Active dynamisation system applied in external fixation

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1. Introduction

It is expected that external fixation of bone fragments ensures appropriate mechanical conditions within the fracture region during the whole period of ossification, as well as structural reconstruction of the osseous tissue. The bone fragments along with the fixation system constitute a specific biomechanical system of a specific compliance with respect to changes of the loads imposed that originate from the skeletal and muscular system that is inextricably connected with the patient’s injured limb. Range of the undertaken studies covers long bones of the limbs, especially the thigh bone, being a bearer for the human body. An everyday mechanical stimulation of the skeletal system is provided by means of typical motor activities (Fig. 1). In the case of immobilization, stimulation of the region of the bone union can take place e.g. by means of a forced variable loading of the limb [3].

![Fig. 1. Influence of motor activity on the load of limbs – skeletal system [1]](image1)

Ensuring appropriate mechanical parameters within the region between the bone fragments is a crucial element contributing to a mechanical stimulation of the bone union processes. The aim of the studies is to acquire data for application of a forced mechanical stimulation, maintaining the variations of the loads that occur during a daily natural motor activity of the patient.

![Fig. 2. Dynastab Mechatronika 2000 fixator](image2)

A stabilization system used during the studies is a unilateral Dynastab Mechatronika 2000 fixator (Fig. 2) [2].

2. Methodology

2.1. Measurement of the loads of the limb during motion

Natural motor activities performed daily are such as: normal walking, ascending and descending stairs, raising and sitting on a chair, bed, etc. Besides all these activities connected with moving around the house or a hospital, one can also distinguish those performed outside, e.g. on the way home or to workplace. These motor tasks are of the most demanding, since they result from a momentary need, with no previous preparation and often without any help from other persons. The first three of the listed activities were accepted as the basic ones, connected with the period of healing the fracture and an early rehabilitation period, so a period, when the bone union is exposed to damage the most.
2.2. Tests of the mechanical compliance of the fixator-bone system
In order to verify a degree of compliance of the bone-fixator system with respect to mechanical loads, one carried out a test detecting displacements of fragments of a thigh bone within the region of fracture using a gravitational load applied in the region of the thigh bone head. A short set of tests has been performed, taking into account direction of operation of the limb (mechanical axis) (Fig. 3).

![Fig. 3. Tests of the compliance of the fixator-bone system](image)

3. Results
Results of the tests, for the interstice of 0 mm and for a tilted tested object are illustrated on the charts below: profile of the load and linear displacement of the bone fragments within the region in the vicinity of the injury (Fig. 4).

![Fig. 4. Profile of the load and displacements of the bone fragments](image)

4. Discussion
Range of standard experimental studies of loads connected with maintaining the function of walking have been extended with behaviors that pertain to maintaining a self-reliance of the patient. The paper discusses problems related to motion of a patient released from a hospital, who has the external fixator still installed. Studying stability of geometrical and mechanical parameters describing the region of the bone union, with regard to variations of the loads transmitted by the limb, resulting from a standard motor activity of a patient, is used for stimulation of the bone union processes.

References