

# ACL-RECONSTRUCTION IMPROVES ASYMMETRICAL PLANTAR PRESSURE DISTRIBUTION DURING WALKING AND RUNNING

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## INTRODUCTION

Anterior cruciate ligament (ACL) deficiency increases tibiofemoral laxity, which may result in functional knee instability and dysfunction [1]. The most widely accepted method for assessing joint movement patterns in ACL deficiency (ACLD) is clinical gait analysis [2]. However, the substantial effort necessary for this method has prevented its widespread clinical application. Alternatively, dynamic plantar pressure distribution measurements have been shown equally sensitive to quantify specific biomechanical loading characteristics and deficiencies of the lower extremities [3,4]. As such we aimed to assess whether high sampling frequency dynamic pedography can be used to detect functional improvements in knee stability following ACL reconstruction in symptomatic ACLD patients.

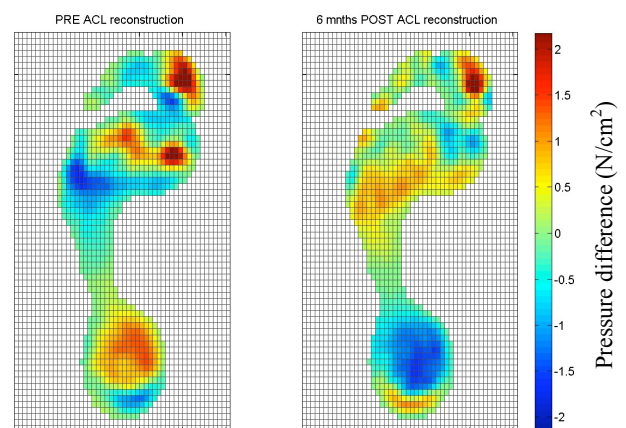
## METHODS

In a prospective case-control study, pre- and post operative asymmetries in plantar pressure dynamics during 3 consecutive walking and running trials were assessed in 9 male and 3 female patients (29±6yr) with unilateral and symptomatic ACLD using a 2m footscan® system (RSscan International, 2x0.4m, 16384 sensors, 125-500 Hz). In all patients a standardized arthroscopically guided single bundle ACL reconstruction (ACLR) was performed using an autologous quadruple hamstring graft. Following a 6 months protocolized rehabilitation program, all subjects were free of knee joint effusion and functional instability and were asked to walk and run with the same speed over a footscan® pressure plate. Asymmetries in plantar pressure dynamics between the ACLD and sound limb were assessed using an operator independent algorithm that normalizes plantar pressure data for foot size and foot progression angle [5]. In addition, plantar pressure was normalized for total pressure. Primary outcome measure was change in average pressure distribution asymmetry (aPDA) using a novel sensor-by-sensor subtraction method. aPDA represents the mean difference in pressure underneath the ACLD and sound foot.

## RESULTS AND DISCUSSION

Before ACLR all subjects showed typical asymmetrical subtraction patterns in plantar pressure dynamics, indicated by a mean aPDA-value of respectively 1.3±0.4 N/cm<sup>2</sup> and 1.0±0.2 N/cm<sup>2</sup> in walking and running, while stance times (walking: 625±45ms vs 633±43ms; running: 246±19ms vs 252±22ms) were practically identical for respectively ACLD and sound limb. Following 6 months of rehabilitation after ACLR, aPDA values improved in 9 out of 12 patients for walking ( $\Delta$ aPDA\_walking: -0.4±0.5 N/cm<sup>2</sup>, ANOVA, P=0.014) and in 10 out of 12 patients for running ( $\Delta$ aPDA\_running: -0.2±0.2 N/cm<sup>2</sup>, ANOVA, P=0.004). Stance time during walking showed a small, but significant increase of 23±1msec on the sound limb side, whereas average foot progression angle (14±8deg), walking speed (1.5±0.15m/s) and body mass (83±8kg) remained identical.

No statistical differences in gait characteristics were observed on the ACLR-side. In the running trials running speed (3.1±0.3m/s) and stance time of the ACLR (246±62ms) and sound limb (249±62ms) were identical. Running foot progression angle on the sound limb increased from 11±5 to 13±5 deg (P=0.03), but remained identical on the ACLR side (16±5deg vs 16±7deg, P=0.97).



**Figure 1:** Sensor-by-sensor (n=868) distribution of pressure asymmetry between ACLD and sound limb (average of 3 walking trials) before (left panel) and after (right panel) ACL reconstruction and 6 months of rehabilitation. Data are means of 12 patients with unilateral symptomatic ACLD.

Since no important differences in standard walking or running parameters could be detected on either the ACL-reconstructed or sound limb following ACLR, the observed improvement in plantar pressure distribution asymmetry (see also Fig. 1) indicates that ACLR results in a more symmetrical internal loading of the musculoskeletal and myotendinous structures in the lower extremities.

## CONCLUSIONS

Standardized plantar pressure distribution analyses may provide clinicians and/or physical therapists with a more practical method to monitor improvements in functional knee stability following ACLR. However, further research is necessary to develop population reference values to improve our clinical understanding of the individual variation in average pressure distribution asymmetry.

## ACKNOWLEDGEMENTS

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