The effect of distance between anthropometric measures in geometric models of thigh volume

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THE EFFECT OF DISTANCE BETWEEN ANTHROPOMETRIC MEASURES IN GEOMETRIC MODELS ON THIGH VOLUME ESTIMATION.

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INTRODUCTION

Calculating the kinetics of human movement through inverse or forward dynamics requires the use of body segment inertial parameters (BSIP) estimates. As the estimation of BSIPs through direct measurement methods (e.g. water displacement, hydrodensitometry or optoelectronic systems) is often costly or unfeasible, and regression equations are often unsuitable for atypical population groups, BSIP estimates are predominantly calculated using anthropometric data and geometric models (Rossi et al., 2013).

Geometric models partition limbs into multiple segments which are matched to geometric shapes (predominantly truncated cones or discs). The upper and lower girths of each shape are measured and the volume is calculated. The volume of each shape is then summed to estimate the total limb volume. However, the number of segments each limb should be divided into: the distance between anthropometric measures, is inconsistently reported in the literature. Using 3D surface imaging, this study explores the effect of the distance between anthropometric measures in geometric models on thigh volume estimation.

METHODS

Following institutional ethical approval, 3D images of one elite female mountain biker's (age 25 years; stature 179 cm; body mass 70.8 kg) left thigh (defined by the gluteal fold and ????????????????????) were captured using two 3D surface imaging devices: a high precision commercially system (3dMD) and a low cost depth camera based system, developed in-house (the Centre of Sports Engineering Research, Sheffield Hallam University, UK).

Each 3D image was manually digitised by a single researcher within KinAnthroScan - custom software created in-house using the Microsoft Kinect software development kit (Microsoft Corporation, Redmond, USA). Using KinAnthroScan anlysis (base upon Crisco & McGovern, 1998) thigh volume was estimated for each system. The circumference of the thigh (at 2 mm intervals along the long axis of the segment) was exported to use within a series of geometric models. The differences between the volumes estimated by KinAnthroScan and the geometric models were then analysed.

RESULTS

KinAnthroScan estimated total thigh volume to be 0000ml and 0000ml, using 3dMD and depth camera system data respectively Any sig diff?. The geometric models demonstrate statistically significant differences with the thigh volume estimations obtain through 3D surface imaging using KinAnthroScan (Table 1).

Table 1: Total thigh volume (ml) estimated by geometric models and KinAnthroScan (*p-values <0.05 when compared to 3dMD estimation).

Distance between measures (cm)	**Geometric model**		**p-value**
	Truncated cone	Disc	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

DISCUSSION

Interpretation of main findings

The results of this study suggests that using geometric models using truncated cones and discs with distances ?????<or> ??? are not suitable alternative methods to high precision surface imaging devices when estimating thigh volume, within this case study. However, the strong agre

The results of this study demonstrate that, for this case study, geometric models

when compared against a high precision method, within this case study, regardless of the distance between anthropometric measures are not capable of estimating total thigh volume. Comaprison with is not between are not suitablefficiently sensitive to estimatecreate highly simplified representations of the human body that are not comparable to surface imaging system

This study reiterates reiterates the …

As many believe (Durkin & Dowling, 2003). that it appears taking more measures it better - however as the majority of research studies use manual measures, taking these measures this frequently may not be suitable. However, the small difference demonstrated better the depth camera and 3dmd system suggest that taking these measures using a surface imaging device may be feasible as the depth camera device is low cost.

The his depth camera system offers multiple advantages over existing techniques: it

The depth camera system used within this study is highly repeatable but gives systematically greater thigh volumes than the 3dMD system. This suggests poor agreement yet a close relationship, which once corrected can yield a usable thigh volume measurement.

CONCLUSION

When collecting thigh volumes estimates using geometric models, Biomechanist should try and minimise the distance between anthropometric measures – as much as practically possible. However, due to the multiple advantages over existing techniques, Biomechanist should consider the use of depth camera based surface imaging systems for thigh volume estimation.

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METHODS:

Following institutional ethical approval, 3D images of one elite female mountain biker's (age 25 years; stature 179 cm; body mass 70.8 kg) left thigh (proximal and distal ends defined by the digitised ‘upper thigh’ and ‘upper knee circumference’ landmarks, respectively) were captured using two 3D surface imaging devices: a high precision commercially system (3dMD) and a low cost depth camera based system, developed in-house (the Centre of Sports Engineering Research, Sheffield Hallam University, UK). Each 3D image was manually digitised; manual identification of marked landmarks by a single researcher within KinAnthroScan software - custom software created in-house using the Microsoft Kinect software development kit (Microsoft Corporation, Redmond, USA). Using KinAnthroScan, thigh volume was estimated for each system, and the circumference of the thigh (at 2 mm intervals along the long axis of the segment) was exported to use within a series of geometric models. The differences between the volumes estimated by KinAthroScan and the geometric model were then analysed.

RESULTS

Geometric Model			Total Thigh Volume (ml)
Truncated cone model		3dMD data	
	1	3dMD data	
	2 (Jones & Pearson, 1969)	3dMD data	
	4	3dMD data	
	6	3dMD data	
	8	3dMD data	
Disc model Separation of segment in disc xcm tick:		3dMD data	
	0.2	3dMD data	
	0.5	3dMD data	
	1	3dMD data	
	2	3dMD data	
	3	3dMD data	
	4		
	5		
	6		

	7		
	8		
	9		
	10		
Crisco and McGovern, 1998			
	3dMD data		
	Depth Camera data		

DISCUSSION

Interpretation of main findings

Geoemtric models as many measurments as possible. Although this may not be feasiable, due to the long time it takes to take body meausres.

The results of this study demonstrate that, for this case study, geometric models

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