TECHNICAL QUALITY ASSURANCE FOR THE STRENGTH MEASUREMENTS PERFORMED WITH A HAND HELD DYNAMOMETER

A. Ancillao (1), S. Rossi (2), F. Patanè (3), A. Pacilli (1) & P. Cappa (1)
(1) Dept. Mechanical and Aerospace Engineering, Sapienza University of Rome, Roma, IT.
(2) Dept. Economics and Management – Industrial Engineering, University of Tuscia, Viterbo, IT.
(3) Faculty of Mechanical Engineering, Niccolò Cusano University, Roma, IT.

Main topics: Movement analysis in clinical practice, Analysis of clinical movement data.

INTRODUCTION and AIM

Strength measurements allow the evaluation of the health status of patients. A very common method to assess strength is the use of Hand Held Dynamometer (HHD). To evaluate strength during knee flexion/extension tasks, the patient is required to be seated on a bench while the therapist applies the HHD on the skank and asks the patient to push against it. These measures are clearly affected by operator and patient positioning. Previous studies concluded that this methodology can be considered questionable due to the low values of inter-trial repeatability [1], [2]. The aim of this work is to develop a methodology capable to assure the technical quality of force measurements by means of an optoelectronic system. This study is granted by the MD Paedigree Project that is part of the 7th Framework Program of the European Union.

PATIENTS/MATERIALS and METHODS

An adult healthy subject (25 years old) was recruited. The Plug In Gait marker set was applied to the subject. A MicroFet™ dynamometer (Hoggan Scientific, Salt Lake City, UT) was equipped with four markers as shown in Fig. 1. In accordance with [1], the subject was requested to extend the right knee with as much force as he could, while the therapist had to push back the subjects' leg. The position of the subject and the HDD were reconstructed by an optoelectronic system. The direction, orientation and application axis of the HDD were computed. The knee extension moment was computed along the axes: flex/extension, ab/adduction and intra/extra rotation. As reference, the knee moment was also computed by multiplying the measured force and the leg length. The angular range of motion of the knee was measured, to ensure that the knee maintained the requested position during the trial.

RESULTS

Forces and torques determined during one of the performed trials, are shown in Fig.2 and 3. As expected, the main component of the force was in the antero-posterior direction (x-axis), with an average of 122 N ± 3 N. The peak force measured by the dynamometer was 158 N. The other components were due to imperfect application of the dynamometer and were significantly lower (avg. of -36 N ± 8 N and 12 N ± 5 N) than the antero-posterior one. For the knee moment, the main component was along the flex/ext axis with an average of 41 Nm ± 5 Nm. The dotted line in Fig. 3 is the reference moment (43 Nm). The black line is the intensity of the moment vector.

Fig.1: HHD equipped with markers, as used in this study

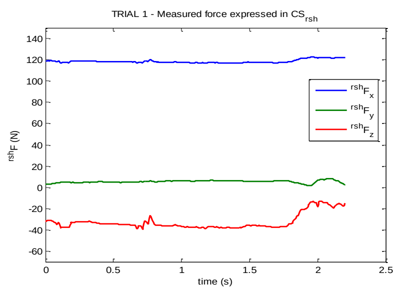

Fig.2: Subject No.1, test: right knee ext, repetition 1: Components of measured force vector.

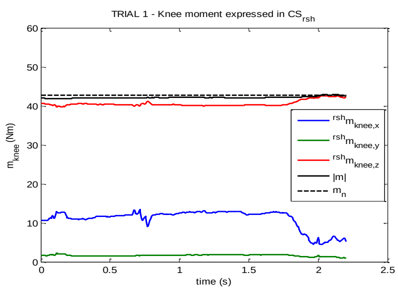

Fig.3: Subject No.1, test: right knee ext, repetition 1: components of knee moment vector.

DISCUSSION and CONCLUSIONS

Forces and torques in the undesired directions were low, while forces and torques in the main directions were consistent with the nominal ones. The undesired components of force and moment could represent a consistent numerical index to characterize the quality of a strength measurement test. In this preliminary study, we concluded that the method is reliable for application to healthy subjects, but further study is required to quantify inter and intra operator repeatability and the method should be tested for application to pathological subjects.

REFERENCES

[1] O. Verschuren, M. Ketelaar, T. Takken, M. Van Brussel, P. Helders, and J. Gorter, "Reliability of hand-held dynamometry and functional strength tests for the lower extremity in children with cerebral palsy," *Disabil. Rehabil.*, vol. 30, no. 18, pp. 1358–1366, 2008.

[2] K. Mahony, A. Hunt, D. Daley, S. Sims, and R. Adams, "Inter-tester reliability and precision of manual muscle testing and hand-held dynamometry in lower limb muscles of children with spina bifida," *Phys. Occup. Ther. Pediatr.*, vol. 29, no. 1, pp. 44–59, 2009.