

# CAN LOWER LIMB SYMMETRY DURING THE LANDING PHASE OF A STOP-JUMP BE ASSUMED?

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## INTRODUCTION

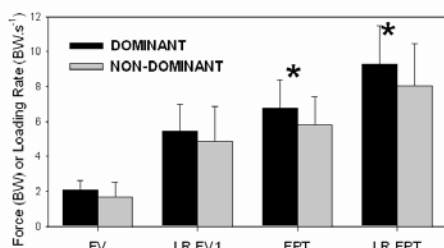
Lower limb symmetry is often assumed in research investigating the biomechanics lower limb tasks [1,2]. However, limb dominance and the high incidence of unilateral lower limb injuries bring this assumption into question [2]. Furthermore, the aetiology of unilateral and bilateral lower limb injuries, such as patellar tendinopathy, are thought to differ [3] and exist as distinct entities necessitating separate treatment [4]. Given the paucity of research in this field, this study aimed to investigate between-limb differences in patellar tendon loading during dynamic landing task to determine whether the assumption of lower limb symmetry during was valid.

## METHODS

Sixteen healthy male athletes performed 5 successful trials of a stop-jump movement that included both a horizontal and vertical landing phase. During each trial, the subjects' ground reaction forces (1000 Hz), three-dimensional kinematics (100 Hz), and electromyographic activity (1000 Hz) of seven lower limb muscles were recorded for both lower limbs. Each participant's dominant landing limb was determined by asking the subject to kick a ball. The patellar tendon forces (FPT) were analyzed using Visual 3D software (C-Motion, USA). Paired *t*-tests were used to detect significant differences between the subject's dominant and non-dominant lower limb ( $P < 0.05$ ).

## RESULTS AND DISCUSSION

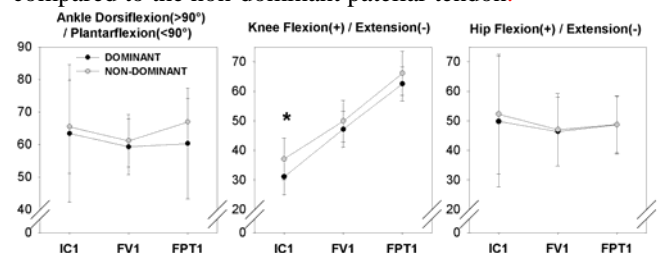
During the horizontal landing, subjects demonstrated significantly higher FPT and FPT loading rate (Figure 1), and less knee flexion at initial foot-ground contact (IC) (Figure 2) for the dominant compared to the non-dominant lower limb.



**Figure 1:** Means ( $\pm$  SD) of the forces (normalized to body weight) generated during the stop-jump. FV = peak vertical ground reaction force; LR FV = FV loading rate; FPT = peak patellar tendon force; LR FPT = FPT loading rate.

Excessive repetitive loading is thought to be the major extrinsic risk factor associated in patellar tendinopathy [5]. The dominant lower limb displayed significantly higher peak FPT and FPT loading rate, suggesting that the subjects were less efficient in dissipating the patellar tendon loads

and, consequently, had a greater potential risk of overloading the patellar tendon compared to the non-dominant lower limb. This may potentially explain the unilateral development of patellar tendinopathy as a result of higher patellar tendon loads sustained by the dominant compared to the non-dominant patellar tendon.



**Figure 2:** Means ( $\pm$  SD) of joint angles displayed at initial foot-ground contact (IC), at FV and at FPT during the landing phase of a stop-jump.

A “stiffer” landing strategy characterized by landing with relatively extended knee joints, which are then forced into greater knee flexion, has been previously associated with an increase risk of developing patellar tendinopathy [6]. Although the dominant lower limb may have been described as displaying a “stiffer” landing strategy by landing in significantly more knee extension, there were no differences in knee joint flexion at peak FPT, indicating that the dominant lower limb was not forced into greater knee flexion and did not utilize a stiffer landing strategy.

## CONCLUSIONS

Healthy athletes were found to sustain higher patellar tendon force during the landing phase of a stop-jump movement in their dominant compared to their non-dominant lower limb. This asymmetry in landing mechanics may assist in explaining the development of unilateral overuse injuries such as patellar tendinopathy. The presence of this asymmetry during the landing phase of a stop-jump movement questions the assumption of lower limb symmetry in studies investigating patellar tendon loading in relation to lower limb landing mechanics.

## ACKNOWLEDGEMENTS

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## REFERENCES

1. Sadeghi H, et al. *Gait Posture*. **12**:34-45, 2000.
2. Schot PK, et al. *Med Sci Sports Exerc*. **26**:1153-1159, 1994.
3. Gaida JE, et al. *Br J Sports Med*. **38**:581-585, 2004.
4. Crossley KM, et al. *J Orthop Res*. **25**:1164-1175, 2007.
5. Cook JL, et al. *Scand J Med Sci Sports*. **10**:216-220, 2000.
6. Richards DP, et al. *Am J Sports Med*. **24**:676-683, 1996.