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COMPARATIVE BIOCHEMICAL ASSESSMENT OF OSTEOSYNTHESIS STABILITY IN FEMUR FRACTURES BY DIFFERENT INTRAMEDULLAR AND EPOSTEAL CONSTRUCTIONS

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Abstract
Experimental method of comparative assessment of biotechnical systems deformability in osteosynthesis of femoral epiphysis transverse fractures with different fixing structures was proposed. Results of experimental study of natural osteal preparations that are synthesized by different technical constructions that work in conditions of plain and complicated deformations types are presented.

Introduction

Alterations in modern home and occupational traumatism, increase of traumas share originated in the result of high impact force (so called high-energy traumas), particularly, of comminuted, fragmented, double, spiral, multiple fractures, and polytraumas, cause objective difficulties in its treatment.

Conservative treatment methods with cast plasters, as it is well known, do not supply with robust restoration of all functions of injured bone; they are accompanied with long-term loss of employability and in 8 – 30 % of cases they lead to disability [1].

Reduction of bed-stay and general disability from several months (in some cases – from several years) to several weeks seems to be an actual task that in modern conditions needs both scientific theoretical and experimental basis and technical provision. This problem solving is possible only with join efforts of doctors, engineering personnell, specialists in material authority, material resistance, designers and technologists.

Thus, for example, in patients with femoral fractures general disability term in 94.7% of cases runs up to 3-8.5 months [2]. One of the most priority problematic osteosynthesis parts is technical part – namely, the development of mechanical devices and systems for osteosynthesis [3].

The aim of the research

Development, substantiation and application of principally novel approaches and technologies with use of methods of osteal fragments stable fixation are necessary, of the methods allowing avoiding limb immobilization that underwent surgery, with cast plaster. This should permit starting active movements in joins at the very first days after surgery and providing dosing load that facilitates early return of injured persons to labor activity.

Materials and methods

Nowadays the majority of researchers incline to the opinion than modern osteosynthesis should be maximally low-invasive and also biological (biological system "bone fragments – fixation" created as a result of osteosynthesis, should maximally approach to the deformability and strength parameters of intact uninjured bone, which in such cases should be considered to be original etalon). At the same time strength, rigidity, dynamic and shock-absorbing parameters of biological system should be approximate to the parameters of uninjured bone.

For experimental substantiation of advantage of blocking and metal-polymeric constructions of compression osteosynthesis the comparative study and stability assessment of intact femur and also of preparations synthesized by different metal and metal-polymeric constructions was carried out.

Experiments were made on 100 fresh femurs that were received at autopsy of persons aged 40 – 60 years, who died in an accident. We examined 10 experimental series by 10 preparations in each series. The preparations were synthesized by Kuncher nail, bayonet-like nail, Syvash corkscrew pin, KMPF-2, KMPF-3, KMPF-5 (the latest were developed at Traumatology Chair of Bukovinian State Medical University by prof. I.M.Rublenik together with the Laboratory of Material Resistance of Chernivtsi National University). Besides this the preparations that were synthesized by KITO plate of Kharkov Institute of Traumatology and Orthopaedy, by AO plate of the Swiss Association of Osteosynthesis and by fixation Seppo were analyzed. The preparations of intact uninjured bone were used for comparison.

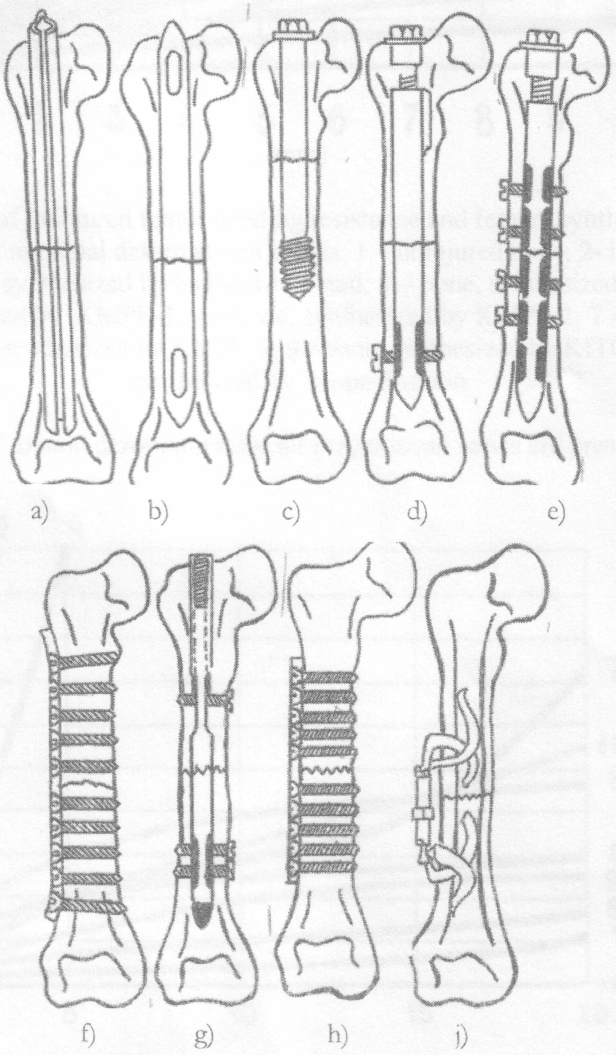
Intramedullar fixation diameter was 13 mm, compressive plate dimensions were 160 x 20 x 5 mm. Intramedular synthesis was performed for midfemoral transversal fracture. During Syvash corkscrew pin application the osteotomy was performed at upper third part to match fracture localization with fixation center. Kucher nails and metal-polymeric fixations were modeled in accordance with physiological bone curves. At eposteal synthesis compression plate was placed along the external surface of the bone, and it was fixed with eight screws.

Osteosynthesis by metal-polymeric fixations was performed in two variants: dynamic and static. For dynamic osteosynthesis KMPF-3 and KMPF-5 were utilized. Static synthesis was performed by KMPF-2. Deformability of uninjured bone and biotechnical system "bone fractures – fixation" was determined by measurement of deformations that originated from application of plain load types to the system: stretching, torsion, bending and also their different combinations, i.e. complex types of load. For this purpose the special device was designed that was protected by inventors certificate [4].

Results and discussion

Diagramed preparations representation with transversal diaphysial fracture, which were synthesized by mentioned above fixations are presented on Figure 1.

Bending deformation was examined in four reciprocally perpendicular planes: ventrodorsal, dorsoventral, mediolateral and lateromedial. On Figure 2 below the diagrams are presented that characterize the bending resistance of all preparation series at the planes of maximal deformations.



Picture. 1. Transversal femur fracture, synthesized by Kuncher nail (a), bayonet-like nail (b), Syvash corkscrew pin (c), KMPF-3 (d), KMPF-2 (e), AO plate (f), KMPF-5 (g), KITO plate (h), and Seppo fixation (j)

On Figure 2 below the graphic relations that characterize deformability of analyzed biosystems at the planes of maximal deformations are presented.

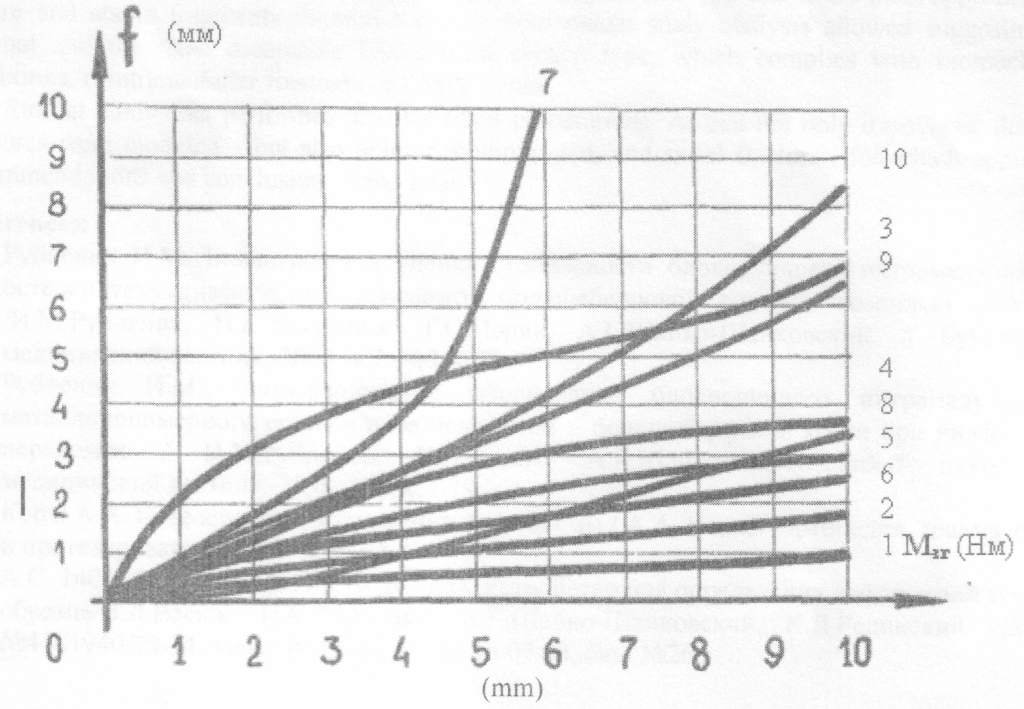


Fig. 2. Characteristics of uninjured femur bending resistance and femurs synthesized by considered above constructions at maximal deformations planes: 1 – uninjured bone; 2- bone, synthesized by Kuncher nail; 3 – bone, synthesized by bayonet-like nail; 4 – bone, synthesized by Syvash corkscrew pin; 5 – bone, synthesized by KMPF-3; 6 - bone, synthesized by KMPF-2; 7 - bone, synthesized by AO plate; 8 - bone, synthesized by KMPF-5; 9 - bone, synthesized by KITO plate; 10 - bone, synthesized by Seppo fixation

Graphic relations of torsion deformation for all preparations series are presented on Figure 3.

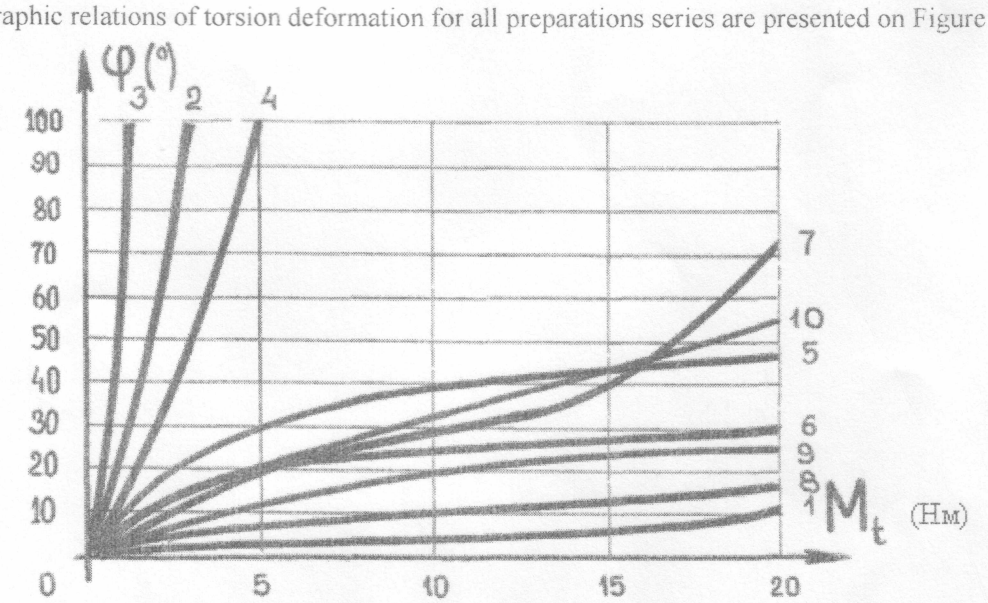


Fig. 3. Torsion resistance characteristics for preparations of intact and synthesized femur: 1 – uninjured bone; 2- bone, synthesized by Kuncher nail; 3 – bone, synthesized by bayonet-like nail; 4 – bone, synthesized by Syvash corkscrew pin; 5 – bone, synthesized by KMPF-3; 6 - bone, synthesized by KMPF-2; 7 - bone, synthesized by AO plate; 8 - bone, synthesized by KMPF-5; 9 - bone, synthesized by KITO plate; 10 - bone, synthesized by Seppo fixation

Conclusions

Undertaken research allowed determining the fixing system type that is the most appropriate for secure and stable fragments fixation creation. Undertaken study analysis allowed suggesting that optimal and the most acceptable biotechnical system type, which complies with biomechanical conditions, is intramedullar fixations of KMPF series.

Similar study was performed also for tibial preparations. At that not only transversal diaphysis fractures were modeled – but also oblique, comminuted, and spiral fractures, for which appropriate recommendations and conclusions were done.

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