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BIOMECHANICAL GROUNDS FOR THE BIOTECHNICAL SYSTEMS EFFICIENCY FOR AN OSTEOSYNTHESYS OF THE STARTING DIAPHYSIAL FEMUR FRACTURES

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Abstract. The experimental value and comparative analysis observed for the effective usage of some fixation constructions for opaque shaft fractures femur bones. We have received experimentally and analyzed the deformative parameters of biotechnical system "bone-fixing construction" in the terms of pressure and their comparison with nominal standard – (the specimen of non- damaged femur bone). The experiments had been performed on 36 fresh specimen of femur bones, brought during autopsy from dying people at the accidents at the age from 20 to 60.
Keywords: osteosynthesis, biotechnical system, fixators, experiment.

Introduction

The occupational, domestic and street traumatism is one of the basic main for disability and invalidity of population. The problem of medical treating of the breaks of long tubular bones in musculoscent system, and the quickest returning of the sufferers to active and full activity is one of the most important and actual task. This problem is not medical, but is a social–economic problem.

We have statistic data of femur's fracture -21,8% cases, fibula's fracture ceses are 52,5%. The conservative treating is very spread nowadays: more than 51% of open fractures are treated conservatively (plaster bandage) and only 49% with surgical approach.

The relation for closed fractures are 89% and 11% accordingly. The osteosynthesis (bone and intramedullary) [4] used in 72,3 % cases for general quantity of surgical intervention.

However, as it recorded that the non-stable of ostesynthesis was in 22% cases. It is caused by [illegible] imperfection of the structure the interstitial fixation constructions.

A wealth of modern fixating constructions are rather wide and various there. Among them [illegible] different bone fixators and systems, rod transosseous constructions, intramedullary fixators. It is [illegible] reason for the existence of variety fixating systems and constructions and it is the reason for [illegible] appearing and developing new constructions for osteosynthesis.

The purpose of the paper

You may create static, dynamic and detentive varieties with technical fixating structures de[illegible] upon the types and kinds of damages and medical recommendations and indications. In present [illegible] we also use the metallic pins, drill wires, screws, plates, wires, clips, compressive-distractive [illegible] and compressive-distractive devices, polymer fixators. We can also add here: the ceramic [illegible] from bones, with thermoplastic memory with electric state, bioresorsable fixators and etc.

In most cases the developing of such constructions is based on empirical approach. It is [illegible] the intuition and the experience traumatic surgeons and it is made without necessary scie[illegible] technical development and biomechanical provision.

The basic factor which witnesses about the results of positive (surgical) treatment of [illegible] tubular bones, is firm fixation, safe fixation of bone (fracture) fragments. It helps the [illegible] consolidation, damage healing, decreasing and combination periods of consoli[illegible] rehabilitation.

However, the irregulate strength of fixator's [4] comes to 25% of non-satisfactory res[illegible]

That is why, the osteosyphesis' important task is quality function's reha[illegible] misculoscerator system. We solved this task is impossible without necessary technical [illegible] laboratory developing for all aspects and ways of constructive execution in modern fixating [illegible] and systems and multifunctionality, and necessary universality which cannot be provide[illegible] design and theoretical methods.

It is necessary to consider that modern investigations in biomechanics area approve that scatter of servation value in %) (but in some cases –are in tenth and more) is usual phenomenon [1,2,3]. Such te is rather typical for biomechanics.

That is why the improving the methods and traumotologist's structures is improving impossible thout realization comprehensive and system approaches, which touch the improving medical latives and ways of treating, and improves engineering decisions of osteosynthesis. It helps to ate new generations of effective, rather cheap comfortable, physiological, commonality fixing stems and structures.

aterials and methods

This paper gives the results of experimental investigations about stability metallic and metal-lymeric systems, which are used for oblique diaphyseal fractures of long tubular bones. The easuring makes on special developed and produced units, which allows to realize all kinds of nple, and also the basic kinds of heavy deformations. [1]

The investigation was performed on 36 specimen on femoral bones, extracted during autopsy om mortal ocassions from the persons from 20 to 60. [5]

The experiments by 6 specimen sere done from each batch. The 1-st batch has specimen of non-maged femoral bones which is considered standard. In 2-6 batches there are specimen, which after lique osteotomy are fixed by Kuncher's nail with two wire cerclages, three screws 10-screw plates O, 10-screw double antirotation plates, compressive metalpolymer fixator of the second model МПФ-2.The osteomothy is made in middle third of diaphysis in femoral bone in saggital anenness. The interrelation of osteomatic length line and bone's diameter is 3:1.

The bones (fracture) fragments were fixed with help of nut's Kuncher, plate AO and also by rews with using usual procedures. The screws which unites with help of dual decoration plate at xation, which may run perpendicularly towards to screws of long plate. At КМПФ-2 (compressive etalpolymer fixator), osteosynthesis', the metallic polymer fixator's running directed in such way, at it would be perpendicular to osteotomy.

There are 3 holding screws which run through both bone (fracture) fragments and polymer parts f fixator's cunnings run perpendicularly towards to bone's longitudinal ax. The bone (fracture) agments, screws and metal polymer fixator join in integral biotechnical structure. Fig.1.

The biotechnical system "bone-fixator" at oblique shaft of femur is under interrelation of mpressive, bending and rotating loads in clinical state. That is why, we did tests for all types of ecified loads.

The study was done by non-destructive examination with improved technique Lindal [6].

There is the specialist gripper fixed in horizontal state on cantilevered bending of specimen's roximal end. The load was pressured on the 100 mm distance from osteomy's middle line.

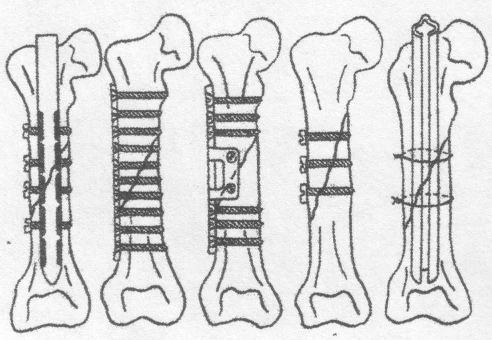


Figure 1. The opaque of shaft [diaphyseal] fracture, synthesed by КМПФ-2 (compressive metalpolymer fixator)(a), 10-screws plate AO (б); 10 screw dual detorational plate (в), three metallic screws (г), Kuncher's nail with two wire cerclages.(д)

The bending moment is from 1 through 10 mm, was pressed perpendicular to bone's longitudinal x in mediolateral, lateromedial, ventrodorsal and dorso-ventral directions. The specimen's bending, where bending force was pressed, was measured in two interperpendicular directions in vertical or orizontal directions with help of clockwise indicator with grating period 0.01 mm.

Discussion

The curvature appears not flat in practically all cases. The horysontal indicates find it opaque This fact explains the starting curvature of bone's longitudinal ax, their specified form.

The received (final) experimental meaning of biomechanical measuring were pressed statisticall and were used for drawing of graphic dependence from the value of curvature of the meaning th bending moment, fig.2

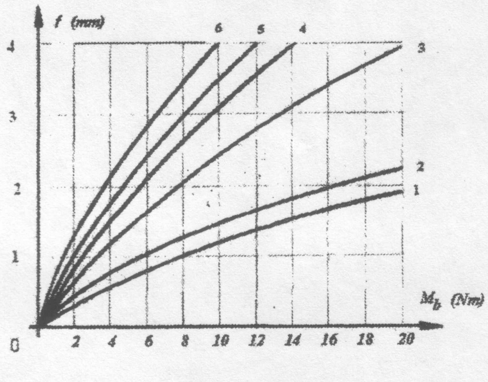


Figure 2. The dependence, bending of the longest curvature of specimen's whole femur (1); synthesized КМПФ-2(compressive metalpolymer fixator) (2); 10-screw plate (AO) (3); 10-screw dual derotational plate (4); three metallic screws (5); Kuncher's nail with two wire cerclages (6).

As you can see from schemes on Figure 2, the biggest resistance to action of bending stresses i made by non-damaged femur, the biotechnical system "bone-fixator" КМПФ-2(compressiv metalpolymer fixator) is unappreciable value to it. We can add the usage of this type fixator by resistance to action of bending stresses is the same in 4 interperpendicular flatness.

The worse than КМПФ-2(compressive metalpolymer fixator) the bending resistance mad specimen, at which bone's fracturtes fix by three metallic screws. For example, the value of curvatur in 2 mm appeared at specimen, with synthesized КМПФ-2 (compressive metalpolymer fixator), a bending moment M_{bend}= 2nm.

The result of measuring bone's (fragments) in 4 directions is at the fixation, but the les resistance were saw at the loads in the flatness osteomacy. The specimen's resistance fixed by Kuncher's nail and cerclage in ventrodorsal and dorsoventral directions does in 5 times less, than a the КМПФ-2 (compressive metalpolymer fixator) usage.

This phenomenon maybe explained that instead of their enough toughness on the Kuncher' cunning, this biotechnical system "bone (fracture) fragments –rod - cerclages" is not enough stable because absent rod's arrester in medullary cavity's wall on the osteomacy, where the channel leave open on considerable length.

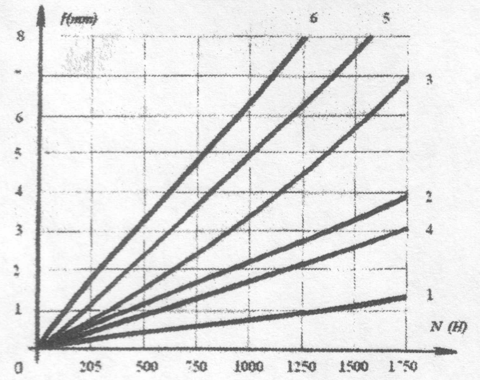
The specimen fixed by plate AO and dual derotational plate, should the less bending resistance i direction of open fracture's fissure in midallatteral direction. The value of this deformation depen upon the plate's rigidity and screw's joint efficiency with bone's compact substance. The speciman' bend resistance fixed with bone constructions occurred in 2 times less in mediallateral, than at t КМПФ-2 (compressive metalpolymer fixator) ostesynthesis.

The specimen's both ends were fixed by specialist gripper during the testing. The longitudi stress of comparison decrease (statistically) to the value of N= 1750 N(Newtons). The value o longitudinal deformation registered by clock- type indicators. The graphical dependence of resu testing for compression of non-damaged femurs and synthesized by all types of fixators, that at testi for bend are presented at the figure 3.

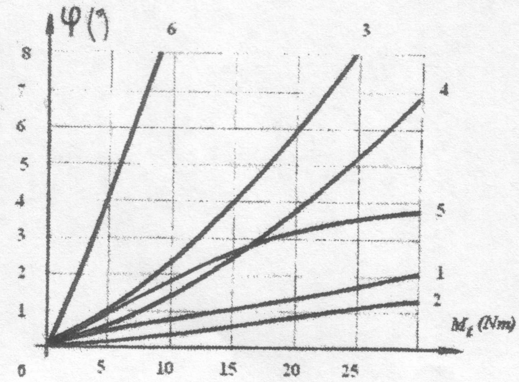
During the speciman's testing, which not sufficient were synthesized by three screws, Kuncher' nail with two wire cerclages installed by their not enough resistance to action of longitude pressu which increased N= 750-1000N (Newtons), that corresponds to the average weight of patient's bo in clinic state.

The maximum bending moment $M_{rot\ max}$=25Nm appears at the rotation test.

The graphic dependence of results testing on rotation specimen, shows as the changing value o rotating angle at the change of outside moment is demonstrated in Figure 4.



ȷure 3. The curves of resistance to specimen's compression the whole femur (1); synthesized by]Ф-2 (compressive metalpolymer fixator); 10-screw plates AO(3); 10 screws' derotational plate (4); three metallic screws (6).



gure 4. The curve of resistance to rotating the whole femur (1), (femoral bone) synthesized by ƆМПФ-2 (compressive metalpolymer fixator) (2); 10-screw dual derotational plates (4); three metallic screws (5); Kuncher's nail with two cerclages (6).

[he results of rotation test (Fig.4) demonstrate, that the synthesized specimen КМПФ-2 pressive metalpolymer fixator) are the closest to the standard. It is explained by constructive iarities КМПФ-2 (compressive metalpolymer fixator), at which blocks with bone's compact ance creates stable biotechnical system "bone-fixator-screws" at which rigidity of the fixator rod the most important role in testing.

[he analogous study was done in transversal shaft [diaphysical] and commited [splintered] ires both on formal and on the shin bone.

lusions

[he worked out techniques and experimental investigations on native specimen allow to came to usion about efficiency and expendity of usage of that or another fixator's model and to choose ruction which allows to make stable osteosynthesis in this or that fracture's state and bone's ges.

[he obtained results allow to choose the most effective construction for a definite type of fracture thopedists. The investigation's results may be used by scientists, and engineers for developing of ınd improving existing systems for osteosynthesis.

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