APPARATUS TO MEASURE 14 ISOMETRIC LEG JOINT MOMENTS

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Introduction
Isometric joint moment generation depends on the joint posture. The investigation of such muscle-length dependent effects is of strong interest for basic biomechanical studies on healthy subjects and patients with certain pathologies as well as for the development of neuroprostheses and actuated exo-prostheses.

Fig. 1: Multi-Moment-Chair Design

Design
In this project an apparatus has been developed that measures isometrically the 14 lower limb joint moments corresponding to the degrees of freedom (DOF) of the hips, knees, and ankles (Figs. 1 and 2). The construction is based on an existing technical concept (Wood et al., 1999). The new version
presented here has been modified in such way that the variation of joint angles - especially of the knee joint - can be performed easier and quicker. Furthermore, it allows the variation of additional joint angles (hip abduction, ankle abduction and inversion), which may be of importance when studying the angle-dependent effects for different kind of movements and pathologies.

The construction consists of three main components that fix the lower limbs and pelvis of the subject: the seat including backrest and armrest, the two foot supports, and the two knee supports (see figures). Joint moments are calculated from measured restraint force-moments at the foot supports and knee supports (proximal to the knee). The main constructive features are that:

(a) All principal joint axes - except internal/external hip rotation - can be adjusted in a range that is similar to the maximum joint angular ranges in humans.

(b) External technical joint axes correspond with the internal anatomical axes to allow correct determination of static joint moments as well as easy - and therefore quick - angular adjustments without causing passive tensions between chair and subject while moving the joints.

(c) The positions of all seven axes can be adjusted in order to adapt the chair dimensions to subjects with different anthropometry and body height varying between 1.3 and 2.0 m.

(d) The large possible range of hip abduction motion makes it possible to "open" the chair so that it is easy to get in and out.

Fig. 2: Realisation of the Multi-Moment-Chair Design
Results and Discussion
All joint moment errors have been calculated to be less than 7% of the peak moment responses, which is considered sufficiently accurate for the proposed application. Experimental validation has still to be done, for example with a dummy, in which known joint moments can be generated and measured by the apparatus. The apparatus can be used for investigations of joint angle dependent moment generations in healthy subjects as well as for the optimisation of stimulation strategies in neuroprostheses.

Reference