchored to the medial aspect of the knee beginning over the pes anserine region and firmly anchored to the lateral margin of the patella with maximum tension. The tape was again worn for 5 minutes prior to data collection and further testing. After becoming accustomed to the tape, participants were asked to complete 3 trials of a sit to stand, full squatting, and maximal vertical jumping task; 1 minute of rest for recovery was allowed between trials.

Figure 1. Placebo taping (A); Leukotape (B); and Kinesiotape (C) techniques.

Mean resultant GRF (Newtons) was computed using measures obtained from an AMTI force platform for the three trials of the sit to stand, squat, and vertical jumping task. The external GRF was used because the spatial relationship relative to the location of the primary joint is helpful in understanding the pathomechanics of a given patient and may have implications in understanding what taping technique and direction of application of the tape might be used to stabilize the joint during ambulation or the completion of a sport specific or functional task. Descriptive statistics were used to compare the mean and standard deviations for mean GRF with and without tape. Two independent variables (functional task and type of tape) and one dependent variable (resultant GRF) were examined. Two-way factorial ANOVAs were used to examine the effect of the different types of tape on mean resultant GRF in relation to the type of tape applied (no tape, Leukotape, Kinesiotape, placebo) and the functional task performed (sit to stand, vertical jumping, squatting). The data were analyzed with rejection criteria set at $p < 0.05$.

RESULTS: There was no statistically significant interaction effect on resultant GRF by type of tape and functional task ($F(6, 108)=.003$, $p=1.0$) and in main effects for resultant GRF by type of tape $F(3, 116)=.003$, $p=1.0$). There was a significant main effect for resultant GRF by functional task ($F(2, 117)=145$, $p=.0005$). Post-hoc analysis revealed that the sit to stand

resultant GRF were significantly lower than the squat or vertical jumping task. As highlighted in Table 2 and illustrated in Figure 2, the highest GRF for the sit to stand task was with the application of placebo tape (M=270.8; SD=87.0 N); for the vertical jumping task with the application of Kinesiotape (M=713.5; SD=159.0 N); and for the squatting task with the application of Leukotape (M=715.4; SD=159.0).

Table 2. Mean Resultant Vertical Ground Reaction Force (Newtons) ± Standard Deviation by Functional Task and Type of Tape

Type of Tape	Sit Stand	Vertical Jump	Squat
Leukotape	M=267.1, SD=8.7	M=709.7, SD=16.3	M=715.4, SD=15.9
Kinesiotape	M=269.2, SD=9.5	M=713.5, SD=15.9	M=714.9, SD=16.1
Placebo tape	M=270.8, SD=8.2	M=713.0, SD=15.5	M=713.8, SD=15.7
No tape	M=262.6, SD=7.8	M=711.3, SD=16.2	M=706.8, SD=16.8

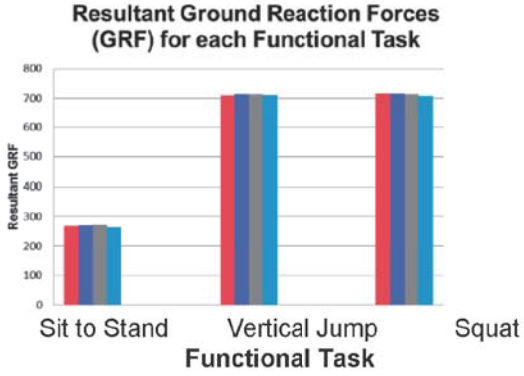

Figure 2. Resultant ground reaction forces for the sit to stand, vertical jumping, and squatting task (- Leukotape; - Kinesiotape; - Placebo Tape; - No Tape).

DISCUSSION: The purpose of this pilot study was to examine the effect of no tape compared to Kinesiotape, Leukotape, and placebo tape on the resultant GRF of the knee in a sit to stand, full squat, and vertical jumping task. The results of this study revealed that the there was no interaction effect between the different types of tape (Leukotape, Kinesiotape, or placebo tape) and type of functional task (sit to stand, vertical jumping, or squatting task) on the resultant GRF; however, there was a main effect in which the type of task did affect resultant GRF (sit to stand lower than the squat or vertical jumping task).

It is has been reported that GRF and loading rates may be important parameters in assessing overuse injuries and overload syndromes of the lower quadrant (De oliveira Silva et al., 2015). It is postulated that the misalignment of the patella results in increased joint compression of the posterolateral aspect of the patellar facets resulting in increased GRF (De oliveira Silva et al., 2015). Over time, the increased compression associated with PFPS may lead to degenerative osteoarthritic changes, decreased physical activity, and the development of other health comorbidities (De oliveira Silva et al., 2015). Although the current study did not find any significant change in GRF with the different types of tape, it may be possible that the use of taping does not change the amount but the distribution and location of forces on the patella creating a wider redistribution of forces across the patella away from contact sensitive regions, thereby, reducing the pain and symptoms associated with PFPS (Dutton, Khadavi, & Fredericson, 2016). The direction in which the tape is applied may assist with not reducing but redistributing the force to alternate locations reducing compression in the knee. These changes may also result in altered moments in the different

planes acting on the patellar surfaces and may result in different findings in a symptomatic and pathological population with knee pain or that has PFPS, also explaining why some of the findings may not have been significant in the current sample used (Schwane et al., 2015). It is has been suggested that examining the loading rates and characteristics of the peaks and valleys noted in the GRF data may be a parameter of interest when analyzing different functional tasks. Future studies should explore these changes and parameters with and without tape in the symptomatic PFPS population during different functional tasks or exercises as this may provide valuable information to the clinician, coach, athlete, or patient recovering from or attempting to prevent overload of the patellofemoral joint (Esculier, Bouyer, & Roy, 2016). The examination of GRF simultaneously with other measures such as video, kinematic, or electromyographic analysis on multiple joints, including changes in the hip or foot, may be beneficial as the altered loading in the knee may be affected by the biomechanical and compensatory changes in other regions. Kinetic and kinematic analysis of the current data set has yet to be completed and may help to further rationalize some of the findings. Also, the future use of a larger sample comparing taping to patellofemoral braces may provide valuable comparisons and insight into the clinical utility and cost effectiveness of different appliances and devices to help clinicians and researchers better understand the clinical and biomechanical effects, or lack thereof, these proposed treatments.

CONCLUSION: There were no statistically significant differences in resultant GRF with the application of different types of tape when completing a sit to stand, vertical jumping, or squatting task. The application of tape resulted in inconsistent increases in GRF with different tapes producing higher GRF depending on the task performed. The effect of tape on GRF may then be task dependent and on what is being performed functionally or for sport. The measure of the resultant (external) GRF may assist the clinician in understanding the pathomechanics associated with various knee disorders. Combining this information in the future with other kinematic and kinetic data may assist with clinical decisions made on the taping technique to use and direction of application of the tape during ambulation or the completion of different sport, occupational, or daily functional tasks.

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