DETERMINATION OF INERTIA ELEMENTS FOR THE LOWER LIMBS

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INTRODUCTION: For kinematic and dynamic studies of the lower limbs, using a three dimensional model is useful. Such models allow one to determine segment movements and forces acting on joints. Inverse Dynamic Analysis can be used to calculate the biomechanical loads applied (Elftman,1939). The reliability of the results depends on the degree of accuracy of the kinematic and anthropometric data (Kingma et al.,1996).The purpose of this paper is to explain a simple way to determine inertia elements of the lower limbs using anthropometric data available in the literature.

METHODS: Body mass and stature are the only anthropometric parameters known for a subject. Body segment inertia parameters are obtained from cadavers and we use here de Leva (1996) segmental data for males to perform our calculations. We consider each segment of the lower limb (foot, shank and thigh) as rigid and independent.

The model supposes a knowledge of the relative mass and the spatial coordinates of at least three points for each segment.

The numerical values of the position of the reflective markers are obtained via a SAGA3 system. Four video-cameras detect infra-red light reflected from the markers.

Different marker localizations are proposed and the assumption describing an anatomical segment as a solid is tested. A mathematical method is developed in order to obtain data which take into account the individual characteristics of the subjects. For each segment we have to determine three successive elements:- the localization of the center of mass,- a coordinate system assigned, - an inertia matrix assigned.

RESULTS: The main difficulty is to place the markers properly on subjects. A simple test, allowing distance determination between markers, was proposed previously to further calculations. Optimal marker localizations are proposed. The mathematical model is developed in such a way as to be easily used.

CONCLUSIONS: These simple-to-use methods presuppose a reducing hypothesis. We assume that for each joint a geometrical center exists. This point lies on the longitudinal axis of the segments and has a fixed three dimensional position relative to the segments forming the joint. The localization of the ‘joint center’ is not referenced to the sagittal and transversal axis.

We use data reported by de Leva (1996). This supposes that the lower limb is a standard limb, reducing accuracy for subjects with some pathological segment orientation or for young, old and female subjects. As the error introduced by using inappropriate segment parameters could be substantial, the choice of the biomechanical model, as well as the optimal measurement method, is absolutely necessary to obtain a good evaluation of the forces acting on the different joints.