Carbon friction pair in hip arthroplasty.

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Revision hip arthroplasty does not lose its relevance since the first implantation of total prosthesis.

The main reason for performing this kind of interference is aseptic loosening of the prosthesis components, which reaches 90% of the revision surgery [1,2,3]. By aseptic loosening lead discrepancy tribological properties of the artificial joint, physical and mechanical properties of materials, as well as macrophage response to wear particles of materials endoprosthesis.

Most manufacturers of total hip replacements used for the manufacture of friction pairs their artificial joints the same type of materials: ceramics, metal, polyethylene. Using them separately and combining with each other, allows you to bring the tribological properties of the artificial joint to joint health rights. But in spite of the continuous improvement and improve implants and materials, the frequency of revision cases is not decreasing, according to some authors, it reaches 20% [4].

Thus, there remains a need to find new material that satisfies the tribological and physical and mechanical properties of natural human joint.

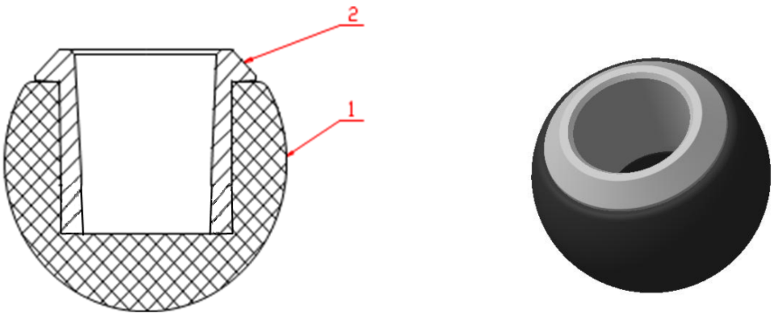
The purpose of the study were the advantages of the new material has tribological and physical and mechanical properties close to those of a healthy joint, the development of optimal design node mobility and experimental rationale for the use of carbon materials in the node mobility of hip joint.

To investigate the mechanical and tribological properties of the material was made mock hip endoprosthesis with node mobility of monolithic pyrolytic carbon.

Node mobility consisted of the following components:

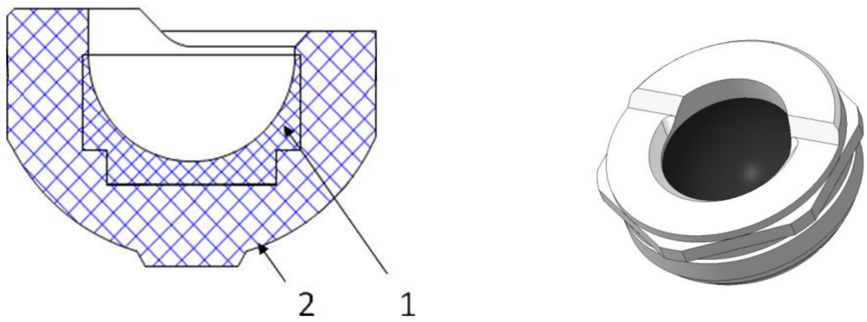
1. head of pyrolytic carbon, with reinforcing titanium sleeve (picture 1);

2. liner of high molecular weight polyethylene, with an insert of pyrolytic carbon (picture 2).



Picture 1: Schematic view of the head and an external node mobility.

1 Monolithic pyrocarbon; 2 Titanium sleeve with Eurocone



Picture 2 The scheme and exterior liner with carbon insert

1 - insert; 2 - plastic adapter;

To determine the margin of safety node mobility of pyrolytic carbon used mathematical modeling, which was carried out by finite element method in the medium «ANSYS 5.7».

The average value of the tensile stress was 40.7 MPa and 79.6 MPa compressive stress, safety factor - 5.8

The maximum value of the tensile stress localized in the head and collar of the sleeve was 85.3 MPa, which is 9-10 times less than the minimum tensile strength of the titanium alloy.

The maximum value of the compressive stress were located in the hub of the head and was 131 MPa, which is 6 times less than the minimum compressive strength titanium alloy.

In accordance with GOST R 52640-2006, we measured the durability of the friction unit hip endoprosthesis method for estimating torque. As a result of this test, the samples retained their integrity. Torque did not exceed 1.5 Nm on the sample surface wear out free products, which fully complies with the requirements of GOST R 52640-2006.

Performed studies to determine the physical and mechanical properties of materials. This was done using a special device that satisfies the requirements of GOST 7038-63 standards and national standard GOST 52640-2006 RF, designed to test the functional characteristics of the node mobility. The resulting work, data were obtained on the moment resistance movement, the elastic modulus, density, tensile strength, Poisson's ratio. (Tab. 1)

Table 1: Physical and mechanical properties of materials.

Material	Modulus of elasticity, GPa	Density, kg / m3	Tensile strength, MPa	Poisson's ratio
Titan	110	$4{,}5\times10^3$	600	0,32
Ceramics	350	$3{,}99\times10^3$	500	0,3
Bone	15	$2{,}4\times10^3$	100	0,3
Pyrocarbon	20-23	$(1{,}8\text{-}2{,}1)\times10^3$	450	0,3

conclusions:

1 Mechanical and tribological properties of carbon friction pairs allow us to recommend this material for use in the node mobility implants large joints.

2: Use for the manufacture of friction pair isotropic pyrolytic carbon will improve the survival rate of total endoprosthesis of large joints.

References

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