Computer Aided Processing System of Medical Foot Orthopedics Based on Medical Engineering

Qinyuan Yu
Shanghai Yang Zhi Rehabilitation Hospital (Shanghai Sunshine Rehabilitation Center), Shanghai 201619, China

Jiangang Cao
Affiliated Rehabilitation Hospital of Xuzhou Medical University (Xuzhou Central Hospital), Xuzhou 221009, China

Linlin Zhang
Shanghai University of Medicine & Health Sciences, Shanghai 201318, China

Longzhu Huang
Shanghai Yang Zhi Rehabilitation Hospital (Shanghai Sunshine Rehabilitation Center), Shanghai 201619, China

Tong Zhang
Shanghai University of Medicine & Health Sciences, Shanghai 201318, China

Bin Wang*
Department of Plastic and Reconstructive Surgery, Shanghai Ninth People's Hospital, Shanghai Jiaotong University School of Medicine, Shanghai 200011, China
*Corresponding author (E-mail: wangbin1766@163.com)

Abstract
The plantar orthosis system based on CADCAM system has very important practical value in the treatment of foot diseases. In order to effectively alleviate the growing incidence of foot disease in our country, the author gives an overview of the related theories of CADCAM system in this study. Then the author designs the foot orthosis based on computer system and applies it to practical during the treatment of plantar diseases. The results show that the CADCAM which is based plantar orthotic system can effectively treat patients with foot diseases by comparing to the traditional foot disease treatment. The purpose of this study is to provide a reference for the improvement of related technologies in the treatment of foot diseases.

Key words: CADCAM System; Plantar Orthosis System; Computer Aided Process; Foot Disease.

Sistema de Procesamiento Asistido por Computadora de Ortopedia Médica para Pies Basada en Ingeniería Médica

Resumen
La ortesis plantares sistema basado en el sistema de CAD / CAM tiene muy importante valor práctico en el tratamiento de las enfermedades del pie. A fin de aliviar la creciente incidencia de las enfermedades del pie en nuestro país, el autor ofrece una visión general de las teorías del sistema de CAD / CAM en este estudio. Entonces el autor diseña el pie ortesis basada en el sistema informático y la aplica a la práctica durante el tratamiento de enfermedades de planta. Los resultados muestran que el sistema de ortesis plantares CADCAM que se puede tratar eficazmente a los pacientes con enfermedades de los pies, comparando a la tradicional pie tratamiento de la enfermedad. El propósito de este estudio es proporcionar un punto de referencia para la mejora de las tecnologías en el tratamiento de las enfermedades del pie.

Palabras clave: Sistema de Ortesis Plantares Sistema CADCAM; Enfermedad de Pie; Proceso Asistido por Computadora.
1. Introduction

With the development of the times, people are now paying more attention to the improvement of their physical health while the basic material life conditions are satisfied. Whereas, feet as a necessary part of people's actions, it tend to have some neglect of plantar disease [2]. The incidence of plantar diseases often affect people's actions to some extent, and it even have some negative impacts on people's daily life. For patients with congenital flat feet, they often suffer the entire soles of the feet soreness caused by long-term external walking. And because of long-term high-heeled shoes walking, people's walking will get affected [3]. Therefore, timely correction for this series of common foot diseases may be alleviated to a certain extent and thus will have a more positive impact on people's overall health [4]. In the new era of development environment, computer technology as an emerging technology, its advantages prompted it to be gradually applied to the development of various industries [5]. In this study, based on the analysis of the design status of foot orthosis in China with computer-aided technology, the author described the system about foot-sole orthosis which was based on CADCAM system. The purpose of this research is to provide a reference for how to make patients recover early and alleviate their illness.

2. State of the Art

Foot diseases, as a disease that has a relatively large impact on human health, are often overlooked by human health research institutions due to various causes such as the site of the disease [6]. However, with the development of medical technology and the changes of the times, especially the high-heeled shoes worn by women in the modern era for the pursuit of beauty, the incidence of foot diseases has been increasing year by year. Therefore, under the developing current situation, orthodontic techniques for foot patients begin to gradually develop, to a certain extent, and solve the seriousness about diseases of foot patients. As a new technology developed under the current era, the rapid development of this technology has led to the diversification, such as three-dimensional technology, which has led to the gradual application of this technology in many industries [8]. Especially in the medical industry, the introduction of such technology has succeeded in alleviating the symptoms of more disease patients and providing an important impetus to the improvement of people's health [9]. Today, many fields of foot orthopedics have started to apply computer technology to the system design of foot orthosis, and provide technical support the correction of foot problems for people [10]. Some studies suggest that many western developed countries have designed computer-based foot orthopedic systems and started selling them as commodities [11]. With the continuous maturation of this kind of system, some scholars have analyzed the using process of the system. The running process mainly scans the patient's foot administration by using the scanning technology of computer technology and constructs its model through the system. According to the collection of relevant data, they studies and obtained the treatment of late treatment [12]. Through the application of this kind of equipment, the patients with foot diseases in many countries and regions have been relieved to a certain degree, which also provides the further basic guarantee for their more comfortable production and life process.

3. Methodology

Because of the most popularity in the world and aging society, some studies suggest that the incidence of diseases of the national foot also rises. Some scholars in our country through the statistics of the incidence of foot patients statistics found that the incidence of foot diseases in our country mainly include foot arthritis, flat foot and diabetes caused by the type of foot patients. Although the state has gradually increased its investment in the treatment of foot patients, the number and quality of foot orthosis used in patients with foot problems in our country are limited due to the related technical and theoretical limitations. There is also a big gap between developed countries in the world. And because the foot orthosis in western has advantaged correction, but the prices also demand higher, which caused limitations for our nationality in the application of foot orthosis. Therefore, by using more reasonable techniques and theories to design plantar orthotics in our country and increasing the production of plantar orthotics, it is of great importance to the rehabilitation of our patient population and its normal production and life Affected. Under this trend, many universities and research institutes in our country have started to strengthen the research on foot orthopedic technology and theory. Especially the development of computer technology, which can collect a large amount of data and information, and can design and construct the site of foot disease by using technologies such as three-dimensional imaging and virtual simulation, and make it more suitable for patient rehabilitation Foot orthosis design, making the technology began to be widely used in the foot orthosis design process (Figure 1). However, due to the late start of the theory and technology in related industries in our country, there is still a lack of designers in the relevant orthotics computer systems in our country, which to some extent resulted in the correction efficiency of the
plantar orthosis designed in our country. Lower or even the process of error correction and other phenomena, which to some extent, affect the actual use of late patients. Therefore, in order to better promote the development of this kind of technology in our country, on the basis of describing the current situation of foot disease in our country and the theory of plantar correction, the author in this study, based on computer technology The CADCAM system builds the plantar orthosis system used in the study. Based on the completion of the system construction, the author applies the system to the actual process of plantar disease correction, and aims to provide a platform for our country's computer technology Of the foot orthopedic technology and improve the theory to provide some reference, and ultimately for our national foot disease reduction in the incidence of disease and the patient's recovery after the onset of increased rehabilitation to provide some technical support for our national happiness A sense of improvement offers a positive impact.

Figure 1. Foot orthopedic technology development

In this study, the author in order to obtain more credible research results, the author based on the relevant information to read and obtain a more complete theoretical knowledge based on the author through the relevant orthopedic technology and practical application of the theory and the combination of practice provides a data support and reference for the development and improvement of foot orthosis in our country. The specific methods of this study are as follows:

(1) Through reading and searching related information, the author summarizes the current incidence of plantar disease in our country and the incidence of other countries, and then on this basis, the incidence of plantar disease in different countries and regions Compared to determine the need for the development of plantar disease correction technology in our country.

(2) While confirming the meaning of this sub-study, the author reviews related theories of CADCAM system and its advantages in the actual treatment of foot patients by reading related materials. On this basis, the author through the relevant information and theory to understand, of which, CADCAM system structure shown in Figure 2 [14]. Thus, the running process of computer system of foot orthosis in CADCAM system was constructed. The research process mainly provided technical support for the subsequent practical operation.

Figure 2. CADCAM system structure diagram
(3) The author based on a relatively clear understanding of the theory and constitutes the CADCAM system used in this study on the basis of the plantar orthotics, and then applies the plantar orthotic foot in patients with actual disease treatment process in this study, the relevant patient information is shown in Table 1. In order to confirm that the orthopedic effect may be influenced by the patient's other modalities of treatment, all orthopedic personnel selected by the author are undergoing other orthopedic procedures. Data were collected from the treatment of foot orthosis on CADCAM system in patients with plantar patients, mainly on the analysis of the patients' symptoms, the time of plantar orthosis design and correction, the design of plantar orthosis Equipment application results and patients with foot orthosis design products applied comfort (maximum comfort score of 5 points) and other data collected to determine the feasibility of the plantar orthotics; the author further analyzed comparatively about the orthopedic effect between the plantar orthodontics and traditional orthopedist based on orthopedic experience; and it concluded that the foot orthosis application advantages which was based on computer system.

<table>
<thead>
<tr>
<th>Illness symptoms</th>
<th>Quantity</th>
<th>Average age</th>
<th>Is there any other orthopedic treatment?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint inflammation</td>
<td>20</td>
<td>47.12±5.43</td>
<td>No</td>
</tr>
<tr>
<td>flatfoot</td>
<td>20</td>
<td>42.41±5.77</td>
<td>No</td>
</tr>
<tr>
<td>Clubfoot</td>
<td>20</td>
<td>39.27±7.24</td>
<td>No</td>
</tr>
<tr>
<td>Bow-shaped foot</td>
<td>20</td>
<td>36.53±4.39</td>
<td>No</td>
</tr>
<tr>
<td>Diabetic foot</td>
<td>20</td>
<td>56.14±10.71</td>
<td>No</td>
</tr>
</tbody>
</table>

4. Result Analysis and Discussion

4.1 The comparison results of foot disease incidence in today’s world

By reviewing the medical record data of national foot disease patients with high prevalence rates of four world foot diseases in China, the United States, the United Kingdom, and Japan, the authors conducted a survey on the prevalence and incidence of plant foot diseases in four countries; and the results is shown in Figure 3. The results show that with the development of the times, the incidence of plantar disease in our country shows a trend of increasing year by year. In 2010, the incidence of plantar in our country surpassed that of the United States and Britain. However, the incidence of plantar in Japan has been highest. By analyzing this result, the author believes that in the development of the times, the economic level of our country has been greatly improved and improved. However, with the increasingly rich living standards of our country, the population of our country is also beginning to show the trend of aging. The problem of aging population may not only limit China's overall economic growth, but also may further reduce the health level of our nationals due to the incidence of certain elderly diseases. Therefore, the treatment and diagnosis of senile diseases has become an important issue in the development of our country, which is also one of the important causes of the increasing incidence of foot diseases in our country. Secondly, the foot patients as one of today's times it is mainly caused by the injury or some disorder of the human skeletal muscle system. The specialization of the nature of the work for some people increases the degree of damage to the skeletal muscular system of the human body, such as the long-term work by wearing high heels, and it’s also the major reason for increasing foot disease rate in our country. In addition, some scholars believe that as people's living standards rise, the incidence of national diabetes increased at the same time may also cause our national foot joints affected by this disease, which result in foot disease, and endanger the health of people’s body [15]. Therefore, paying attention to the diseases of foot patients is of great importance to the improvement of the health of all citizens. In this development needs, our country also needs to further strengthen the foot disease research and related foot orthosis technology and system design. Only through a more complete study of technology and theory can we provide technical support for the reduction of the disease rate of our country's somatic diseases. And provide a positive impact on the improvement of the health of our nationals.
The foot disease incidence constantly increasing in China day also indicates that the necessity of the study of foot orthosis in our country. The development of computer technology began to gradually apply to the developing various industries, as this kind of technology can collect related data and information of each industry, so some industries in the development process can obtained some basic information resources which is good for the development of the industry through the analysis of data and information. Therefore, to some extent, it promoted the enthusiasm for the development of the industry. China's health care industry experts have also begun to consider the computer technology and the traditional foot orthopedic technology combined to form a suitable for different groups of patients with foot orthopedic technology. Such as the emergence of CADCAM system, the system can be based on the empirical data collected by the system for the feet of patients with foot disease information data analysis and processing to design an actual foot orthosis with the same shape, and then the patient can intuitively understand the graphics. The post-orthodontist can debug and process the constructed graphics according to the actual needs of the patient, and finally debug the actual foot orthosis that suits the patient. The application of this kind of technique reduces the uncomfortable feeling of foot orthosis to a certain extent, and with the application of this technology, it is also effective to avoid the waste of material for some orthopedic design materials. Therefore, the superiority of this technique is of paramount importance for the development of foot orthosis. After the author summarizes the related theories and advantages of CADCAM technology, the author then builds a computer system of foot orthosis based on this technology, and the system running diagram is shown in Fig. 4. From the figure we can clearly see that the CADCAM system based on the construction of the plantar orthotics can be more comprehensive information on the patient's foot planar collected and based on all the data and information through the computer's calculation model for integrated treatment, Which provided the data information support for the actual production of foot orthosis in the later period and also increased the reliability performance of the constructed foot orthosis.
4.3 The therapeutic effect of foot orthosis system for patients with foot disease based on CADCAM system.

In order to determine the practical value of the designed plantar orthotics, the authors applied this system to actual treatment of foot patients. Analysis of the patient's symptoms, foot orthosis design correction device time, plantar orthosis design correction device application results and patient foot orthosis design products, such as the application of awareness of data collection, the results are shown in Table 2. The results show that the plantar orthotics system can analyze the patient's symptoms more accurately, the accuracy of the analysis of the disease is as high as 93%, and the design of the orthosis is relatively short. The final application effect and the patient the application of comfort is higher. Thus, it shows that the CADCAM system-based orthopedic system has a more important practical significance in the treatment of patients with foot disease.

<table>
<thead>
<tr>
<th>Illness symptoms</th>
<th>Number of people</th>
<th>Analyze the exact number</th>
<th>Design time</th>
<th>Application effect</th>
<th>Application comfort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint inflammation</td>
<td>20</td>
<td>18</td>
<td>14.21±3.27</td>
<td>Patients all achieved the desired results</td>
<td>4.11±1.27</td>
</tr>
<tr>
<td>flatfoot</td>
<td>20</td>
<td>20</td>
<td>5.49±1.11</td>
<td>Patients all achieved the desired results</td>
<td>3.94±0.92</td>
</tr>
<tr>
<td>Clubfoot</td>
<td>20</td>
<td>20</td>
<td>6.73±1.41</td>
<td>Patients all achieved the desired results</td>
<td>4.32±0.99</td>
</tr>
<tr>
<td>Bow-shaped foot</td>
<td>20</td>
<td>19</td>
<td>5.92±0.78</td>
<td>Patients all achieved the desired results</td>
<td>4.19±1.01</td>
</tr>
<tr>
<td>Diabetic foot</td>
<td>20</td>
<td>16</td>
<td>21.34±5.93</td>
<td>Patients all achieved the desired results</td>
<td>4.37±1.35</td>
</tr>
</tbody>
</table>

4.4 Comparison results of diagnosis and treatment about the foot orthopedic system based on CADCAM system and traditional plantar treatment

The author further analyzes the effect of foot plantar orthosis system based on CADCAM system in the traditional treatment of foot plantar. And the results are shown in Table 3. The results showed that the CADCAM-based system of orthotic orthosis was significantly higher than that of traditional plantar orthodontic treatment in every comparison index. This may be due to CADCAM system-based orthopedic system by making use of massive data information of computer technology, which makes the designed corrective equipment become more suitable for patients.

<table>
<thead>
<tr>
<th>Correction method</th>
<th>Accuracy of illness analysis</th>
<th>Design time</th>
<th>Application effect satisfaction</th>
<th>Application comfort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot orthosis system</td>
<td>93.00%</td>
<td>11.32±5.31</td>
<td>87.12±4.33%</td>
<td>4.30±1.51</td>
</tr>
<tr>
<td>Traditional plantar correction</td>
<td>79.00%</td>
<td>16.45±7.11</td>
<td>71.17±11.23%</td>
<td>3.67±1.93</td>
</tr>
</tbody>
</table>

5. Conclusions

With the development of the times, the medical industry in this world has been greatly improved. People are starting to pay more attention to the improvement of their own health while material needs are met. Foot disease as a disease affecting people's basic behavior in today's era, it may be caused by either natural causes or due to acquired habits or other diseases caused by complications. Based on the collection of data which are related to the incidence of foot disease in our country, the author analyzed the causes of foot disease in our country and so on, which confirmed the significance of this study. As a key technology for the treatment of foot diseases, the design and development about foot orthosis have practical significance for patients who got foot disease, and the emergence of computer technology for the design of foot orthosis provided technical support. However, due to the late start of this kind of technology in our country, there are still a series of shortcomings in this research. In this study, based on the overview of CADCAM system theory, orthotic design and practical application, the results may have some shortcomings due to the limitations about the theoretical level of the author, but the relevant data of this study can still provide reference for the follow-up study.
References


