# HIP ADDUCTOR MUSCLE STRESS DURING SHORT PASSING IN SOCCER

[1]**Filip G Lysdal**, [1]Kristian R L Mortensen, [2]Thomas Dupré, [2]Johannes Funken, [2]Ralf Müller, [3]Jan Mayer, [2]Hartmut Krahl, [1]Uwe G Kersting and [2]Wolfgang Potthast
[1]Department of Health Science and Technology, Aalborg University, Denmark
[2]Institute of Biomechanics and Orthopaedics, German Sport University Cologne, Germany
[3]Turn- und Sportgemeinschaft Hoffenheim 1899 e.V., Zuzenhausen, Badem-Württemberg, Germany
Corresponding author email: fgly@hst.aau.dk

## INTRODUCTION

Muscle injuries are the most common injury in professional soccer accounting for up to 37% of all time-loss injuries [1,2]. The hip adductors are the second-most injured muscle group in soccer constituting up to 35% of all muscle injuries. A larger proportion of groin injuries may however be adductor related [2]. Musculoskeletal modeling may offer a valuable tool for quantifying muscle loading.
The objective of the study was to model the muscle stress in adductor longus due to a perceived high eccentric loading during the swing phase of a kick [3] and gracilis due to the highest stress presented in a pilot study [4].

## METHODS

Seventy-three elite male soccer players (age = 15.6 ± 3.7 years, height = 170.4 ± 13.0 cm, mass = 61.6 ± 14.7 kg) participated in the study that took place inside the Footbonaut™ at the training facilities of TSG 1899 Hoffenheim (Zuzenhausen, Badem-Württemberg, Germany). The Footbonaut™ is a soccer specific training device consisting of a 14×14 m playing field surrounded by eight ball machines and 64 ball receivers. The Footbonaut™ can pass balls from four different directions and vary the passes in terms of speed, angle and spin. Subsequently the player has to pass the ball into one of the 64 targets surrounding the playing field. All ball machines and targets have a dimension of 1.3×1.3 m and are equipped with photoelectric sensors to register whenever a ball is dispensed or received.

Each subject received a total of 32 footballs at ground level with a speed of 40 km/h. The subjects were instructed to pass the ball using the inside of the foot. The dispensing of footballs and subsequent targets followed the same sequence to standardize the protocol for all participating subjects in the present study.

A 3D motion capture system composed of 16 high-speed infrared cameras (Vicon MX-F40, Vicon Motion Systems Ltd., Oxford, Great Britain) was used to capture kinematic data from 61 retro-reflective markers. The kinematic data were low-pass filtered using a 4$^{th}$ order Butterworth-filter with a cut-off frequency of 12.5 Hz.

Ten random passes from the subjects' dominant legs were chosen for further analysis [2]. Joint angles, joint moments and muscle forces were computed using the AnyBody Modeling System (Version 6.0, AnyBody Technology, Aalborg, Denmark). Inverse dynamics simulations were conducted using the Anatomical Landmark Scaled Model [5], a rigid-body musculoskeletal model that is individually scaled to the anthropometrics of each subject. The simulations were time normalized using MatLab 2015b (MathWorks Inc., Natick, Massachusetts, USA) and analyzed between toe-off and ball contact.

Muscle forces were normalized to body mass to account for the anthropometric differences between subjects. The respective physiological cross-sectional areas [6] were used to calculate muscle stress.

## RESULTS AND DISCUSSION

Comparing the computed joint angles and moments, it became evident that the maximum joint moments occur during an eccentric contraction, with the hip abduction angle peaking at 73% of the swing phase.

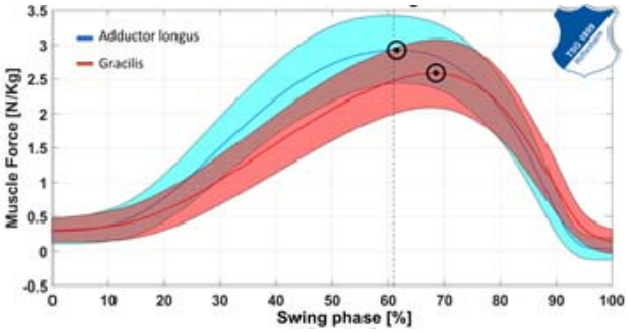


**Figure 1**: Muscle force during the swing phase [N/kg]. (The vertical dashed line indicates maximum hip extension).

Maximum muscle force in the adductor longus occurred at 61.5% of the swing phase (Figure 1) with a maximum stress of 2.1 kPa/kg (± 0.32). Maximum muscle force in the gracilis occurred at 68.0% of the swing phase with a maximum stress of 5.72 kPa/kg (± 0.97).

## CONCLUSIONS

The nature of short passing places the hip adductors under great stress during the eccentric phase of the kick. The presented stress in gracilis is more than 2.5 times greater than in adductor longus and might also play an important role in groin related injuries and pain to the pubic bone.
This high eccentric stresses combined with the repetitive nature of passing in soccer might explain the high incidence of groin related pain and injuries.

## REFERENCES

1. Hägglund M, et al. *The American Journal of Sports Medicine*, **41.2**: 327-335, 2013.
2. Hölmich P, et al. *British Journal of Sports Medicine*, **48**: 1245-1250, 2014.
3. Charnock BL, et al. *Sports Biomechanics*. **8.3**: 223-234, 2009.
4. Lysdal FG, et al. Proceedings of International Congress of Sciences and Football, Valenciennes, France, Proceeding 138, 2016.
5. Lund ME, et al. *International Biomechanics*. **2**: 1-11, 2015.
6. Klein Horsman MD, et al. *Clinical Biomechanics*, **22**: 239-247, 2007.