EFFECTS OF PATELLAR TENDON STRAP ON ELECTROMYOGRAPHIC ACTIVITY OF QUADRICEPS MUSCLES DURING DROP LANDING

Burkay Utku[1,2], Arif Mithat Amca[2] and Serdar Arıtan[2]

Department of Sports Medicine, Atatürk Education and Resarch Hospital, Ankara, Turkey[1]
Biomechanics Research Group, Department of Exercise and Sport Sciences, Hacettepe University, Ankara, Turkey[2]

The purpose of this study was to clarify how patellar tendon strap affects on electromyographic activity of quadriceps muscles during drop landing. Four healthy male athlete participants made three drop landings with/without strap and acceptable landing trials were analysed. There was a marginal delay for vastus lateralis onset timing for strapping condition and this may be one of the main contributions of strapping for decreasing knee pain during athletic activities.

KEY WORDS: Patellar tendon strap, electromyography, knee pain

INTRODUCTION: Anterior knee pain is a common clinical term used for describing knee pain deriving from retro/peripatellar area, patella and its insertions. Pain can restrain athletic performance during running, jumping and kicking type of activities. The maltracking of the patella being caused by quadriceps muscle imbalances is one of the main etiology of anterior knee pain. The delay between vastus medialis (VM) and vastus lateralis (VL) muscle onset timing causes abnormal lateral tracking of the patella and further activity related pain (Mostamand, Bader & Hudson, 2011). Patellar tendinopathy (jumper's knee) is also another main etiology of anterior knee pain. It is a chronic, painful injury of patellar tendon and appears in consequence of repetitive jumping activities (de Vries et al, 2016). Lian et al. (2005) showed that elite basketball and volleyball players are subjected to patellar tendinopathy with a prevalence of 32% and 45%. This activity related overuse injury can even lead to end up athlete's sports carrier.

Patellar tendon (PT) strap is one of the easy usage material especially recommended for anterior knee pain. It is a soft knee support band which is applied on the soft tissue between kneecap and tibial tubercule. Bohnsack et al. (2008) defined the benefits of the knee strap as decreasing infrapatellar tissue pressure, patellofemoral contact area, patellofemoral contact pressure which relieves anterior knee pain. In a cadaveric study, patellar tendon strain is found to increase during knee flexion and tendon loading which is present through functional knee exercises (Lavagnino M. et al, 2008), however PT strap decreased patellar tendon strain by decreasing patellar tendon length and increasing patella-patellar tendon angle (Lavagnino M. at al, 2011). Whether PT strap decreases anterior knee pain by affecting on quadriceps muscle electromyographic activities throughout functional exercises is still unclear. During body weight squat, defined as a low stress activity on quadriceps muscle, knee strapping improved VL onset time compared with no strapping (Straub & Cipriani, 2012) but how the electromyographic activity would change during activities which need high motor unit recruitment is not obvious yet. Therefore, this preliminary study is intended for understanding the effect of PT strap on quadriceps muscle imbalances at the time of landing.

METHODS: This study was approved by the local human ethical committee. Four healthy male athletes participated to the study. Participants were questioned if they had any previous knee surgery, major trauma, recent knee pain during activities or pain reliever medication usage for knee pain as an exclusion criteria. Participants' height, weight and anthropometric data were measured.

Surface EMG electrodes were placed over the area of greatest muscle bulk of vastus medialis(VM), rectus femoris(RF) and vastus lateralis(VL) muscles of right knee. Five reflective markers were attached to heel, toe, ankle, knee and hip to determine the start and finish of the movement and to analyse the kinematics of the movement. Maximum EMG data and also EMG data during fall activity were collected with pre-amplified(1k), single differential EMG electrodes at 1000 Hz(DE-2.1, Delsys Inc., Boston, MA). The trials were captured at 500 Hz(PhotronSA3 Camera, Japan).

Participants first performed a 5 seconds maximum isometric voluntary contraction (MVIC) and the mean amplitude of the highest signal portion with 500 ms duration was used for normalization of the EMG activity. Participants then performed a 5 minutes warm-up session on a stationary cycling. The PT strap(Mueller®, Wisconsin, United States) was placed between the kneecap and tibial tubercule as tight with no discomfort. A 50 centimeter height platform was used for drop landing activity. Three landings without strap and three landings with strap were performed. Ten acceptable landing for each condition were assessed. Collected EMG raw data were analysed with Matlab R2014a (Mathworks, Inc., Natick, MA, USA) custom written programme. Raw EMG signals of each muscle were first corrected for signal drift by subtracting a baseline trial. The adjusted data were then band-pass filtered using a 4th order zero-phase Butterworth filter with cut-off frequencies of 10 and 250 Hz. Root-mean-square (t = 50 ms) was then calculated with the processed EMG data. The kinematic data were also low pass-filtered at 50 Hz (sixth-order Butterworth filter).

The kinematic data were evaluated for defining the time of toe touch of floor and it was accepted as ground contact. The EMG pikes lasting at least 50 miliseconds for separately each muscle during ground contact were chosen and the mean of maximal EMG amplitudes during landing were calculated. The onset of quadriceps muscles for maximal EMG activity was defined as the time when the EMG signal exceeded the mean maximal EMG amplitude of quadriceps muscles. The time difference between ground contact and the onset of the muscle was accepted as the delay of the muscle. This delay and the maximal EMG amplitudes were compared with Wilcoxon signed rank test for each muscles. All statistical analyses were performed using IBM SPSS software (Version 21.0, IBM, Inc., Armonk, NY).

RESULTS: The mean maximal EMG amplitudes for each muscles did not significantly change at the time of landing by using strap. There wasn't also a significant improvement for VM-VL onset timing difference, however the VL onset marginally delayed (p= 0.12) with strapping condition during landing (Figure 1).

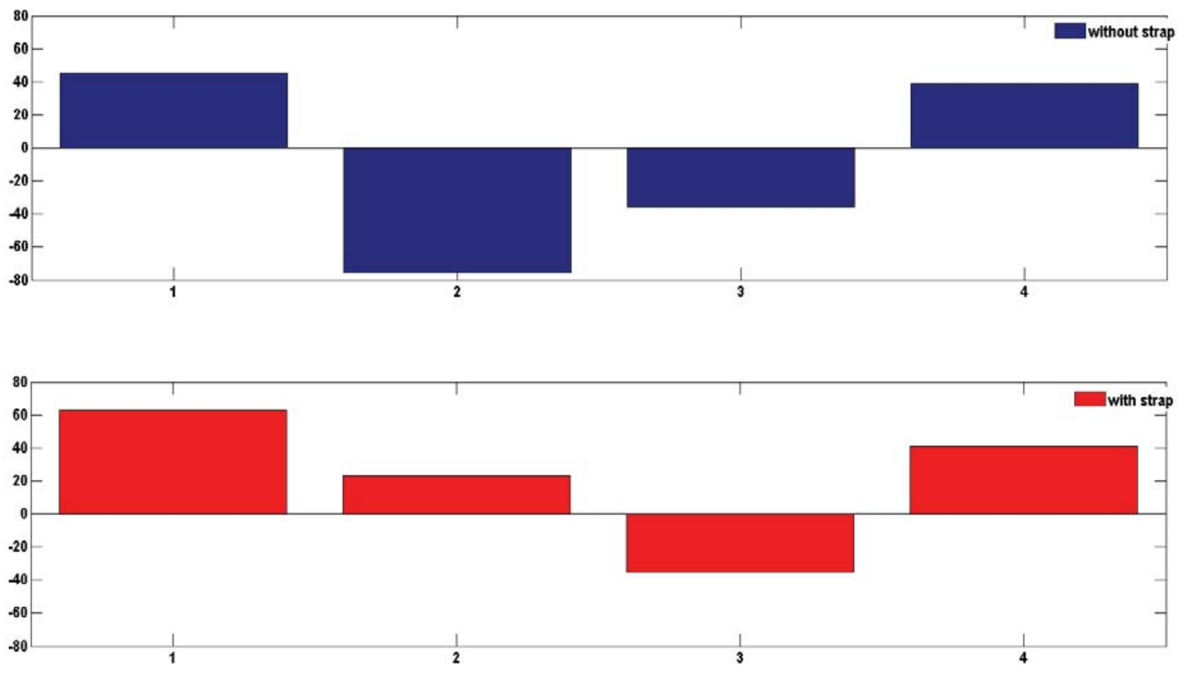

Figure 1. The Vastus lateralis maximum peak onset difference from the time of landing for four participants. Negative values mean VL peak contraction comes earlier than the ground contact (p=0.12).

DISCUSSION: In a recent study by Rosen et al. (2016), the healthy participants and participants with patellar tendinopathy performed drop jumps with/without PT strap. The EMG amplitude was lesser at the pre-landing time and it increased after landing during jumping. They found that strapping decreases pre-landing VL activation significantly. As the EMG amplitude increases during jumping, the electromyographic suppressor effect of PT strap was not clear in the discussed study. Also, in our study, there wasn't any suppression of maximal EMG amplitude for any quadriceps muscle at the time of landing.

Straub and Cipriani (2012) found that strapping condition does not improve VM-VL onset timing difference during the body-weight squat, however a significant delayed VL onset for infrapatellar strapping condition when compared with no strapping was found. In addition, a marginal delay for VL muscle for strapping condition, which was not valid for VM-VL delay onset timing difference, was noticed. This muscle delay may also improve the maltracking during quadriceps contraction and may diminish knee pain.

The study has some limitations. First, the number of participants were less. Also, they were healthy participant with no knee pain during trials. Therefore, the healthy participants' data were assessed to estimate how strap alleviates pain.

CONCLUSION: PT strap is known to alleviate pain during athletic activities. The marginal delay of VL during strapping condition may help improving the maltracking of the patella and may be one of the logical explanations how PT strap decreases pain.

REFERENCES:

Mostamand, J., Bader, D.L., Hudson, Z. (2011). The effect of patellar taping on EMG activity of vasti muscles during squatting in individuals with patellofemoral pain syndrome. *Journal of Sports Sciences*, 29, 197-205.

De Vries A., Zwerver J., Diercks R. et al. (2016). Effect of patellar strap and sports tape on pain in patellar tendinopathy: A randomized controlled trial. *Scandinavian Journal of Medicine and Science in Sports,* 26, 1217-24.

Lian O.B., Engebretsen L., Bahr R. (2005). Prevalance of jumper's knee among elite athletes from different sports : a cross-sectional study. *The American Journal of Sports Medicine,* 33, 561-7.

Bohnsack M., Halcour A., Klages P. et al. (2008). The influence of patellar bracing on patellar and knee load-distribution and kinematics: an experimental cadaver study. *Knee surgery, sports traumatology, arthroscopy : official journal of the ESSKA,* 16, 135-41.

Lavagnino M., Arnoczky S.P., Elvin N. et al. (2008). Patellar tendon strain is increased at the site of jumper's knee lesion during knee flexion and tendon loading: results and cadaveric testing of a computational model. *The American Journal of Sports Medicine,* 36, 2110-8.

Lavagnino M., Arnoczky S.P, Dodds J. et al. (2011). Infrapatellar straps decrease patellar tendon strain at the site of the jumper's knee lesion: A computational analysis based on radiographic measurements. *Sports Health*, 3, 296-302.

Rosen, A.B., Ko, J., Simpson, K.J. et al. (2016) Patellar tendon straps decrease pre-landing quadriceps activation in males with patellar tendinopathy. *Physical Therapy in Sport*, 24, 13-19.

Straub, R,K., Cipriani, D.J. (2012). Influence of infrapatellar and suprapatellar straps on quadriceps muscle activity and onset timing during the body-weight squat. *Journal of Strength and Conditioning Research*, 26, 1827-37.