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ORIGINAL PAPER

Proposed Use of the Computer as a Tool to Aid Analysis of Properties of Materials in Fixators of Spine

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ABSTRACT

With objective of analyzing the mechanical behavior of the internal fixators of spine and of the bony structure, the pieces and the group were made (it structures bony x internal fixator) with the aid a software of solid modeling. The materials used in the rehearsals had been the titanium, now in the market and a castor oil polyurethane destined to the development of you implant bony.

Key words: castor oil, internal fixators, simulated and structures bony..

1. INTRODUCTION

From beginning to end of life, the skeletal system adjusts to maintain the structural integrity of bones, which in daily life is subject to various conditions of mechanical loading. Consequently, the structural response, in part, due to the past history of loads imposed on the skeleton, the need for this, and the anticipation of future demands (1).

In orthopedic practice, often faced with situations where there is continuity of bone changes (segmental bone loss or fractures), especially because of the high-energy trauma, tumors, infections and congenital malformations (2).

There is a continuous deformation depending on the time of load application. The main element in the ability of the vertebra to support load is spongy. The cortical bone contributes 10% of the compressive strength and bone with 50% (3).

The fixators of the spine for correction of conditions is to make the injured segment disk using screws and rods appropriate way to extend a force to be applied.

Currently the fixators, have been used not only for stabilization of fractures, but also stretches pain and bone compressor, conveyor segments or fragments of bone and reducing fracture (4). However, little is known about the mechanical behavior of these structures and what is the correlation between the choice of the system and assembly, the type of disease being treated and the complications that can set the (5).

The increase in applications and the number of handset models available and studies the influence of effort on bone demanded investigation of the mechanical characteristics of these devices, and different

mounting, in order to adapt them to clinical applications desired (6). Most of the fasteners found on the market for clinical tract, have been used in studies of simulations is made of titanium (7).

In Brazil, the study of biomechanics of the column began in 1987 (8). There are three types of biomechanical studies of the spine: tests of strength, endurance and stability (9).

Strength tests are made by applying a progressive force majeure, until there is structural failure. The fatigue is done by repeated application of a load until structural failure occurs and the stability is given from the application of different loads with different meanings (10).

With a view to facilitate the analysis of specific points of three-dimensional models created the finite element method (FEM), which is the subdivision of the problem in small regions (elements) where the field behavior of interest may approximate the functions simple, such as polynomials or harmonic functions. One reason for this simplification is the reduction of unknowns in the system of equations and consequently reducing the computational time.

In 1984, the Group of Analytical Chemistry and Polymer Technology, University of São Paulo, campus of São Carlos, through the Professor. Dr. Gilberto Chierice, began research for the development of a new polyurethane polyol derived from the castor (11).

Chemical or biological stability, density, and appropriate weight, strength and elasticity, and low cost are essential qualities for the appointment of a biomaterial, but all these factors must be combined with the biocompatibility, which is the primary requirement

for a material that can enter into contact with living tissue without damaging it (12).

2. MATERIALS AND METHODS

The modeling of the internal fixators of the spine (rods, shoes, nuts, screws) and bone structure (cylinder) will be made up in modeling software (Figure 1).

Figure 1 – Fixators x Bone Structure

After modeling the whole, the geometric data will be transferred to the simulation software. The problem will be divided following the steps for using the Finite Element Method thereby generating meshes for each of the components (nails, shoes, bolts, screws, bone structure) (Figure 2).

Figure 2–Mesh Generation

Silvestre Filho (12), analyzed by means of tensile and bending mechanical properties of castor oil polymer reinforced by carbon fiber rods in hip implants. Were also carried out computer simulations of the stem, along with the test device designed for comparison with the experimental results. In their simulations were used as input data the elastic modulus and Poisson's ratio of materials used and also the use of the finite element method. The properties of the materials used in internal fixator of the spine and bone structure are presented (Table 1). Model validation will be performed flexion-compression and lateral bending progressive loading (Figure 3), all degrees of freedom less than the surface of the bone structure (cylinder)

locked to prevent movement of the whole.

Material	Modulus of elasticity (GPa)	Coefficient Poisson
Bone ¹	1,37	0,30
Titanium ²	103,4	0,33
Polyurethane ³	0,7	0,37

Table 1 *Properties of Materials*

Table 2 shows the different values of the loads to be applied in the internal fixation of the vertebral column (titanium and polyurethane castor) (13, 14, 15).

Figure 3–Lateral Flexion tests and flexion-compression

TESTS	LOAD(N)
1	981
2	1177
3	1373
4	1569
5	1765
6	1961
7	2157

Table 2–Values for load tests

The system of fixation with titanium, commonly implemented in patients, using screws 35 mm long and 6 mm in diameter (Figure 4), which is applied at an angle of 60 degrees between the two captive screws to the vertebrae, and separate 10mm (16).

3. RESULTS AND DISCUSSION

The controversy regarding the methodology for conducting mechanical tests for the evaluation of orthopedic implants is basically the use of human bones and testing machines (17). To date not known stiffness ideal implant for use in the spine, and exper-

Figure 4—Components of Fixation System [16]

imental and clinical investigations indicate that increased mechanical stability of the system accelerates bone healing and decrease the rate of pseudarthrosis, and based on this evidence the spinal implants have been developed (18).

The practical results are still far from ideal surgical solution to the problems of the spine, as compared with the reconstructive surgery of large joints such as hip and knee, which enable the maintenance of the movements takes place even spinal arthrodesis and removing movements in situations in which instruments to that segment of the locomotor system. Within the scope of the current fixation systems, there are clear evidences that the screws poliaxial can contribute significantly to address the problems related to the alignment of screws, and their use with the side bars with adjustments, can further aid in the solution this type of problem. It would be very difficult at the moment, to abandon the use of systems that use the longitudinal rods to connect the implants, but many believe that it is valid to divulge the idea of the use of transverse rods, which can perhaps be improved in future or assist in the development of alternative systems for spinal fixation [16].

Through the simulation software loads were applied in flexion-compression and lateral flexion to check the mechanical deformations of the different structures.

The software for the simulation showed the points of high and low voltage (Figure 5) and the critical points occurring in the geometry of the object.

This research project aims to contribute to fixators of the spine, made up derived from castor oil, also show the efficiency of computational methods for simulation of fasteners and analyze the mechanical behavior of materials and study changes in the geometry of the material savings in time and cost.

The polyurethane derived from castor oil is a cheap material and depending on the analysis structural

Figure 5—Points of maximum and minimum stress

could replace the titanium material is expensive. Some critical points in the geometry of the object can be modified through software bringing some savings in waste materials.

4. CONCLUSION

From the sum of the results obtained in carrying out the tests concluded that the simulation software proved efficient in determining the values of compression and tension using the finite element method. The deformations of different materials were compared and the necessary changes for improvements could be made on the same model without the need of building a new one. Based on the literature of the subject and with the collaboration of medical professionals, the results of this research will serve to deliver the application of polyurethane derived from castor oil in the design of internal fixators of the spine.

CONFLICT OF INTEREST: NONE DECLARED

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