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БУДУЩЕЕ ПРОТЕЗИРОВАНИЯ ВЕРХНИХ И НИЖНИХ КОНЕЧНОСТЕЙ

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The Future of Upper and Lower Limbs Prosthetics

Аннотация. В статье представлена информация о тестировании и критериях протезирования в целом, основные аспекты взаимодействия органических тканей и датчиков в искусственных конечностях. Основная цель статьи – описать настоящее положение дел в сфере протезирования конечностей, их виды, критерии, способы тестирования и рассмотреть проблемы, возникающие при протезировании конечностей у людей.

Ключевые слова: Протезы, протезирование конечностей человека, проблемы протезирования.

Abstract. The article presents information about testing and criteria of prosthetics in general, and the main aspects of interaction between organic tissues and sensors in artificial limbs. The main purpose of the article is to describe the current state of affairs in the field of limb prosthetics, their types, criteria, methods of testing and to consider the problems arising from human limb prosthetics.

Key words: prosthetics, prosthetics of human limbs, prosthetics problems.

Introduction

Now there are many people in the world who can’t live a full life like all of us because they have either defects in their limbs at birth or loss of limbs as a result of some events. That's why people have invented prostheses, which have existed for a long time, but the inventor scientists have only now achieved the proper functioning of these prostheses. Prosthetics is mainly divided into 2 categories, lower limbs and upper limbs.

What is prosthetics?

Prostheses, in our time, are artificially created parts of the body that are used to replace parts of the body that have been lost or missing since birth. Prostheses can both have a purely aesthetic function or help to restore functionality to the desired part of the body. In the case of limbs, for example, biosensors help to provide the carrier with the ability to move the limb.

New prosthetic testing method

The assessment is mainly done with the help of several test groups of different ages and needs (prosthetics). They are selected in specialized centers. These same groups give an assessment based on various criteria and the prototypes shown to them. Tests often use the Likert scale.

Criteria for prosthetics

When releasing and testing new models there are many criteria, and here are the main ones:

1) Performance: Improvements in material science will likely lead to the production of more efficient dielectrics, while progress in construction will allow for better use of these dielectrics and their conversion into actuators.

2) Reliability: A particularly important aspect for biomedical/biological applications. The more integral the actuator becomes to the functioning of an orthotic or prosthetic, and the more crucial the orthotic and prosthetic becomes to a person's way of, or very life, the more reliable the actuator must be.

3) Reverse functionality for artificial muscles compared to the original ones: While not necessarily a shortcoming, it must be recognized that dielectric elastomer artificial muscles have an opposite active state compared to natural muscle. Natural muscle contracts when energized, while dielectric elastomer artificial muscles contract when de-energized. However, research in this area is ongoing and Carpi et al. and others have demonstrated dielectric elastomer designs that are capable of operating in a contractile mode like natural muscle.

4) Electrical safety: Prostheses powered by dielectric elastomers must be safe for the user and others. During normal operation at low currents, dielectric elastomers require high voltage to operate. External devices must be robust to withstand wear and tear and changing environmental conditions, while maintaining the integrity and safety of electrical equipment. Both indoor and outdoor devices must be thoroughly tested and inspected.

Skeletal fixation of prostheses

Scientists use a variety of methods in their development, and one of them is to borrow some developments that can take root in the field of prosthetics. Several decades ago, the Swedish physician Per Branemark astounded the dental profession by developing a surgical technique to permanently anchor artificial teeth into the jaw. Despite numerous outcries about the futility of such efforts at the outset, his methods are now accepted worldwide as a routine method of dental restoration. In the past few years he has turned his attention to achieving similar results for upper and lower limb amputees and has generated similar controversy. Preliminary results, and enthusiastic feedback from participating amputees, justify further exploration of this technique

If these prostheses are proven to be effective over an extended period of time (at least 10 years), direct attachment of the prosthesis to the frame can help avoid the difficulties associated with the creation of individual prostheses, where installation comfort depends on the volume matching of the amputation of the stump. As a dynamic body, the stump tends to contract (atrophy) over time, although it can also swell with increasing temperature or weight, which can lead to abrasion. With osseointegration, these volume changes do not affect the fit of the prosthesis.

The drawbacks of this technique are that it requires two stage surgery to attach the titanium implant to bone. The procedure carries the risk of osteomyelitis or infection at the abutment of the implant, and meticulous personal hygiene is a prerequisite in patient selection. On a practical note, the typical Western person with a lower limb amputation, elderly and with poor circulation, is not likely to be a candidate for such an involved surgical procedure. It is primarily the subset of younger individuals, often with traumatic amputations, for whom this technique holds the greatest promise.

Comparative trials of this technique are not possible. To date, the patients selected for this procedure have a high level of amputation above the knee, for which all other prosthetic methods have proven ineffective. However, a three-year observation of several dozen participants showed that amputations with an osseointegrated prosthesis quickly develop excellent limb control, at least in part because of the heightened sensitivity called "osteoperception" in Branemark. This combination of enhanced comfort, perception and control is expected to drive the next round of technological innovation, as is the case with more advanced outlet models.

Advances in orthopedic technology

Over the past two decades, prosthetics technology has advanced significantly, largely driven by the needs of amputees. Otherwise, healthy middle- tibia amputees must be able to perform the full range of normal duties, walk without any noticeable limp and play sports and entertainment.

Carbon fiber composites developed in the aerospace industry are increasingly used in artificial limbs, mainly because of their excellent strength and weight characteristics. One of the most successful innovators was Flex-Foot, founded by an American researcher and amputee Van Phillips. By the 1990s, Flex-Foot carbon spring-loaded feet were widely recognized as the most effective way to store and release energy while walking and, in particular, for sports activities during leisure and competition. The combination of improved connector and legroom comfort and dynamic response allows medalists at the Paralympic Games to travel a distance of 100 meters approximately one second before the Olympic record.

State of the art and problems

It is useful to look at the current state of the art here. Modern prostheses are equipped with connectors, which are made by a specialist prosthetist for precise fixation to the stump of the patient being amputated. It is very important that the fitting is accurate, and most prostheses must be adjusted regularly, which, like all customization processes, is time consuming, time-consuming and often inconvenient. There are not many prosthetics and travelers to clinics on this or that issue (this is, of course, even more acute in developing countries and conflict zones, where amputation of limbs is disproportionately common and weakens health). Even optimally adjusted nests are not ideal; the stump can slip off the surface, become sweaty and uncomfortable, and prolonged wear and tear can be painful. This is especially true for lower limb prostheses. As the body weight falls on the ulcers in the nests, there is a constant risk of infection.

The most modern prostheses available today have a certain degree of mental control, but no sensory feedback. Control is achieved through a phenomenon called myoelectricity. The remaining stump muscles still react when the user "moves" the missing limb, resulting in electrical signals on the skin that can be detected by sensors in the socket. Although these signals may not be fully consistent with the movements that a missing limb would make, the user can learn to make prosthetic movements in the desired direction.

Myoelectric sensors are quite inexpensive, and signals can be processed with ready-made chips and sent to the motors in prostheses. Companies such as Open Bionics, about which the engineer has told, use such technology in the prosthetic hands and palms which are developed for an open source code and can be made of the details made on commercial 3D-printers.Myoelectric control is highly dependent on the fit between the stump and the prosthesis, as the sensors that detect the muscle signal must be positioned accurately on the right skin area.

In addition, this technology is best suited for hands and hands. Legs represent another set of problems because, when walking normally, the movements of knees, feet and ankles are more autonomous and less conscious than the movements of hands, hands and fingers; they also have to cope with various types of stress and perform more mechanical and supportive functions. Therefore, the area of prosthetics in general is sharply divided between the upper and lower extremity specializations.

Conclusion

The future development of limb prosthetics will very much depend on market demand. As a consequence, the market for low-cost and functional devices will expand to meet the needs of different countries with different degrees of development. In prostheses, technologies from other fields of science and technology will continue to be adapted to bring functionality close to the present one. Now the main problem is the cost of modern prostheses and their components and attempts to reduce the price without losing functionality continue.

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