Clinical Biomechanics 31 (2016) 74–78

Contents lists available at ScienceDirect

Clinical Biomechanics

journal homepage: www.elsevier.com/locate/clinbiomech

Patellar taping alters knee kinematics during step descent in individuals with a meniscal injury: An exploratory study

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ARTICLE INFO

Article history:
Received 17 February 2015
Accepted 26 September 2015

Keywords:
Taping
Kinematics
Meniscus
Knee
Physiotherapy

ABSTRACT

Background: Meniscus lesions are common musculoskeletal knee injuries which often lead to pain, limitation and compensations during functional tasks, such as descending stairs. This study investigated the effect of patellar taping with tension and without tension on three-dimensional (3D) kinematics of the knee during a slow step descent task in patients with meniscal lesions.

Methods: Ten patients diagnosed with a meniscal lesion, confirmed by magnetic resonance imaging, underwent five, step descent movements at slow speed under three different conditions: 1) no taping; 2) tension-free taping; and 3) patellar taping with medial tension. 3D kinematic data were recorded from the injured knee using an eight-camera infrared Vicon motion analysis system. Maximum and minimum angle values and total range of motion (maximum/minimum value) in three movement planes during single-limb stance were compared using a repeated measure ANOVA.

Findings: Results showed a significant increase in the maximum and minimum angle value in the sagittal plane (mean differences = 2.4° and 4.2°, respectively) and a decrease in the transverse plane (−6.3° and −2.2°, respectively) for the patellar taping condition compared to the no taping condition. A decreased rotational angle range when comparing the patellar taping to the no taping (−4.1°) and tension-free taping (−3.1°) conditions was also observed. These changes remained significant when pain was considered as a covariate in the analysis. The tension applied to the patellar tape played a role in controlling the sagittal and transverse plane step-down movement among patients in our study.

Interpretation: These results support the use of patellar taping with a medially oriented tension to help to reduce the transversal plane movement of the knee in this population and they bring new light to the taping effect.

1. Introduction

Menisci play essential roles in knee function, namely contributing to joint stability, lubrication, proprioception, shock absorption and load distribution (Bedi et al., 2010; Ghosh and Taylor, 1987; Netravali et al., 2010). Meniscal tears are common, with the majority occurring on the medial side (Metcalf and Barrett, 2004). Axial loading with a combination of flexion and internal rotation of the tibia on the femur seems to be the most common mechanism of injury (Lamontagne, 2008). One of the most common functional complaints among patients with meniscal injuries is difficulty descending stairs (Callaghan et al., 2009). This task requires the knee to control movement dynamics and energy absorption (Novak and Brouwer, 2011). By doing so, the quadriceps create significant stress on the patellofemoral joint. In order to stabilize this joint, medial and lateral retinaculum tightens as the knee goes into flexion (Garth et al., 2011). These structures have expansions attaching to the medial and lateral meniscus, called medial and lateral meniscopatellar ligaments (Fulkerson, 2008; Merican and Amis, 2008). This tension through the retinaculum could stress the meniscal lesion, causing pain and altering normal knee kinematics during a step-down movement. It is thus important to document the effect of rehabilitation treatments in restoring normal knee biomechanics during stair descent.

Patellar taping is a common intervention used by physical therapists (Callaghan and Selfe, 2012). This intervention was initially developed to act on the kinematics of the patella for persons with patellofemoral pain (PFP) (McConnell, 1986). Evidence from imaging studies supports its immediate effect on the position of the patella (Derasari et al., 2010). Other studies have demonstrated the effects of taping on three-dimensional (3D) knee biomechanics during step descent (Selfe et al., 2008, 2011). Selfe et al. found a reduction in the tibial rotation moment in the transverse plane in healthy individuals and a reduction in the range of motion in the frontal plane when taping was used on individuals presenting PFP (Selfe et al., 2008). Moreover, numerous studies have shown that patellar taping can also be effective in reducing pain among individuals presenting PFP or knee osteoarthritis (Warden et al., 2008). These results, combined with the premise that patellar

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http://dx.doi.org/10.1016/j.clinbiomech.2015.09.018
0268-0033/

taping could influence the tension on the meniscopatellar ligaments, suggest that knee kinematic modifications might also be observed in patients with meniscal lesions.

The primary aim of this study was to investigate the effect of patellar taping on 3D knee kinematics of individuals with a medial meniscal lesion during a step descent task. The secondary objective of this study was to document the relationship between kinematics and pain intensity during step descent. Based on the literature, we hypothesized that the use of patellar taping would have a positive effect on kinematics and pain during the stance phase of patients with meniscal lesions. In this context, patellar taping would: 1) increase the flexion/extension range of motion and the maximal flexion angle in the sagittal plane; 2) decrease the valgus/varus range of motion in the frontal plane; and 3) decrease the knee rotation range of motion in the transverse plane. We also hypothesized that pain intensity would decrease in association with the kinematic changes mentioned above.

2. Methods

2.1. Design

A pre-experimental intra-subject design in which each participant acted as their own control was used to compare the effect of three experimental conditions (the independent variable) on knee kinematics (the dependent variable) of patients with meniscal lesions during step decent. These three conditions were: 1) without any intervention; 2) with tension-free taping; and 3) with patellar taping. The order of the second and third condition was inverted between each participant to avoid a potential learning effect. This study was approved by the ethics committee of the *Centre Hospitalier Universitaire de Sherbrooke* (CHUS). The research took place at the *Clinique de Réadaptation Universitaire de l'Estrie*.

2.2. Participants

Ten participants were recruited following diagnosis of a meniscal lesion by an orthopedic surgeon. Patients aged 18 to 65 years had to have an magnetic resonance imaging (MRI) confirmed medial meniscal lesion to participate in the study. Patients presenting concomitant lesions revealed by MRI, such as osteoarthritis (>2 on the Kellgren–Lawrence scale) or other ligamentous or cartilaginous lesions were excluded. Individuals with impaired balance, neurological disorders, lower limb pain (other than knee pain), a history of lower limb injury, lower limb skin lesion or any other condition that could affect knee kinematics during a step-down task were also excluded. There was no restriction with regard to the type, degree or duration of the meniscal lesion.

2.3. Procedure

All participants were asked to descend a 20 cm custom-made step barefoot at a slow velocity, controlled by verbal feedback given by an evaluator. The knee with the meniscal lesion was used as the weight-bearing leg, while the non-injured leg was used for landing. The step descent was practiced before each condition to ensure that the task lasted 3 s, plus or minus 0.5 s. Once the correct speed was achieved consistently, five repetitions were performed for each condition. Participants were asked to look at a target while stepping down to control for visual proprioceptive feedback. A five minute break was allowed between each condition. Participants walked for one minute to allow for normalization of the proprioception. Baseline kinematics, namely the no intervention condition, were first recorded during the step descent task without any taping applied to the injured knee. The tension-free taping was then applied after shaving of the skin (if necessary). This 5 cm wide, non-rigid tape (Hypafix™) was applied horizontally across the patella of the injured knee (flexed at 30°) using a strip of tape measuring half of the knee's circumference. In the patellar taping condition, another strip of rigid tape (measuring 3.8 cm in width; Leukotape P™) was placed over the first strip, using firm tension and manual unloading of the soft tissues medial to the patella (See Fig. 1). Wrinkling of the skin on the medial side of the knee was the indicator for proper tension of the tape between each patient. This taping technique is consistent with the medial glide component of the original description of patellar taping done by Jenny McConnell (McConnell, 1986).

2.4. Data collection

Three-dimensional (3D) kinematic data were recorded at 100 Hz using an eight-camera Vicon™ system and Nexus™ software (v. 1.5.2). Sixteen reflective markers, measuring 1 cm in diameter, were placed bilaterally on the following body segments: anterior and posterior superior iliac spine, lateral thigh, lateral knee epicondyle, lateral shank, lateral malleolus, Achilles tendon insertion and the head of the 2nd metatarsal. The automatic segment definition and movement axis were first obtained during calibration recordings using anthropometric data and the lower body plug-in-gait Knee Alignment Device™ (KAD) pipeline. The KAD was used during calibration measurements to optimize the knee axis definition. For this study, only kinematic data for the weight-bearing leg, namely stance phase data, was considered. Initiation of the vertical movement of the toe marker on the non-injured landing leg denoted the beginning of the single-leg stance phase; the end of the vertical movement for this same marker indicated the end of the single-leg stance phase. Data were normalized from 1 to 100% of the stance phase. The following knee kinematic parameters were extracted from the raw kinematic data using a custom-made algorithm with a custom Matlab™ program: maximum and minimum angle values for the sagittal, frontal and transverse planes, and range of motion (maximum/minimum value). The data was not filtered since no differences were observed between the raw data and the data filtered with a two-way Butterworth filter applied to some data samples. Pain intensity data was collected for each trial using a visual analog scale.

2.5. Data analysis

Descriptive statistics (mean and standard deviation) were used to characterize the patient samples. Percentages were also used to estimate the relative effect of the conditions on the dependent variable. A repeated measure ANOVA comparing the three experimental conditions was performed along with a post-hoc pairwise *t*-test comparison for the nine parameters described, the single-leg stance time and the pain intensity. This analysis was performed using SAS 9.2 software with the significance level set at $P = 0.05$.

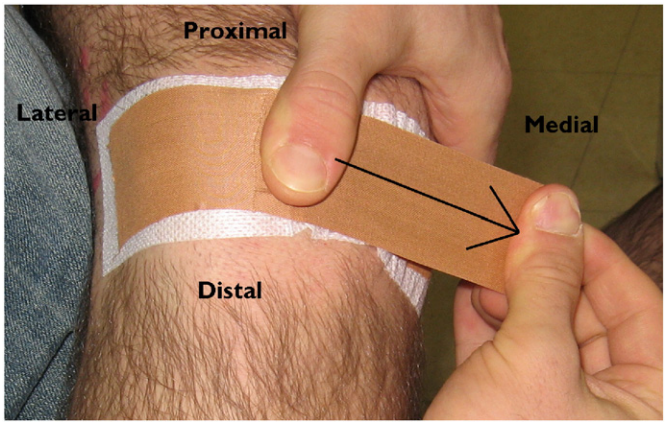

Fig. 1. Illustration of the tension manually applied to the patellar taping. Note that the white tape had to have wrinkles to ensure sufficient tension with the tape and that the soft tissues medial to the patella were manually pulled anteriorly when applying the tape.