Evaluation routines of the spatial path of the gait line in walking in healthy subjects and patients with chronic achilles tendinitis

S. Grau¹, W. Baeurle¹, H. Baur¹, A. Hirschmüller¹, A. Gollhofer², H.-H. Dickhuth¹, F. Mayer¹,³
¹ Medical Clinic and Policlinic, Dept. of Sports Medicine, University of Tübingen, Germany
² Institute of Sports Science, Dept. of Biomechanics, University of Freiburg, Germany
³ Clinic of Orthopedic Surgery, University of Tübingen, Germany

Introduction

The roll-over process of the foot during gait is analyzed among other reasons to discover the cause of complaints. Very few researchers tried to study the direct relationship between (running) injuries and biomechanical parameters in general and between achilles tendon pain and biomechanical parameters in specific. Over the years, many authors (CLARKE et al. 1984, NIGG 1987, NIGG et al. 1992, Van Gheluwe et al. 1995, and many others) suggested that achilles tendon pain is caused by different biomechanical quantities: extent and velocity of initial and total pronation, extent and velocity of initial and total rearfoot motion, extent of supination of the push-off angle, magnitude of maximal impact at touch-down, etc. In the past this took place essentially kinematically although the validity and the reliability are often unsatisfactory (Capozzo 1996, Reinschmidt 1997, Stacoff 1998). In contrary, new studies on plantar pressure distribution showed a clearly better reliability compared to kinematic procedures (Baeurle 1999). Nevertheless it remains unclear, which routines in plantar pressure evaluation allow to distinguish reliably between healthy and injured subjects.

Methods

The course of the gait line was determined in 20 complaint-free subjects (male, n=10; female, n=10) and 20 patients with chronic achilles tendon complaints (male, n=20). All subjects were instructed to walk barefoot (4km/h) over a pressure distribution platform (Emed SF, 50 Hz). In order to show possible differences between healthy and injured subjects, the deviation of the gait line (GL) from the foot’s longitudinal axis (FLA) was calculated with the following global [a) + b)] and rearfoot specific [c)] evaluation routines:

a) Sum of the perpendicular distances (zi) of 10 equidistant points along the path of the center of pressure towards the FLA

\[ G = \sum_{i=1}^{10} \sqrt{(z_i)^2} \]

b) Sum of the medial and lateral area (A_{lat}, A_{med}) between FLA and GL, normalized to the squared footlength (FL)

\[ G = \frac{(A_{lat} + A_{med})}{FL^2} \cdot 100 \]

c) Angle between FLA and the straight line through the starting point of GL and the turning point which determines the beginning of push-off.

(a): Calculation of quantity G (version 1) (b): Calculation of quantity G (version 2) (c): Definition of the rearfoot angle of the gait line
Results
All three evaluation routines showed statistically significant differences (p<0.05) between the groups in walking. Routine c), however, showed the most distinct group differences in the 95% confidence interval. The evaluation of the sum of the medial and lateral area between FLA and GL (routine b), didn’t increase the selectivity between healthy and injured subjects (although the complete course of GL was evaluated) compared to routine a) where only distinct points were taken into account.

Discussion
Different evaluation routines to distinguish reliably between healthy and injured subjects in walking could be shown. The global routines a) and b) were found to be less selective than the rearfoot specific routine c). Nevertheless, the rearfoot specific routine doesn’t represent the precise course of GL. Therefore the question arises, whether the selectivity will further increase when the course of GL will be analyzed in a defined rearfoot mask with the described evaluation routine b). In the future it will be of interest to evaluate the running movement, although decreased spatial resolution of pressure sensitive insoles and the shod condition itself might lead to a more difficult evaluation process.

REFERENCES