

Research on Development Status and Trend of Mechanical Prosthetics

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Abstract: With the progress of social economy and science and technology, there are more opportunities for the development of medical industry. Moreover, the life span of human beings is increasing, and the requirements for quality of life are getting higher and higher, which makes clinical medicine and rehabilitation medicine face greater challenges. Orthodontics and appliances are an important part of rehabilitation medicine. Amputees and disabled limbs, by wearing appropriate mechanical prostheses and orthotics, can effectively improve the limb function, help to recover and return to normal social life. Therefore, mechanical prosthesis plays an important role in rehabilitation medicine. Fitting artificial limbs and orthotics requires the coordination and cooperation of doctors, patients and rehabilitation teachers, and only in this way can their effectiveness be maximized. Based on this, this paper first expounds the function, classification and characteristics of mechanical prosthesis, and then expounds the present situation and future development trend of mechanical prosthesis technology in China.

Keywords: Mechanical prosthesis, Orthotics, Development status, Development trends.

1. Introduction

According to relevant statistics, the proportion of disabled people in China is about 7% of the national population, and this figure is still increasing in recent years [1]. All kinds of physical disabilities cause inconvenience to patients' psychology, daily life and employment. At present, China's economy is growing rapidly, the construction of a harmonious society is vigorously promoted, the level of social security is constantly improved, and the rehabilitation of the disabled is booming [2]. Prosthetic and orthopedic industry, which is closely related to the rehabilitation of the disabled, has ushered in a vigorous development opportunity. Prosthetics are artificial hands and feet that are made and assembled to restore the shape or function of the original limbs and compensate for the partial defects of limbs caused by amputation. The orthosis is an external support device, and its main function is to relieve the dysfunction of the patient's neuromuscular system [3]. Prosthetic orthosis is a part of rehabilitation medicine and rehabilitation engineering, and the assembly of mechanical prosthetic orthosis needs the cooperation of a team composed of patients, clinicians, prosthetic orthosis technicians and rehabilitation technicians [4]. Only in this way can the application of this technology continue to develop. Prosthetics can restore the original shape or function of the disabled limbs, and reduce the dysfunction, so that they can live, study and work independently in the future.

With the extension of human life and the development of clinical medicine and rehabilitation medicine, the technical requirements for mechanical prostheses are getting higher and higher. In rehabilitation medicine, mechanical prosthesis occupies an important position [5]. Prosthetic limb is an important motor function substitute tool for amputees, and it is an artificial limb manufactured and assembled to make up for amputees' limb defects and compensate their limb functions [6]. With the gradual implementation of clinical examination of prosthetic orthopedic prescriptions, the expansion of prosthetic orthosis assembly outlets, the further popularization of prosthetic orthosis products, and the gradual

matching and improvement of raw materials and spare parts supply services, the role of mechanical prostheses in clinical and rehabilitation medicine will become more and more important [7]. At present, the mechanical prosthesis technology is gradually popularized in the medical field, and the details of prosthetic products, including parts quality and materials, are constantly improved and adjusted. The significance of mechanical prosthesis for rehabilitation medicine is also more prominent. Based on this, this paper analyzes the present situation of mechanical prosthesis and orthosis, and discusses the future development trend of mechanical prosthesis technology.

2. Function and Classification of Mechanical Prostheses and Orthotics

2.1. Function and classification of mechanical prosthesis

The main function of prosthesis is to restore the normal function and shape of limbs. For patients with limb injuries, prosthetics can compensate for their disabled limb functions. Prosthetics can restore the original shape or function of the disabled limbs, and reduce the dysfunction, so that they can live, study and work independently in the future. For example, knee joint is a highly nonlinear, time-varying and strongly coupled system [8]. Intelligent knee joint can automatically adjust the control torque of prosthetic knee joint to adapt to the changes of walking speed and joint angle, so that the gait of prosthetic knee joint is closer to that of healthy people in symmetry and follow-up, and it has high bionic performance. The idea of mechanical prosthesis technology lies in comprehensive rehabilitation, and at the same time, other related disciplines are taken as theoretical guidance [9]. Including materials science, biomechanics, electronics, engineering, polymer chemistry and medicine. In the practical application process, all kinds of advanced technologies should be applied through the close cooperation of patients, medical staff, patients' families and rehabilitation workers to help patients recover to the maximum extent. Therefore, the

prosthesis and orthosis technology is more practical. Figure 1 shows a mechanical prosthesis.



Figure 1. Mechanical prosthesis

Prosthetics can be divided into upper limb prostheses, lower limb prostheses, artificial joints and decorative prostheses according to their positions and functions. The upper limb prosthesis can be divided into artificial finger, palm, forearm prosthesis and upper arm prosthesis. Lower limb prosthesis can be divided into artificial toe, foot, leg prosthesis and thigh prosthesis, etc. For patients with lower limb disability, wearing lower limb prosthesis can completely compensate for the loss of human function, so that patients can take care of themselves and even work, thus returning to society. Artificial joints include artificial knee joints, hip joints, spinal joints, etc. Decorative prostheses include artificial ears, nose, dentures, etc.

2.2. Functions and classification of orthotics

Orthotics are a kind of external support devices. Its function is to reduce the dysfunction of muscle system such as limbs of patients [10]. Orthotics can be divided into upper limb orthosis, lower limb orthosis and trunk orthosis according to their positions and functions. Its functions are: (1) Fixing joints. (2) Protect the injured joints and limbs of patients. (3) The use of orthosis for patients with bone deformity and joint deformity can avoid deformity at the place where the lesion is corrected. (4) The long bearing weight of patients' limbs is greatly reduced. (5) It can control the muscle reflex spasm in the process of walking or standing. (6) It can effectively improve patients' walking and eating behaviors. Prosthetic and orthotic devices, which are different from common devices, are auxiliary devices to be worn on the human body, and need to strictly meet the psychological, pathological and medical principles of the physically disabled. Orthotics are used to treat the physiological and pathological requirements of people with dysfunction, and they need the guidance of clinicians and rehabilitation workers.

3. Characteristics and Development Status of Mechanical Prosthesis

China started late in prosthetic research, and there is still a big gap compared with developed countries such as Europe, America and Japan, and there are some prominent problems, such as low technical content of products and a big gap in

some important varieties. Throughout the development history of assistive devices in various countries, the research and development of rehabilitation assistive devices began with the research and production of prosthetic devices, orthoses, wheelchairs and other assistive devices, and China was no exception. In the past, the production of artificial limbs and orthotics was handled by the civil administration system. Clinicians don't know much about the knowledge of prosthetic orthosis, which leads to the separation between the patient's means treatment and the prosthetic orthosis treatment, and then the ideal rehabilitation effect can't be achieved. Prosthetic and orthotic techniques depend on the close cooperation between rehabilitation personnel, patients and clinicians, and all kinds of techniques can be used to effectively help patients achieve the effect of limb rehabilitation. The existing intelligent knee prosthesis products are shown in Table 1.

Table 1. Intelligent knee prosthesis products

Country/region	Product
China	V One
	TGK-5PSOIC
	ADLIB
	Pneumatic four-bar intelligent knee joint
Germany	C-Leg
	Genium
Iceland	POWER KNEE
	Reho Knee
Britain	Adaptive Knee
	Orion2
	SmartIP
Japan	Hybrid Knee
	Intelligent Knee Single Axis
	Intelligent Knee Four-bar Axis
Italy	REL-K Electronic K nee

At present, there are many kinds of intelligent prosthetic products all over the world, and there are many kinds of prosthetic prototypes in the laboratory research stage. It is the main task of prosthetic and orthotic technology in rehabilitation medicine to make the old, weak and disabled people recover and promote their functional recovery, reconstruction or compensation by means of engineering. For those who are physically disabled due to accidental injuries, the technical means of artificial limbs and orthotics are the only and sometimes even the only rehabilitation method. At present, the National Institute of Prosthetic Science, a civil affairs department, is constantly improving its technology on the basis of introducing foreign advanced technology. There are more and more enterprises in various countries in prosthetic appliances, and the competition is more intense. The research on intelligent lower limb prosthesis, especially knee prosthesis, has developed rapidly in China. Many universities and institutions have carried out corresponding research and achieved certain results. At present, foreign intelligent prosthetic products are relatively mature and expensive, and domestic prosthetic companies still can't meet patients' demand for high-performance prosthetics.

Physical therapy, occupational therapy, speech therapy and other rehabilitation methods are needed to cooperate with prosthetic orthosis technology. Therefore, prosthetic and orthotic technology plays an important role in rehabilitation

medicine and plays an irreplaceable role. In recent years, effective platforms for communication between clinicians and prosthetic orthosis technicians have been built in various parts of China, which has greatly popularized the knowledge and content of prosthetic orthosis treatment. At present, more efforts have been made to promote the integration of patients' surgical treatment and prosthetic orthosis treatment, providing a better guarantee for patients' comprehensive rehabilitation. In addition, the currently established Clinical Prosthetic Orthotics Group has also promoted the contact between prosthetic orthosis manufacturers and medical institutions, and further promoted the setting up of orthosis studios in medical institutions, thus greatly facilitating the assembly and manufacture of personalized orthoses.

4. Development Trend of Mechanical Prosthesis

(1) Traditional products are combined with computer technology to form mechatronics or artificial intelligence products. For example: intelligence of lower limbs. Intelligent knee joint is very different from the mechanical knee joint control method developed before. Most laboratories study knee joint or ankle joint alone and design artificial limbs. There is a big gap between the above design and normal walking characteristics in gait and other performance. Normal walking is the interaction between knee joint and ankle joint, so a better way is to combine the design of knee joint with that of ankle joint, and consider the movement of knee joint and ankle joint, so as to design knee-ankle joint integrally. At present, many well-known foreign companies have self-developed intelligent knee joint products. Three foreign prosthetic companies, Germany, Britain and Japan, have their own brand-name and intelligent knee joint products, and they are still developing. However, although the combination of computer technology and traditional technology has been developed for several decades, due to the complexity of the body data, the intelligent technology still needs to be further improved and studied.

(2) Man-machine integration is the application of biomaterial technology to human rehabilitation, forming a "man-machine integration" product. This technology was developed in the 1990s. For example, an implantable osseointegrated prosthesis. Implant is made of biocompatible material, one end of which is implanted, which grows into a whole with the stump bone, and the other end is connected with the prosthesis. This can avoid the discomfort of the receiving cavity, which is more in line with the biomechanical principle, and at the same time it brings feasibility to the development of this technology. In addition to the advantages of overcoming the discomfort caused by the original socket and being more in line with biomechanical principles, this technique has many technical potentials that can be further developed, such as realizing neural control.

(3) The plasticity of human body function is strong, which can be used as a principle to design certain devices to promote the recovery of human body function. Bionic control is to design some devices according to the plasticity of human body's function to promote the recovery and regeneration of functions. This technique allows artificial limbs to be directly connected to human bones through skin-wrapped metal implants. For example, biofeedback functional rehabilitation technology, biofeedback rehabilitation therapy is an active training method to restore and improve muscle autonomy.

Through visual and auditory feedback, it enables patients to control muscle contraction independently, so as to achieve the purpose of nerve-muscle training. From these advances, it can be seen that intelligent control technology with adaptive, self-organizing and self-learning functions, especially intelligent control technology with real-time and fast learning performance, is the inevitable trend of future development.

5. Conclusions

The research of mechanical prosthesis abroad started earlier and the technology is mature, and there are many kinds of intelligent prosthesis products on the market. Domestic research started late, but it has developed rapidly in recent years. Many universities and research institutions have conducted research, and self-developed products have also appeared on the market. Mechanical prosthesis is an artificial hand and foot made and assembled to restore the original shape or function of limbs and compensate for the partial defects of limbs caused by amputation. For disabled patients and amputees, the installation of mechanical prostheses can restore the original shape or function of the disabled limbs, and reduce the dysfunction, so that they can live, study and work independently in the future. In recent years, with the increasing number of amputees caused by traffic, industrial accidents, natural disasters and cardiovascular diseases, the research of mechanical prosthesis has become a hot spot in various countries. Therefore, it is of theoretical and practical significance to study the development status and trend of mechanical prosthesis. Based on this, this paper expounds the function, classification and characteristics of mechanical prosthesis, and expounds the present situation and future development trend of mechanical prosthesis technology in China. In order to promote the mechanical prosthesis technology in China to a new level.

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