„Oscillations of the Achilles tendon with modifications in shoe wear “

Autor: Dorian Grenier

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Introduction

An oscillation is a regular fluctuation in value, position or state about an equilibrium or a mean value. In running for instance, the impact force generated upon ground contact causes a shock wave that travels through the soft tissues and skeletal components where they cause oscillations in the wobbling structures of the body. The concept of dampening vibrations is often referred to as muscle tuning (Wakeling et al., 1999). The purpose of this study was to show differences in Oscillations occurring at the Achilles tendon in relation to various shoe modifications at a predetermined speed on a treadmill.

Methods

Oscillations were measured with a triaxial piezo-electric accelerometer (Noraxon USA Inc., Model 317A with a bandwidth of 5Hz – 1,8kHz) mounted on the skin overlaying the Achilles tendon. Three different shoe modifications were employed in order to elicit various changes in the oscillations recorded. 20 male recreationally trained subjects (aged 22.45 / SD +-1.36) were asked to run at a treadmill at 15.1 km/h while measurements were performed.

Figure 1: Fully prepared leg (right).

Data was analyzed by calculating the symmetry index (SI) and the relative asymmetry index (RAI) which are further described in equation 1 and 2, respectively. The SI-values of the norm shoe and configuration 1 are compared to the SI-values of the norm shoe and configuration 2 during each phase of the gait cycle.

$$SI = \frac{Con_x - Con_y}{(Con_x + Con_y)*0.5} * 100\% \quad (1)$$

Con_x is the value of the neutral shoe condition and Con_y is the value of either condition number one or condition number two. These calculations were performed on all three axes of the accelerometer in respect to the different phases of the gait cycle, for both, the proximal and distal accelerometer.

$$RAI = \frac{\bar{U}}{Y} * 100\% \quad (2)$$

$\bar{U}$ is the average difference between the values noted for the neutral shoe condition and config. one or config two and Y is the absolute difference between max and min value. $\bar{U}$ is calculated through equation 3:

$$\bar{U} = \frac{\sum_{i=1}^{i=n} |Con_x - Con_y|}{n} \quad (3)$$

Results

The SI in anterior-posterior direction between config 1 and normshoe as well as between config 2 and normshoe can be seen in figure 2. SI-values far beyond 100 % in all of the axes.

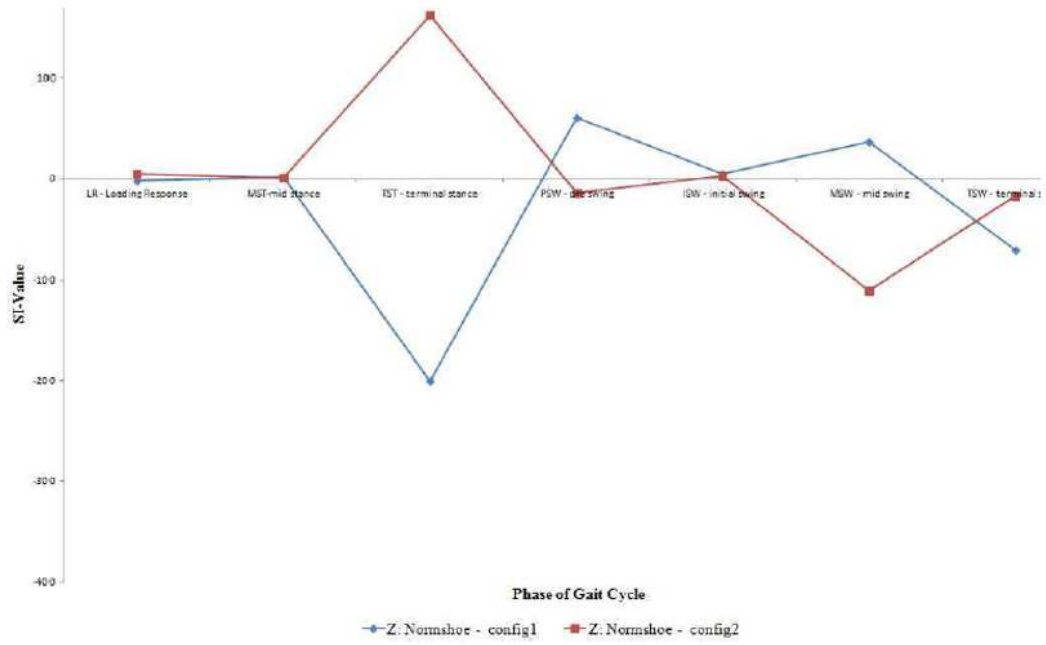

Figure 2: SI between normshoe and config 1 as well as between normshoe and config 2 throughout the stance phase.

Throughout most of the stance phase, the norm shoe - config 2 comparison displays slightly greater levels of relative asymmetry in the X-axis than the norm shoe - config 1 comparison. In medio-lateral direction (Y) of the distal accelerometer, the norm shoe - config 1 comparison yielded higher levels of asymmetry in the mid-stance and terminal stance phase (figure 3).

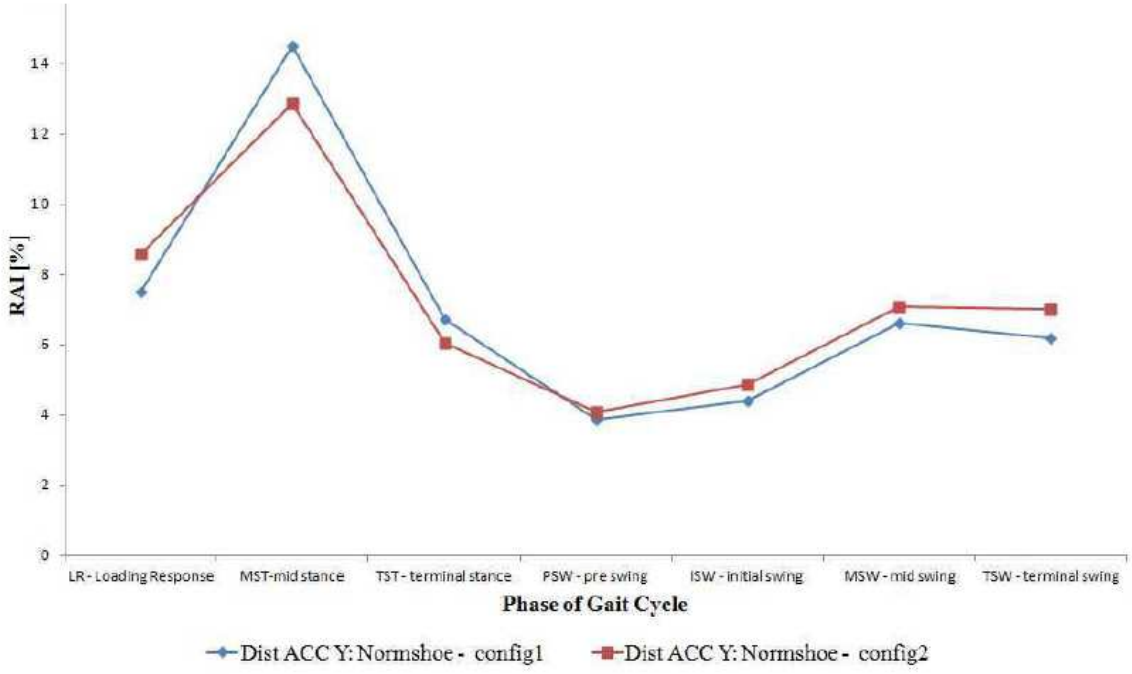

Figure 3: RAI between normshoe and config 1 as well as between normshoe and config 2 throughout the stance phase.

Discussion

When calculating the SI, the algebraic sign is the only parameter that changes if the two values are being switched, so it can instantly be seen which value is bigger. This is one reason the SI was chosen over other methods to calculate levels of symmetry. To exemplify a huge limitation that comes along, when applying Robinsons formula to our data set, a sample calculation is presented below: This is the data point 648 of Subject Number 2, proximal accelerometer, SI between configuration 3 and 1 in medio-lateral direction (Y):

$$\frac{(-1{,}1613 - 1{,}1609)}{(-1{,}1613 + 1{,}1609) * 0{,}5} * 100\% = 1161100\%$$

In a data set where positive and negative values in a range close to zero are compared, results way over 100 % are generated. This will skew the whole set towards one direction and ultimately lead to a falsification of data, when compared to other means of the subject population.