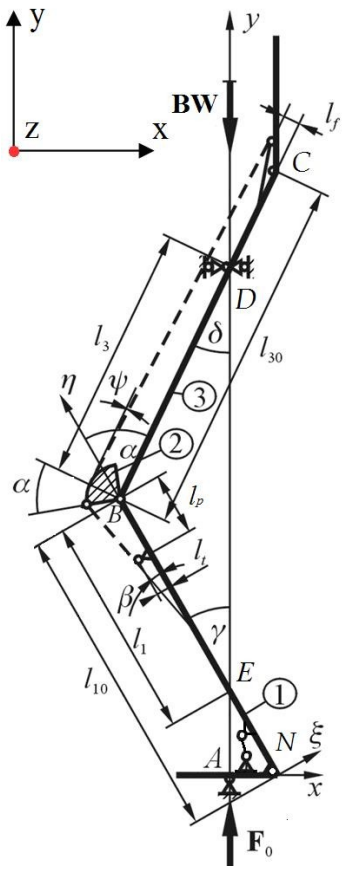
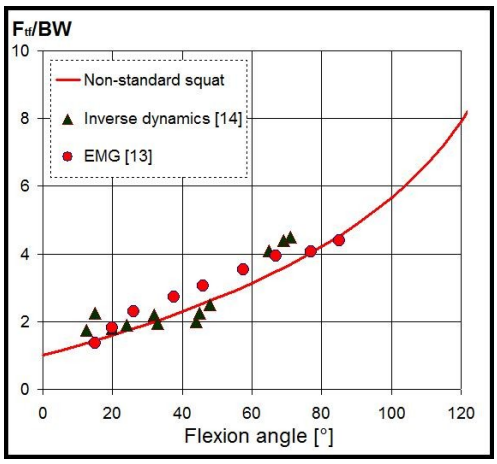
Development of analytical-kinetical knee joint model



Analytical models related to the kinetics of the patellofemoral joint are still in short supply. Among the earliest models, most authors created quasi-static, analytical studies in order to determine the overall stiffness of the joint as a function of flexion angle. However, no investigation of the patellofemoral forces was actually carried out. The ratio between patellofemoral forces such as F_{pf}/F_q and F_{pt}/F_q (ratio of the patellofemoral compression force to quadriceps force and the patellar ligament force to quadriceps force, respectively) has been determined both by experimental methods and with the help of various mathematical models. However, only the standard squat movement was investigated, where the forward movement of the trunk is not considered.



To solve this problem, a new analytical model has been presented, which draws the attention to the effect of the moving centre of gravity on the knee joint kinetics. This model is capable of predicting accurately the patellofemoral, tibiofemoral, patellar ligament, and quadriceps forces in the knee during standard or non-standard squatting motion.

This analytical model is derived from theoretical assumptions and experimentally determined parameters based on multiple human participants. The results of the analytical model correlated well with inverse dynamic results taken from the literature.

Among the patello- and tibiofemoral forces, the obtained $F_q(\alpha)$ force function can be extended for further use as an input function for isometric motion, since most descriptive relationships found in the literature provide only the ratio of the patellofemoral forces divided by the quadriceps force.

Selected publications on the topic:

- **G. Fekete**, B. M. Csizmadia, M. A. Wahab, P. De Baets, L. V. Vanegas-Useche, I. Bíró: Patellofemoral model of the knee joint under non-standard squatting. *Dyna Colombia*, 81 (183), pp. 60-67, 2014. IF (2013): 0.217
- **G. Fekete**, B. M. Csizmadia, M. A. Wahab, P. De Baets: Experimental determination of horizontal motion of human center of gravity during squatting. *Experimental Techniques*, 37 (6), pp. 66-76, 2013. IF (2013): 0.583
- **G. Fekete**, B. M. Csizmadia, P. De Baets, M. A. Wahab: Review of current knee biomechanical modelling techniques. *Mechanical Engineering Letters*, 5, pp. 30-36, 2011.