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Research Article

Discussion and Research on Orthopedic Biomechanics Testing Technology

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Abstract: With the continuous development of today's science and technology, orthopedic research has also achieved continuous updates in materials and machinery. In this case, the mechanics testing technology of orthopedics also needs to be further updated and developed, so that it can effectively meet the requirement for today's orthopedic mechanical testing. Based on this, this article analyzes several advanced orthopedic mechanics testing techniques. It is hoped that this analysis can provide a reference for the good application and development of orthopedic mechanics testing technology.

Keywords: Orthopedics; Biomechanics; Mechanical testing; Testing technology

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1 Introduction

Because the human body has a very complex skeletal structure, in the application process of orthopedic materials and equipment, in order to effectively ensure the formation of sufficient fit between the human body, and give full play to the application effect. It is necessary to test with the help of corresponding biomechanical testing technology. From the current point of view, orthopedic biomechanics testing technology mainly includes resistance measuring strain technology, optical measurement mechanics technology and finite element testing technology. Therefore, in the research of orthopedic biomechanics testing technology, we should conduct in-depth research on these technologies, and improve the effect of orthopedic biomechanics testing through the reasonable application of these technologies.

2 Resistance measurement strain technology

The so-called resistance measurement strain technology is the "electrical measurement method" we often talk about. This technology mainly uses electronic instruments to convert non-electrical strain into an electrical test method. In the specific application of this method, there are mainly three advantages that can be reflected, and the specific conditions are as follows(Table 1).

Table 1. Three advantages of resistance measurement strain technology

Serial number	Advantage	Specific situation
1	very high accuracy and sensitivity	can realize a resolution of a micro strain (10^{-6})
2	strain gauge has a very small size	although the size is small, it can effectively meet the strain measurement under a large stress gradient, and can perform static strain and dynamic strain measurement in the range of 0-500 Hz
3	measurement result is in the form of electrical signal	the result of measurement is in the form of electrical signal, which makes it easier to realize automated measurement and data processing

With the help of this testing technology, not only on-site measurement can be realized, but also simulation measurement can be realized. The data measured by this technology can truly and objectively reflect the rules of stress distribution inside the component, so it is more direct compared

with other testing technologies. At the same time, the technology can also be used under more complicated environmental conditions, and has a telemetry function, which can realize automatic data recording, analysis and processing, and realize sensor parameters, displacement parameters, pressure parameters and other forms of mechanical parameters according to actual needs.

At present, this technology is mainly used for instrument stress testing of limb bones and internal fixation. As a practical and simple biomechanical testing technology, this technology is very suitable for femoral stress testing after hip prosthesis is installed. At the same time, this technology also shows significant advantages in the process of clinical animal experiments. Through the application of this technology, internally fixed devices can be directly tested during specific operations. This is the function that other forms of mechanical testing technology cannot be achieved. For example, in the long-term testing process of bone strain in the body, scholars such as Maliniak have carried out the research of the strain gauge sticking technology. In the specific research, the hydroxyapatite coating combined with polysulfone is used for sticking. It was fixed on the dog's femur, and then the wire was connected. After twelve weeks, it was found that the strain gauges were all intact[1].

However, this technology can only measure the strain on the build surface point by point, and cannot directly observe all of its stress distribution. In the test, it can only measure the average strain occurring within the area of the corresponding strain. Therefore, there are certain shortcomings in terms of stress concentration and overall understanding.

3 Optical mechanics technology

Optical measurement mechanics technology is also called optical measurement method. This technology mainly utilizes basic optical principles, combined with related mechanics theory, with the help of mathematical tools to perform deduction, through experimental methods to determine the displacement, strain and stress of the structure and to study these mechanical quantities. In experimental mechanics, this technique belongs to a very important branch. The basic feature of optical measurement mechanics technology is to use the optical fringe image in the model to realize the display of the size and distribution of the internal mechanical quantity of the measured structure. This technology is a full-field measurement technology. Therefore, through the application of this technology, it can achieve many advantages that other technologies cannot achieve. The specific conditions are as follows(Table 2).

Table 2. Application advantages of optical measurement mechanics technology

Serial number	Advantage	Specific situation
1	comprehensiveness, concentration and convenience of measurement	It can achieve a comprehensive understanding of the internal stress distribution or displacement distribution of the structure, and clearly reflect the stress concentration, so as to achieve the real-time acquisition of the stress concentration coefficient, making the determination of the location of the stress and its value more convenient , Thus providing sufficient convenience for obtaining the stress boundary value of the structure.
2	Intuitiveness	allows relevant personnel to understand the test results at a glance
3	Analyze and solve	with the help of this technology, the stress or displacement of the structure can be obtained point by point, and the stress and displacement at any position can be solved

In the process of studying the strength of structures, this technology can be used to compare and improve related scheme designs, especially in some photometric images that need to be obtained by photographing and videography. The application of this technology can avoid the inconvenience caused by the direct installation of sensors or other test devices on the structure, and it can also effectively avoid the damage of the structure caused by the contact measurement[2]. The acquired image information can also be stored for a long time, thereby providing sufficient reference basis for subsequent research and review.

Nowadays, although electronic computer technology has been applied and developed quite well in the engineering field, especially the application and development of virtual simulation technology, it has brought a relatively large impact on experimental testing technology. However, because the human body structure itself is very complicated, and the human bones have quite irregular structural characteristics, as a form of experimental mechanics testing technology, the role photomechanics technology which is used in the field of today’s orthopedic biomechanics testing

technology should not to be underestimated. For example, Antonescu used photomechanics technology to study the abnormal distribution of stress after bone joint inflammation. Through research, it was found that osteotomy on the upper end of the tibia is an effective method to treat osteoarthritis. To confirm this research in conclusion, Antonescu also followed up the therapeutic effect of 152 corresponding clinical cases. Through observation, it was found that the therapeutic effect obtained by this method was very good [3]. For another example, experts and scholars such as Ihn used epoxy resin to establish a photoelastic model of the knee joint to study the stress changes after different parts of the meniscus. After research, it was found that meniscus played a crucial role in the human knee joint movement.

4 Finite element testing technology

4.1 Overview of basic principles

In the process of orthopedic biomechanics testing, the basic principle of finite element testing technology is to regard a continuum with infinite mass points and infinite degrees of freedom as a collection formed by finite elements. In this way, it is possible to calculate mechanical parameters for various complex research objects such as bone structure and motion.

In the specific application process of finite element testing technology, the accuracy of the finite element model should be set according to the different requirements of different objects. In specific applications, the more elements are selected, the higher accuracy the finite element will be. If the element mesh density of this finite element model is close to infinity, the solution error obtained will be closer to zero.

With the good development of computer technology today, the development of finite element testing technology is also very rapid. With the assistance of computer technology, many complex calculations can be successfully implemented. Nowadays, many general programs and special programs have been effectively developed. Combining these programs into the pre-processing mechanism and the post-processing mechanism can realize the scientific division of the unit grid and the formation of result graphs. It can be seen that computer software can play a lifeline role in finite element detection technology.

4.2 Application of finite element analysis software

In terms of the finite element software currently used in orthopedic biomechanics finite element testing technology, well-known finite element software mainly includes NASTRAN, SPA and ANSYS. Among them, ANSYS software passed the design and analysis in 1995. Thousands of inspections on engineering problems have resulted in a comprehensive judgment of all indicators such as the stability, reliability and accuracy of the program, and the first to pass the ISO9001 quality certification[4], therefore, compared with other two finite element analysis software, the advantages of this software are more significant.

ANSYS, the finite element analysis software, belongs to the form of a software package with powerful design, analysis and optimization functions. As a software program that can be applied in the field of orthopedic biomechanics testing and calculation, the main features of the program are shown in the following aspect (Table 3).

Table 3. The main features of ANSYS finite element analysis software program

(3) Application of finite element testing technology in orthopedic biomechanics testing

Serial number	Advantage	Specific situation
1	convenience	Compared with the NASTRAN program and the SAP program, the ANSYS software program is a complete Windows program, which is more compatible with today's computers and is more convenient to use. It can provide more convenience for the finite element model demonstration of orthopedics workers.
2	more suitable for human body structure	The software can perform dynamic and static analysis of the structure, as well as the solution of instantaneous dynamics. At the same time, it can extract the natural frequency of the structure to realize modal analysis, which is more suitable for analyzing the complex process of human physiological movement.
3	more reliable calculation	With the help of this software program, nonlinear two-dimensional calculations and three-dimensional calculations can be performed on structures, materials, elements, and geometry. The human bone structure just belongs to the combination of these nonlinear calculations. Therefore, the application of this software can make the obtained calculation results more reliable.
4	quality assurance	Because the technology has passed the international quality system certification, so the quality is also more secure.

In the research on orthopedic biomechanics testing, the finite element testing method involves very comprehensive aspects. It not only includes the stress analysis in the skeletal system, but also includes the research on the internal and external fixation system of the bone, and also includes various Research on the design and optimization of various artificial prostheses. With the development of orthopedics related technologies in recent years, finite element testing technology has also begun to be more and more widely used in various aspects of joints, cartilage, artificial joints, spine, pediatric spine, and trauma orthopedics. Application of this technology can not only construct more realistic models, but also obtain more accurate and reliable calculation results, making the test conclusions of orthopedics biomechanics more credible.

5 Conclusion

In summary, in the continuous development of today's medical technology, the development of orthopedic medical technology has also achieved brand-new breakthroughs, and various new materials and equipment have begun to be widely used in orthopedic treatment. In this process, in order to effectively verify the stress changes and displacement changes of various components, etc., it is necessary to apply advanced biomechanical testing techniques to obtain satisfactory test results. In today's orthopedic biomechanics testing technology, the most advanced and commonly used testing technologies include resistance measurement strain testing technology, optical measurement mechanics technology and finite element testing technology, each of which has its own unique advantages. Therefore, in the specific orthopedic biomechanics test process, a reasonable test technique can be selected according to the actual situation to achieve scientific and accurate acquisition of test results

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