Motion of the Paediatric Foot during Gait: Associations with Obesity

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Introduction

Childhood obesity is associated with altered gait characteristics. Three-dimensional (3D) motion analysis of the lower limbs has revealed that obese children walk with with less hip flexion and more knee valgus implicating structural changes to the lower limb[1]. However, little is understood about the impact of obesity on 3D motion of the paediatric foot. The aim of this study was to examine the associations between foot motion during gait and obesity in 7 to 11 year boys.

Method

Fifty five boys (mean age 9.56 ± 1.13 years, and range 7 – 11 years) were recruited.

Percentage body fat (%BF) was measured by air displacement plethysmography (mean %BF 23.78 ± 9.33%, and range %BF 9.57 - 42.06%) using child specific regression equations.

Three-dimensional foot motion was measured using an 8-camera motion capture system (Vicon Motion Systems Ltd, Oxford, UK). Two force plates (Bertec, Model MIE Ltd, Leeds, UK) recorded ground reaction force to define gait cycle events and phases . Three-dimensional angular motion was tracked for the calcaneus, midfoot, metatarsals and hallux[2]

Principle component analysis was utilised to reduce angular data to components. The relationships between these components and %BF was assessed by multiple regression, accounting for confounding variables. Only foot motion that was significantly (p<0.05) associated with %BF was reported.

Results

Principle component analysis revealed 11 components composed of 3D foot motion data. Of these components 3 were significantly associated with %BF after accounting for confounding variables.

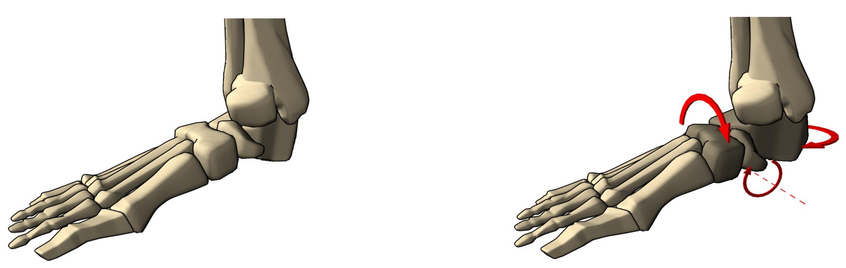

Figure 1. Differences in foot bone motion between participants with lower fat mass (on left) and participants with higher fat mass (on right)

The 3 components (Figure 1) consisted of calcaneus transverse plane, midfoot sagittal plane and midfoot frontal plane motion. Figure 2 shows that boys with greater %BF demonstrated greater external rotation of the calcaneus; midfoot dorsiflexion and eversion.

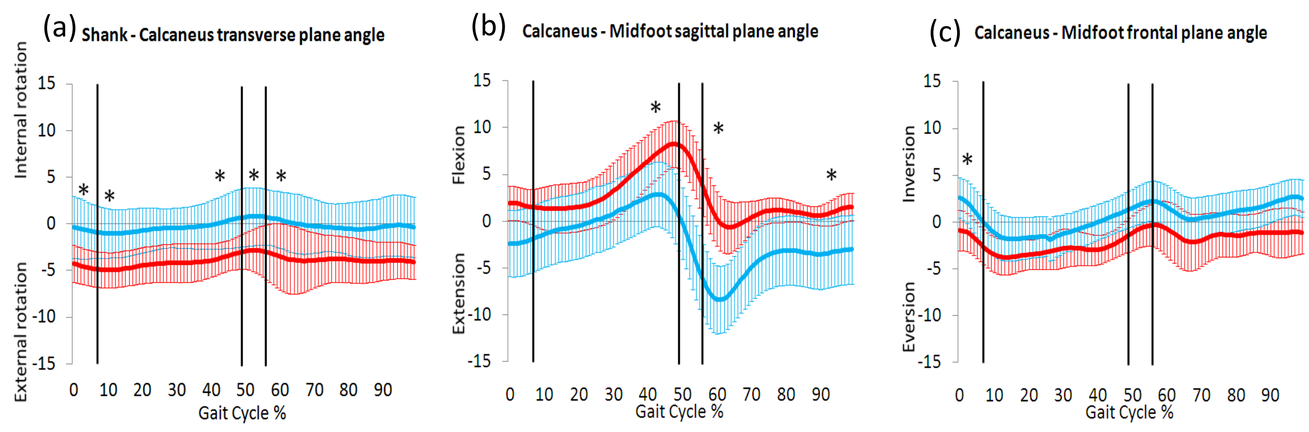

Figure 2. (a) Shank-calcaneal transverse plane motion, (b) calcaneal-midfoot sagittal plane motion and (c) calcaneal-midfoot frontal plane motion. Red line indicates boys with %BF in the top 10%, blue line indicates boys with %BF in the bottom 10% of the study sample. * denotes where in the gait cycle relationships between body fat and foot motion were found

Discussion

Findings from this study support the view that obesity is associated with altered motion of the foot during gait. The motion of the calcaneus and midfoot during the gait cycle (Figure 1) suggests a pronated foot in boys with higher %BF. Excessive pronation of the subtalar joint leads to a flattening of the medial longitudinal arch and a precursor to altered function and pathology in later years. Further work is required to understand the long term impact of altered foot motion during gait associated with childhood obesity.

References

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