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Correlation between plantar pressure and Oxford Foot Model kinematics

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Introduction

Plantar pressure measurement is widely used to assess foot deformity and plan treatment. However, measurement is notoriously variable, and the outcomes of questionable clinical relevance. The aim of this study was to provide an objective, comprehensive and clinically relevant measure of foot deformity by correlating pressure measurement with multi-segment foot model kinematics.

Methods

35 children with hemiplegic cerebral palsy were assessed (19 male, 16 female, age 10.8 ± 3.2 yrs). Each child had 29 markers attached to both legs and the affected foot, according to the Oxford Foot Model (OFM) [1]. Data were collected with a 12 camera Vicon 612 system (Oxford, UK) and a prototype, piezo-resistive pressure plate (Istituto Superiore di Sanita, Rome, Italy) with a spatial resolution of 5 mm [2]. The positions of the markers on the foot were superimposed onto the pressure footprint at a time corresponding to mid-stance. The co-ordinates of each marker were then projected vertically onto the footprint (Figure 1). This provided the means to automatically divide the foot into five sub-sections on the basis of anatomical landmarks, and to correlate pressure findings with the output from the OFM. Peak force and area from each subdivision was correlated with clinically relevant variables from the OFM.

Results

No significant correlation was found between hindfoot varus and the medial/lateral distribution of force at the hindfoot (Table 1). This was presumed to be due reduced ground contact at the heel. There was also only minimal correlation between hindfoot varus and midfoot force and contact area. The force in the midfoot tended to be higher than that of the healthy population, regardless of whether the hindfoot was in varus or valgus. In the case of a varus hindfoot, this was due to weight bearing on the lateral border, while in the valgus hindfoot, it was due to a flattening of the arch. Dividing the midfoot into medial and lateral sections could have shown a more significant

Table 1: Correlation between OFM and pressure plate results

Foot Model	Pressure Plate	Corr
HF Varus	Lat:Med heel force	0.07
HF Varus	Lat:Med heel area	-0.11
HF Varus	Midfoot force	0.29
HF Varus	Midfoot area	0.15
FF supination	Lat:Med FF force	-0.54
FF supination	Lat:Med FF area	-0.48
FF/Tibia supination	Lat:Med FF force	0.41
FF/Tibia supination	Lat:Med FF area	0.43
HF Varus	Lateral FF force	0.64
HF Varus	Lat:Med FF force	0.59
HF dorsiflexion	Heel force	0.30
FF dorsiflexion	FF force	-0.45
FF/Tibia dorsiflex	FF force	-0.63

FF = forefoot, HF = hindfoot, Corr = correlation.

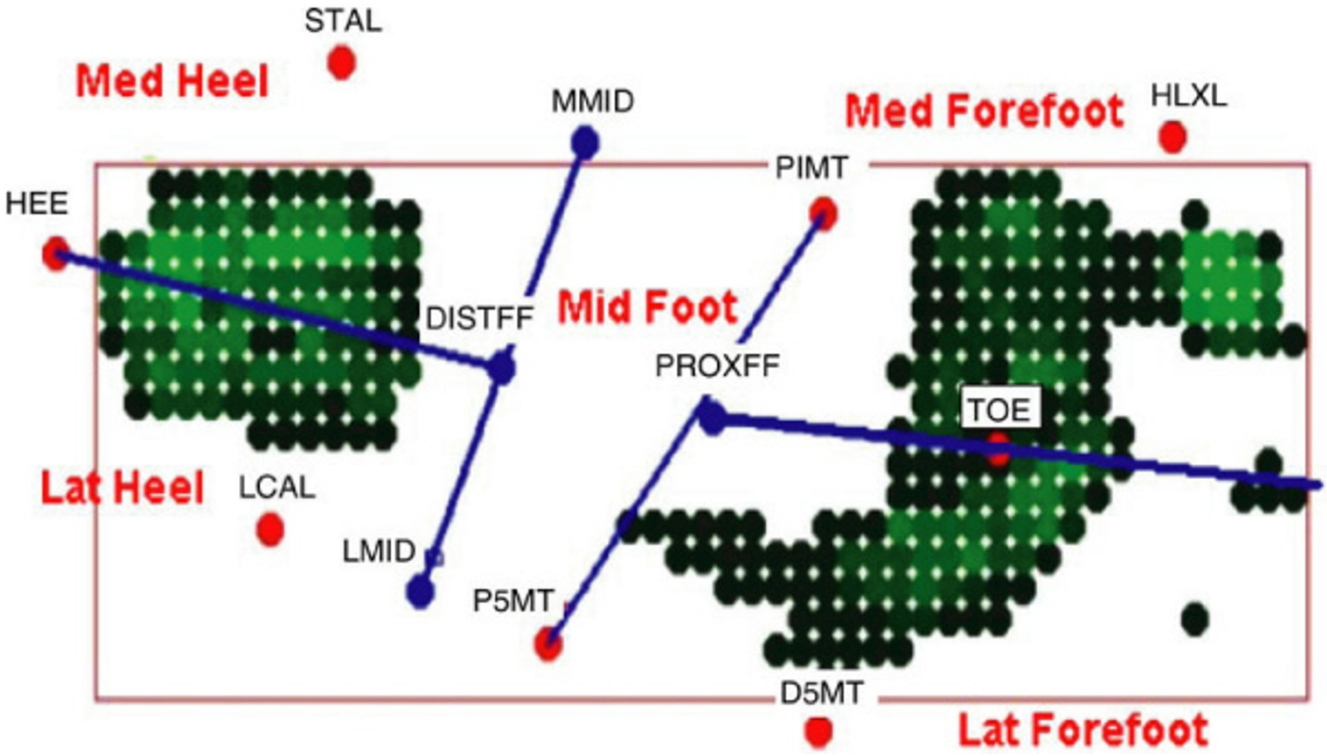

Figure 1
Pressure footprint showing five sub-areas. The labelled circles represent the projected positions of markers on the foot.

correlation. Interestingly, an inverse correlation was found between forefoot supination (in relation to the hindfoot) and lateral force at the forefoot. The direct correlation between hindfoot varus and forefoot lateral loading (0.64) indicates that the hindfoot varus is responsible for increased lateral forefoot loading. Therefore, high loading of the lateral forefoot may not always be attributable to forefoot supination.

A significant correlation was found between increased forefoot dorsiflexion and decreased forefoot force as expected.

Conclusion

Correlating pressure measurements with multi-segment foot angles provides valuable insight into foot pathomechanics.

References

1. Stebbins J, *et al.*: *Gait & Posture* 2006, **23(4):**401-10.
2. Stebbins J, *et al.*: *Gait & Posture* 2005, **22(4):**372-6.