

# CLINICAL TRIALS OF USING KNEE EXTERNAL FIXATORS WITH ADAPTABLE KINEMATICS FOR FUNCTIONAL TREATMENT OF PERIARTICULAR FRACTURES

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## INTRODUCTION

An orthopaedic fixator to be used for the treatment of periarticular fractures of the knee joint are presented in this work. The design of the device is documented by experimental research of the knee joint kinematics. Experimental and simulation research suggest the use of a four-bar linkage mechanism. The fixator makes it possible to move the lower leg relative to the thigh throughout the treatment. This paper also presents results of first clinical implementation of fixators.

## METHODS

A proper works of the knee-joint decides about static and dynamics of this limb and the whole organ motion. The kinematics of the knee-joint is very complex. There is not a simple hinge-joint and the motions taking place in it have a complex character. The motions take place around a few axis that change their location and submit to complex rights of biomechanics and kinematics. The solution suggested in this work bases on new approach to an issue – a four bar linkage construction of adaptationally variable parameters to adapt fixator parameters to individual patient knee kinematics. The mechanism is simple and allows for a number of regulating options to change its kinematics. The list of publications on the knee joint is rather extensive. In studies [1,2], the knee joint dynamics is analysed, taking into account the geometry of the bone, as well as the spatial configuration and the non-linear characteristics of the joint ligaments. Studies on knee joint dynamics and analysis can also be found in paper [3]. This work contains:

- 1) Experimental research to describe kinematics of human knee and the range of regulations indispensable to the adjustment of the four-bar linkage mechanism indispensable to individual features of the patient (The sampling test consisting from 100 patients. These studies were conducted in cooperation with Hospital of Orthopaedics and Rehabilitation of the Second Medical Faculty of the Medical University of Warsaw.
- 2) Mathematical and simulation model of external fixator-knee system. Computer simulation results
- 3) Description of external fixator design
- 4) Clinical experiences

.It was assumed that the analysis of the motion of the joint in the two-dimensional system would be sufficient to solve the problem . A modern x-ray unit of a low radiation power was used. It enabled to x-ray the joint in motion and observe it in real time, as well as to store the picture as a single photograph. 30 digital photographs of the motion of the knee joint were made for each patient. A group of 100 patients of a different skeletal structure, different sex and age was examined. The relative motion was determined between the tibial bone and the femoral bone, expressed in the  $X_u$  ,  $Y_u$  system connected with it. (Fig. 1).

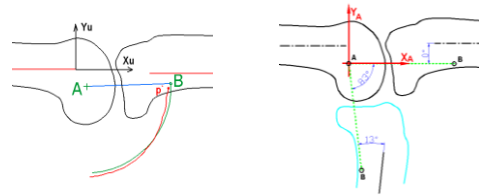


Fig. 1 Scheme of the motion of the knee joint

The optimization problem consist in finding position and parameters of four bar-linkage mechanizmu to minimize the differences received between the trajectories: from experiment and computer simulation. This procedure was performed for each patient. One reach a very good agreement. On the basis of the parametric sensitivity analyses a method for positioning the fixator was elaborated. Next we used obtained results to the design and construction of fixator. The fixator enables movements between tibia and femur during the whole treatment period, which are so close to natural physiological movements that they do not interfere with the process of the union of the fractured bone and they realize the principle of functional treatment. Moreover, the fixator enables adjusting movements that allow the movements forced by the fixator to comply with the natural physiological movements of the joint, with an inaccuracy to be compensated by the joint flexibility.



Photo 2. Knee joint fixator - clinical implementation

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