

Research on the Application of VR Technology in Postoperative Rehabilitation

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Abstract:

With the development of modern medicine, more and more cases have been successfully treated by surgery, and so is the number of patients requiring postoperative rehabilitation. At present, most of the domestic research in the field of postoperative rehabilitation based on virtual reality technology is still in the initial non-electronic manual stage. This study enhances the intuitiveness and science of the real situation through virtual reality technology, and adopts a scenario-based rehabilitation approach that is more dynamic and perceptually impactful, which can to some extent compensate for the disadvantages of slow stimulus reception in the real world and inaccurate information transmission in communication for the benefit of the majority of postoperative rehabilitation patients.

Keywords:

Virtual Reality Technology, Postoperative Rehabilitation, Rehabilitation Patients

1. Introduction

Virtual Reality (VR) is a kind of high-simulation 3D simulation system generated by the aid of computer technology. It integrates computer graphics technology, multimedia technology, network technology, human-computer interaction technology, sensor technology, three-dimensional display technology and simulation technology and other science and technology [1], restore or build a realistic environment, for information transmission to create a sense of immersive.

With the continuous advancement of technology and the gradual improvement of medical technology, many originally incurable diseases can be diagnosed and treated early. As a result, the survival rate of patients has greatly increased, and so has the demand for post-operative rehabilitation. Only by combining post-operative rehabilitation treatment technology with science and technology can we better meet the market demand, achieve rehabilitation results and restore patients to health.

With the continuous maturity of virtual reality technology, the application of virtual reality technology has a broad development prospect in postoperative rehabilitation. Applying virtual reality technology to postoperative rehabilitation, virtual reality technology is used to simulate the requirements as well as scenes in rehabilitation

training, and the data are counted by capturing equipment to achieve a high-efficiency and low-risk rehabilitation effect. The immersive experience of virtual reality technology immerses patients in the real environment, generates new somatosensory construction through visual perception, auditory perception, force perception, and tactile perception, overcomes the passivity and insecurity of traditional postoperative rehabilitation, and can stimulate the senses more scientifically and help postoperative patients recover to a greater extent.

2. The Necessity of Virtual Reality Technology in Postoperative Rehabilitation

2.1. Virtual reality technology continues to improve

VR technology is developing very rapidly in China, and its potential for development in the medical field is huge compared to industries such as games and film, and the current market on VR is more popular in three areas: film and television, games, and medical care [2]. Virtual reality technology is getting closer and closer to people's daily lives and can better meet people's intuitive needs for information. Compared with the traditional postoperative rehabilitation technology, the use of virtual reality technology for postoperative rehabilitation is closer to the concept of modern rehabilitation training. At present, China has paid great attention to the development of virtual reality technology, and with the implementation of "Internet + medical", China will usher in a new era of "intelligent medical". With the rapid development of virtual reality technology and enterprises, new industries and cultures will gradually take shape, and the application of virtual reality technology in post-operative rehabilitation will enter a new stage of rapid development.

2.2. The number of post-operative rehabilitation patients continues to increase

With the continuous development of the economy, people's health consumption needs increase and the aging of the population becomes more and more serious, the number of postoperative rehabilitation patients continues to increase, and postoperative rehabilitation treatment ushers in a new development opportunity. According to the statistics of The Lancet study, China is the country with the largest rehabilitation demand in the world, and the total number of rehabilitation demand reaches 460 million people in 2019, which contains elderly people, chronic disease patients, disabled people groups, postoperative people, autistic children, etc. from the current rehabilitation patient portrait [3]. According to the Ministry of Health, the number of post-operative rehabilitation patients treated increased from 48.74 million in 2015 to 75.95 million in 2021. The number of discharged patients increased from 2.51 million to 12.16 million. With the increasing awareness of patients' rehabilitation, the overall requirement of postoperative rehabilitation treatment has gradually shifted from the traditional rehabilitation mode to the consumption mode, and postoperative rehabilitation has received more and more attention.

2.3. State support for medical rehabilitation policy

Since the 1980s, China has started to carry out postoperative rehabilitation treatment in an organized, planned and large-scale manner, and has formulated a series of policies to promote the development of rehabilitation medicine.

In 2010, the former Ministry of Health issued the Notice on the Inclusion of Some Medical Rehabilitation Programs in the Scope of Basic Medical Insurance, which

included nine medical rehabilitation programs for therapeutic rehabilitation, including exercise therapy, comprehensive training for hemiplegic limbs, comprehensive training for cerebral palsy limbs, comprehensive training for paraplegic limbs, occupational therapy, training for cognitive-perceptual dysfunction, speech training, training for swallowing dysfunction, and evaluation of daily living ability. were included in the scope of medical insurance coverage to promote the development of rehabilitation medical services [4].

In 2015, the General Office of the State Council issued the "Guiding Opinions on Promoting the Construction of Graded Medical Treatment System", which proposed to improve the "treatment-rehabilitation-long-term care service chain", implement the separation of acute and slow treatment, and provide patients with scientific, adaptive, and continuous treatment services. The development of graded diagnosis and treatment is of great significance to the development of rehabilitation hospitals[4].

3. Virtual Reality Technologies Needed in the Field of Post-Operative Rehabilitation

3.1. Application of virtual image generation technology based on real sense

In the pre-operative rehabilitation picture construction, after constructing a virtual reality layered model with grid texture, a fast texture-based synthesis method was used to match the obtained image with the image in the model and map it to obtain a virtual reality image with a sense of realism. The virtual reality technology based on realism is generated by eliminating the random minimal interference through the star matching algorithm, which is a virtual reality layered model using grid structure to generate virtual reality images with a sense of realism by experimentally verifying the images, and its generation rate is much higher than the traditional virtual reality image generation technology.

3.2. Application of optical field retinal imaging technology

Most products on the market use traditional virtual reality image technology, such as Google carton VR glasses and Microsoft Hololen. But technically, this is only a means that allows people to see 3D, which is not suitable for human eyes, and long-term use will make people feel dizzy, thus increasing the chances of screen sickness. The use of light field retinal imaging technology in virtual reality technology can be a good solution to the phenomenon of vertigo caused by traditional virtual reality imaging technology, thus solving the problem of visual fatigue caused by virtual reality technology. The use of light information to represent light field still lines can reduce the difficulties of promoting this technology and make it better adapted to the characteristics of doctors and patients, which is the main direction of the future development of virtual reality technology.

3.3. Entry technology

Compared with the traditional entry technology, hand motion capture and voice recognition technology are used in combination with facial capture technology.

3.3.1. Hand motion capture technology

The quality of hand motion capture has a great connection with the experience of using and the quality of the whole project. Therefore, LEAP's Leap Motion hand

motion capture system is used, which can accurately recognize 10 fingers and all hand joints of both hands. It has an ultra-wide spatial field of view of 150°, a high accuracy of 1/100 mm, and can track hand movements at a speed of more than 200 frames/s, making it possible to use hands freely in the virtual environment as in the real world, without a delay of 200-1500ms like other devices [5].

3.3.2. Speech recognition technology

Speech recognition technology can turn the words in the human voice into information that can be read by a computer, such as keystrokes, binary codes or strings, and then recognize and transform the input speech through data computation.

3.3.3. Facial capture technology

Facial capture technology consists of two parts: image processing and information transfer. The facial capture system automatically extracts valid information from the selected video, extracts the corresponding features from it, and analyzes the expressions and emotions in it, and then uses MotionBuilder software to obtain the data and apply it to a set of predefined controls to analyze the received facial information.

3.3.4. Displaying Devices

A head-mounted display is a device with one display optic in front of one eye, or two display optics in front of each eye. HMDs are worn on the head or as part of a helmet [6]. Compared to non-helmet systems, HMDs do not require the position and angle that the user can see does not cause initial discomfort, but some patients may experience discomfort in the initial stages of use.

4. Advantages of Virtual Reality Technology in Postoperative Rehabilitation

4.1. Limitations of traditional postoperative rehabilitation means

Traditional postoperative rehabilitation training has a single function and a wide variety of types, and does not allow for comprehensive rehabilitation training and exercise. It is usually carried out in a one-to-one format between doctors and patients, and there are many limitations due to the influence of environment and conditions.

4.1.1. Existing rehabilitation resources are not sufficient

Since most post-operative rehabilitation patients have functional impairment problems in the limbs, traditional post-operative rehabilitation training is usually conducted by rehabilitation physicians and patients in a one-to-one or multi-to-one format, and the number of rehabilitation physicians and rehabilitation equipment is much lower than that of the post-operative rehabilitation population, which cannot meet the current market demand. Post-operative activities are limited by equipment, environment and number of people, so patients cannot complete post-operative rehabilitation training at home, and the rehabilitation site is limited, so they can only conduct rehabilitation training in a specific hospital or rehabilitation center.

4.1.2. Monotonous and tedious rehabilitation training process

In postoperative rehabilitation effect assessment, low patient participation rate is one of the important factors affecting the rehabilitation effect. Traditional postoperative rehabilitation training is generally a series of repeated rehab training, and its process is monotonous and tedious, which is difficult to make postoperative rehabilitation patients interested and enthusiastic about postoperative rehabilitation, or even bored, thus affecting the progress of postoperative rehabilitation and recovery effect.

4.1.3. Quantitative data evaluation is difficult to achieve

At present, postoperative rehabilitation evaluation methods mainly include subjective symptom evaluation method, behavior evaluation method and scale evaluation method, all of which are judged by doctors and cannot obtain refined data, making it difficult to quantitatively evaluate the results and intensity of training, which is not conducive to the formulation and adjustment of subsequent postoperative rehabilitation training programs. This is not conducive to the formulation and adjustment of subsequent postoperative rehabilitation training programs, thus affecting the effect of postoperative rehabilitation.

4.2. Advantages of virtual reality technology in postoperative rehabilitation

4.2.1. Motivation of postoperative rehabilitation patients for training

Virtual reality technology combines physiological treatment and psychological guidance to provide postoperative rehabilitation patients with game-based rehabilitation training, providing them with vivid and interesting training methods through images, music and voice prompts, so that they can train in the form of games, thereby mobilizing their motivation for rehabilitation training.

4.2.2. Record rehabilitation training data and adjust rehabilitation programs

Virtual reality technology can provide different training methods for different types of post-operative rehabilitation patients, and make detailed real-time records of the corresponding data of patients during the rehabilitation process, and generate corresponding rehabilitation training reports, so as to further adjust the rehabilitation training plan and training intensity more suitable for patients according to the reports.

4.2.3. Increasing rehabilitation resources Reducing work intensity and making rehabilitation more flexible

Post-operative rehabilitation training is no longer restricted by the location and time period of rehabilitation, and one rehabilitation physician can instruct several patients for training at the same time, which reduces the work intensity of rehabilitation physicians, reduces the occupation of rehabilitation equipment and resources, and makes up for the lack of supply in the post-operative rehabilitation market.

5. Problems in the Application of Virtual Reality Technology in Postoperative Rehabilitation

5.1. Low acceptance compared to traditional methods

Because of the variability and suddenness of the disease, patients usually do not pay much attention to postoperative rehabilitation, and they know little about the new

rehabilitation technology. Among the population of postoperative rehabilitation patients, part of them are elderly patients, and this group of people knows little about emerging technologies, distrusts machinery, and is slow to learn and accept knowledge, thus making it easy to use virtual reality technology for rehabilitation with significantly lower efficiency than traditional methods. On the part of physicians, some elderly physicians believe that the rehabilitation methods they are familiar with are more suitable for the treatment of patients, but due to their age, their learning ability gradually decreases and their inability to use these advanced medical devices skillfully can also have a certain impact on postoperative rehabilitation.

5.2. Willingness of hospitals to purchase equipment at high prices

Virtual reality is a product of the rapid development of technology, and it requires a lot of hardware and software to run it, which costs hundreds of thousands of dollars. This may not be a problem for those large hospitals, but it is different for small and medium-sized hospitals. Although hospitals can afford to pay for the equipment, they will not invest a large amount of money in this industry with unstable development prospect, and most of them are to respond to the government's call to purchase a small amount of equipment to influence the rehabilitation effect. The preliminary survey found that most hospitals, with limited medical conditions, would only speak of virtual reality technology as a future development direction rather than a primary means of postoperative rehabilitation.

5.3. Inadequate laws and regulations

The application of virtual reality technology in postoperative rehabilitation is in the exploratory stage and has not yet been promoted on a large scale, and no specific procedures and standards have been formulated.

6. Conclusions

With the rapid development of economy and network technology, the postoperative rehabilitation industry is bound to follow the trend of the times and make the rehabilitation consultation more convenient for patients through Internet technology. Although the current application of virtual reality technology in postoperative rehabilitation is still in the fumbling stage, and patients still have doubts about it, we should face the world, absorb the experience at home and abroad, combine the social development and the needs of the people, apply virtual reality technology to postoperative rehabilitation treatment, and inject a new atmosphere of the times. On the one hand, we should improve relevant laws and regulations, strengthen the application and management of virtual reality technology in postoperative rehabilitation, and clarify the responsibilities and requirements of rehabilitation physicians; at the same time, the general public should also learn more about the application of virtual reality technology in postoperative recovery. In conclusion, the application of virtual reality technology to postoperative rehabilitation can meet the needs of postoperative rehabilitation patients, promote the development of postoperative rehabilitation medical technology in China, and promote the implementation of the strategy of "Healthy China".

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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