SUMMARY OF DOCTORAL THESIS

“Model tests of the load of the skeletal-muscular system of the lumbar segment of the vertebral column in everyday life activities”

The doctor’s dissertation is concerned with the use of the mathematical modelling of the human locomotor system to assess loads of the lumbar segment of the vertebral column. The dissertation aimed to analyse factors affecting loads of the skeletal-muscular system of the lumbar segment of the vertebral column when performing everyday life activities. The dissertation was inspired by the potential application of test results in teaching the proper ergonomics of movements as well as verification of exercise programmes and therapeutic-preventive workshops aimed to minimise overloads of the lower segment of the vertebral column in a group of parents of children with physical disability.

The dissertation involved a vast study of scientific reference publications concerning medical and biomechanical aspects of loads exerted on the lumbar segment of the vertebral column in a group of parents of children with physical disability. The work also involved an overview of testing methods, including mathematical models of the human locomotor system, enabling the determination of loads of the lower segment of the vertebral column. The dissertation presents in detail the previously obtained in-vivo test results and model-based test results.

The implementation of dissertation-related objectives required the identification of 4 stages of tests including experimental and/or model tests. The first stage involved the selection of an appropriate model of the human skeletal-muscular system in the AnyBody environment to simulate loads affecting the lumbar segment of the vertebral column. The subsequent stage, involving the use of a modelling method selected in the AnyBody programme, included the determination of loads affecting the lumbar segment of the vertebral column during everyday life activities. The experimental motion kinematics tests, the results of which constituted initial data in the model tests, were attended by 30 females, i.e. the mothers of disabled children. The tests involved the determination of the correlation between motion kinematics and values of responses in intervertebral joints. The third stage of the tests included the assessment of the effect of the strengthening or weakening of abdominal and dorsal muscles on loads of the
lumbar segment of the vertebral column. To this end it was necessary to perform theoretical model tests simulating the growth of muscles in the lumbar segment of the vertebral column and an exercise-induced increase in muscular strength resulting from changes in cross-sections of the above-named muscles. The final stage included the assessment of the efficiency of a programme composed of 6 monthly therapeutic exercises strengthening abdominal muscles, developed by physiotherapists from the University of Physical Education (AWF) in Katowice supervised and directed by Professor A. Myśliwiec. The programme was addressed to parents of disabled children. The assessment was based on the experimental tests of motion kinematics and USG tests performed in a 10-strong group of mothers of disabled children and the results concerning loads of the vertebral column obtained in model tests. The experimental tests and simulations were performed two times, i.e. during the initial tests and after 6 months. During the above-named period of six months, i.e. between the initial tests and repeated tests, the test participants took part in the programme of therapeutic exercises strengthening deep stabilising muscles, primarily the transverse muscle of the abdomen.

The above-presented methodology can be used to determine loads of the skeletal-muscular system during various locomotor tasks. In addition, the methodology can be used to assess to what extent the strengthening of individual muscles, e.g. within targeted training, will affect the values of loads exerted on the locomotor system.