

Estimation of Whole Body Moment of Inertia Using Self-imposed Oscillations

M. Damavandi^{a,b}, P. Allard^a, F. Barbier^c, J. Leboucher^c, C.H. Rivard^a, and N. Farahpour^a

^aLaboratoire d'Étude du Mouvement, Sainte-Justine Hospital, University of Montreal, Montreal, Canada

^bUniversity of Sabzevar Teacher Training, Department of Physical Education, Sabzevar, Iran

^cUniversity of Valenciennes, Le Mont Houy, Valenciennes, France

INTRODUCTION

>Body segment moment of inertia values are required to estimate joint muscle moments during clinical evaluations, sport activities, etc. Most often these values are estimated from anthropometric tables obtained from cadaver populations. They do not represent accurately the adolescent population, obese individuals, elderly people etc.

OBJECTIVES

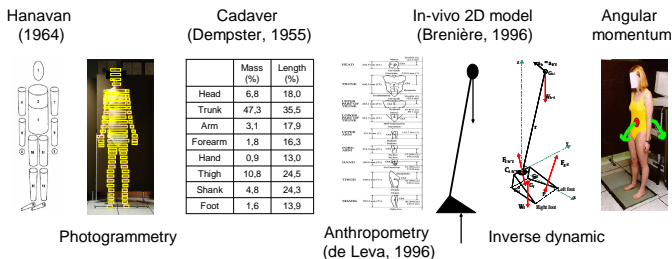
>To estimate the personalized in vivo moment of inertia of the whole body using three-dimensional (3-D) inverse dynamic and angular momentum approaches.

>To compare their results to five other methods routinely used.

METHOD

>Seven male subjects performed 10 three self-imposed oscillations along the antero-posterior (AP), medio-lateral (ML), and longitudinal (Lon) axes.

>Methods applied to estimate the moment of inertia of the whole body were



RESULTS

>Fig. 1 presents the moment of inertial obtained from the different methods.

>No statistical difference between the moments of inertia estimated by the different methods applied in the study along all the three axes.

Table I. Coefficient of correlation of the moment of inertia along each axis between the method proposed by de Leva (1996) and the others models.

Methods	Axis	de Leva (reference) anthropometric table		
		antero-posterior	medio-lateral	longitudinal
Photogrammetry		0.94	0.98	0.88
Hanavan		0.99	0.99	0.98
Dempster		—	0.97	—
Brenière		0.71	0.92	—
Inverse dynamic		0.97	0.97	0.97
Angular momentum		0.97	0.99	0.94

DISCUSSION

>The inverse dynamic and angular momentum approaches had values in the same order of magnitude as the other classical methods.

>The de Leva [3] anthropometric method was considered as the reference to compare with the other techniques. The values obtained with the angular momentum were 2.0% off compared to the other methods (3.4%). The inverse dynamic values as well as the other methods were within 4% of those de Leva [3].

>The advantage of the angular momentum and inverse dynamic methods over the de Leva [3] technique resides in individualized in vivo values rather than estimations obtained from tables.

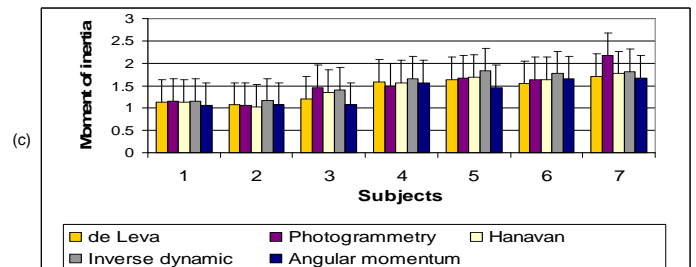
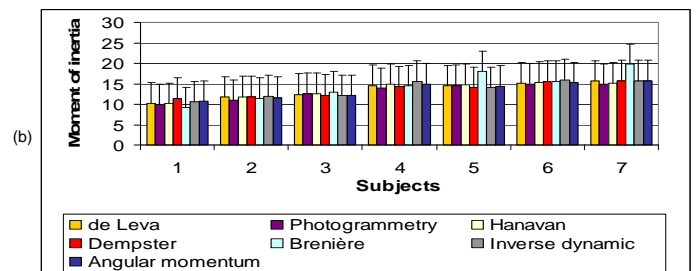
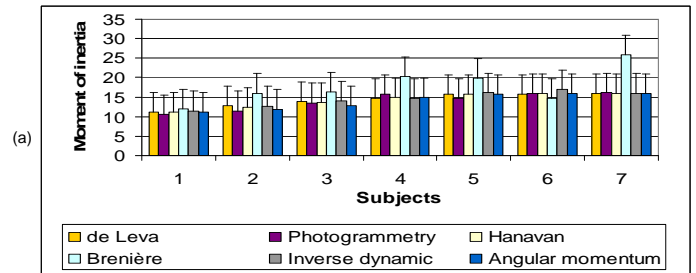


Fig. 1. Moment of inertia (kg.m²) of subjects' whole body calculated at the center of mass for the different methods for self-imposed oscillations about (a) AP, (b) ML, and (c) Lon axes.

CONCLUSION

>The inverse dynamic method and the angular momentum procedure gave moment of inertia values within the range of the other methods.

>The proposed methods could be applied to estimate the personalized in vivo moment of inertia of people with different body morphology.

REFERENCES

- [1] Barbier, F., Allard, P., Guelton, K., Colobert, B., and Godillon, A.P., "Estimation of the 3-D Center of Mass Excursion From Force-Plate Data During Standing," IEEE Transaction on Neural System and Rehabilitation Engineering, Vol. 11, No. 1, pp. 31-37, March 2003.
- [2] Brenière, Y., "Why we walk the way we do," J. of Mot. Behav., 28, pp. 291-298, 1996.
- [3] de Leva, P., "Adjustments to Zatsiorsky-Seluyanov's segment inertial parameters," J. of Biomech. 29 (9), pp. 1223-30, 1996.
- [4] Dempster, W. T. Space requirements of the seated operator. WADC Technical Report (TR-55-159), Wright-Patterson Air Force Base, OH, 1955.
- [5] Hanavan, E. P., "A Mathematical Model of the Human Body," AMRL Technical Report 64-102. Wright-Patterson Air Force Base, OH, 1964
- [6] Jensen, R. K., "Estimation of the biomechanical properties of three body types using a photogrammetric method," J. of Biomech. 11, pp. 349-358, 1978.