THE CONSTRUCTION OF A NOVEL TRUNK MODELLING METHOD AND THE USE OF DIFFERENT BODY SEGMENT DATA SETS IMPROVES THE PREDICTION OF HUMAN WHOLE BODY CENTRE OF MASS

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Introduction

The importance of correctly indentifying the location of the centre of mass (COM) has both clinical and practical implications (Lenzi, 2003) and is fundamental to gait efficiency and pathology (Gutierrez-Farewik *et al.*, 2006). Reducing the error in the COM measurement is essential. The greatest cause of error in determining the COM location is affected by the modelling of the trunk, being biggest mass proportion. It is hypothesized that a novel approach to trunk modelling may result in a reduction in COM location error by dividing the trunk into thorax and abdomen segments.

Methods

Eight male participants (age 22 ± 4.1 years; BMI 22.7 ± 3.3 kg.m^{-2}) were suspended by a harness within a rigid frame. Retro-reflective markers that make up the conventional marker set with additional markers were positioned on anatomical landmarks and were captured by 12 high speed cameras at 100Hz. All analysis was done in MatLab 7. Planes were established along the sagittal plane for both the thorax and abdomen. The thorax was limited by the vertebrae T10 and C7, xyphoid process and jugular notch. The midpoint of the medial border of the scapulae; inferior angle of scapulae; nipples; and the floating ribs lines defined the outlining shape of the thorax. The limits of the abdomen were defined by the xyphoid process, umbilicus, T10 and the sacrum. The polygon was created using the midpoints of the anterior superior iliac spines and floating ribs. The centre of the trunk was determined based on the proportion of the thoracic area relative to the abdominal area. Uniform density along the two planes was assumed. Segment inertial datasets based on those compiled by Dempster & Gaughran, (1967) and de Leva (1995) were used. The error values of the two kinematic models, using segment data from both living and cadaver populations, were compared to a direct measurement of COM location using suspension and analysed through a two-way ANOVA ($\alpha < 0.05$).

Results

The creation of the novel trunk model reduced the error of the COM location, using the Dempster data set, by 40.45 ± 18.95% and the de Leva data set by 26.30 ± 3.76%. Further analysis showed that 75.83% of the variation ($p<0.0001$) was attributed to the differences between the trunk models and 20.38% of the variation ($p<0.0001$) was attributed to the differences between the segment inertial datasets. No significant correlations were observed between the COM measurement error and the anthropometric variables.

Discussion

The improved accuracy in the COM measurement can be attributed to the novel trunk being more representative. Through the construction of the novel trunk model the predicted whole body COM was improved.

References

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