Exploration on the Application of Motion Analysis and Simulation System in Rehabilitation Training

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Abstract: With the continuous progress of economic level and scientific research height, society has put forward higher requirements for the development process of rehabilitation field, and motion analysis and simulation system is a new application mode in rehabilitation training. The application of traditional theoretical knowledge to the internal structure of modern rehabilitation training makes it more practical and practical. In order to improve the efficiency of rehabilitation treatment work and the level of rehabilitation training plans, this article mainly analyzed the motion analysis methods and rehabilitation time measures in traditional rehabilitation training, and studied how to evaluate the exercise ability, diagnose diseases, and treat rehabilitation individuals in different environments. At the same time, the possibility of combining simulation systems with traditional theoretical knowledge was explored through practical cases, and optimization and improvement were carried out based on traditional rehabilitation training systems. A comparative experiment was conducted to verify the reliability of the optimized rehabilitation training system in this article. Through the evaluation of its application effectiveness by patients, it can be seen that compared to traditional rehabilitation systems, the training plan for optimizing rehabilitation system decision-making was more easily accepted by patients, with an average improvement of about 15.49% in four aspects of motion analysis, decision-making speed, rehabilitation progress, and risk response. This article proposed an optimized rehabilitation training system based on motion analysis and simulation systems, which can better meet the needs of rehabilitation therapy for individual development issues and greatly improve the decision-making speed of rehabilitation training plans. This can reduce the probability of sudden risk outbreaks while ensuring rehabilitation efficiency, and promote the integration process of advanced technology and traditional theoretical knowledge.

Keywords: Motion Analysis, Simulation System, Rehabilitation Training, Physical Function, Treatment Plan

ICSETPSD 2023, November 17-18, Coimbatore, India

DOI 10.4108/eai.17-11-2023.2342770

1. Introduction

In recent years, with the improvement of na

ztional health awareness and the pursuit of quality of life, rehabilitation training has gradually become an important research direction in the medical field. The rehabilitation training program is a comprehensive therapy to help patients recover their physical functions, improve their quality of life and improve their ability to take care of themselves. With the development of science and technology and the increasing demand for rehabilitation, traditional rehabilitation training programs are difficult to meet the needs of today's society. The application of motion analysis and simulation systems in the field of rehabilitation is also gradually becoming popular. Due to the general demand of patients for shortening the recovery period as soon as possible after surgery, the requirement for professional level of rehabilitation training has reached a new level, and there is an urgent need to explore the feasibility of combining traditional motion analysis theory with advanced simulation systems.

In rehabilitation training, motion analysis is the process of making detailed judgments on the patient's physical function and action level. In order to accurately evaluate the patient's physical condition and formulate a reasonable rehabilitation training plan, research on traditional motion analysis methods is essential. Patients who are affected by different illnesses need to undergo exercise analysis with different focuses. The patient's physical condition is the primary consideration for exercise assessment, and only based on the patient's physical condition can a more scientific and reasonable rehabilitation training plan be determined [1-2]. In the rehabilitation treatment plan for patients with cardiovascular disease, it is very important to correctly determine the health benefits of endurance exercise intensity for patients with rehabilitation to maintain their life safety. Since patients' exercise intensity domains are often not in the same range, it is necessary to emphasize the necessity of continuous adjustment in the exercise analysis process [3-4]. In the rehabilitation treatment plans for patients with joint injuries, there is often a lot of research on postoperative motion intervention, neglecting the evaluation and judgment of preoperative motion status. In fact, motion analysis of preoperative limb function can also play a significant role in promoting subsequent rehabilitation. Therefore, it is necessary to divide the time domain stages of patient motion analysis in a more detailed manner [5]. Motion analysis is a necessary and reliable tool in rehabilitation treatment plans, and further exploration is needed for the study of patient motion analysis methods.

Simulation systems based on advanced computer technology and integrated sensor technology can provide significant assistance in rehabilitation training. They are used for real-time monitoring, analysis, and evaluation of human motion, providing more scientific and personalized guidance for rehabilitation training. The rehabilitation training scheme based on simulation systems has gradually been widely applied, and the main functions of the system are patient compliance and motor function evaluation. However, in practical applications, more cases are needed to explore its optimization direction [6-7]. The control methods of different models can give

different emphasis to the functions of the rehabilitation system. Among them, the adaptive Iterative learning control model can make the lower limb rehabilitation equipment more stable, and the combination of virtual reality technology can assist the rehabilitation process of the fine hand movement of chronic stroke patients [8-9]. The virtual simulation system has a new application development in the field of rehabilitation, which can help patients with heart disease to take physical exercise at different stages, and can also collect the recent actual exercise level of target patients, so as to analyze the short-term, medium-term and long-term exercise development and physical function of patients [10]. The above research helps to improve understanding of the current application status of advanced simulation technologies in the field of rehabilitation, and further in-depth analysis is needed in subsequent application research.

The application research of motion analysis and simulation systems has gradually received attention with the advancement of rehabilitation field development. Due to the good interactivity and operability of motion analysis theory and simulation systems, patients can accelerate the process of rehabilitation treatment through interaction with the rehabilitation system, making their rehabilitation training plans more interesting and scientific [11-12]. Traditional rehabilitation training systems have problems such as difficulty adapting to social progress, inability to meet increasingly complex patient rehabilitation needs, low level of information collection for rehabilitation individuals, weak real-time monitoring effects, and long rehabilitation training cycles. Therefore, this article explored the motion analysis methods of traditional rehabilitation training systems. By combining advanced computer information processing technology and highly integrated sensor acquisition devices, optimization and improvement were made to address the shortcomings and shortcomings of traditional rehabilitation training systems. This enables the analysis of patients' motor ability and physical condition to be improved during the rehabilitation treatment cycle, and accelerates the decision-making speed of patients' rehabilitation plans, thereby reducing treatment costs for patients. Compared to traditional rehabilitation systems, optimizing rehabilitation systems can more comprehensively and accurately analyze patient body and movement information, greatly reducing the risk level of the rehabilitation process, and making decisions on patient rehabilitation training plans more scientific and reasonable.

2. Exercise in Rehabilitation Training

In rehabilitation training, motion analysis is widely used as an analytical tool to assist in rehabilitation. Motion analysis can accurately quantify the patient's movement ability from aspects such as posture, angle of movement, degree of exertion, and actual speed through highly sensitive sensor devices. This quantitative analysis can help rehabilitation therapists better understand the patient's rehabilitation process and adjust rehabilitation plans in a timely manner [13-14]. Based on individual differences and rehabilitation progress of patients, personalized rehabilitation training plans can also be developed through comprehensive motor analysis, making rehabilitation training more scientific and reasonable. In practical applications, motion analysis often provides a rough understanding of the overall condition of patients from three aspects: balance

state, muscle strength level, and joint function evaluation [15-16]. Among them, the analysis of balance state can be based on the patient's movement posture and changes in body center of gravity to improve their balance ability, which can enable patients to better control and adjust their body, and improve their own control ability. The evaluation of muscle strength level and joint function requires rehabilitation therapists to measure based on professional equipment and adjust the patient's rehabilitation training plan in a timely manner based on feedback. Figure 1 shows the composition of the motion analysis structure.

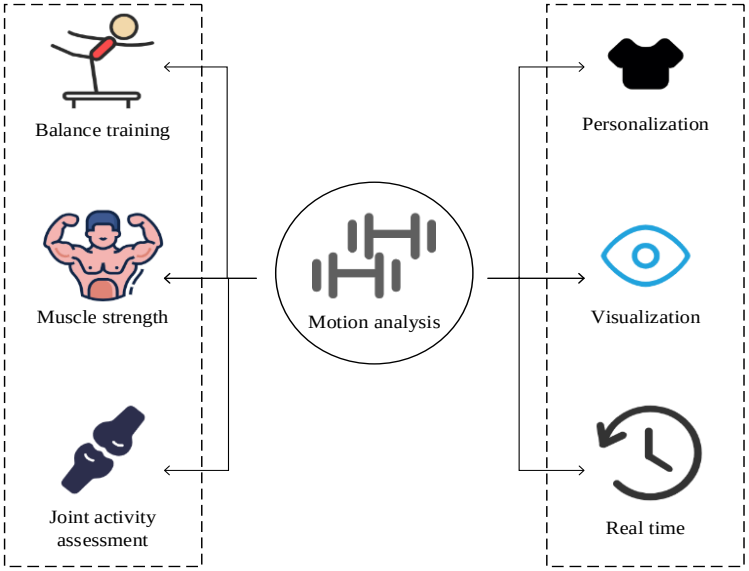

Fig.1 Composition of Motion Analysis Structure

3. Application of Simulation Systems in Rehabilitation Training

The simulation system interacts with patients through virtual simulation of rehabilitation training, which can provide interesting, personalized, and accurate rehabilitation training guidance for patients. It can also develop rehabilitation training plans that are tailored to the patient's actual needs and characteristics [17-18]. The simulation system automatically adjusts the rehabilitation training plan based on patient motion data and analysis feedback from sensor devices, and changes the guidance plan in a timely manner, making the decision-making process of the rehabilitation training plan more efficient. In practical applications, simulation systems can also create a realistic simulation rehabilitation training environment. Through virtual reality technology and simulation simulation technology, patients can immerse themselves in the virtual space for rehabilitation training. This not only allows patients to have real senses, but also improves their participation and enthusiasm in

rehabilitation training [19-20]. In the process of simulation training for patients, the simulation system can monitor the patient's physical state in real time, and correct the data fed back by motion analysis in a timely manner, so as to avoid sports injury and prolong the rehabilitation cycle of patients. Figure 2 shows the working interface of the simulation system.

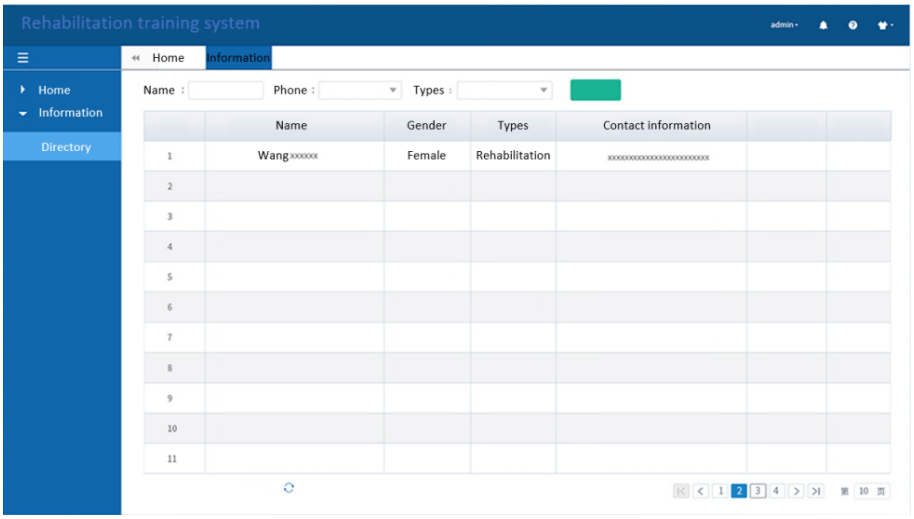

Fig.2 Simulation System Work Interface

4. Application Practice of Optimal Rehabilitation System

With the improvement of modern medical level and the progress of social development, human demands for health and quality of life are becoming increasingly high, especially the in-depth application of motion analysis and simulation systems in the field of rehabilitation has gradually become an important research direction. In order to conduct in-depth research on the application effect of motion analysis and simulation systems in rehabilitation training, this article verified the feasibility and reliability of optimizing rehabilitation systems. This article conducted an application experiment of rehabilitation systems in the process of patient rehabilitation training, and compared the impact of traditional and optimized rehabilitation systems on the quality of patient rehabilitation training and the effectiveness of evaluating patient motor ability. This article randomly selected 10 patients with lower limb injuries in a certain hospital as experimental subjects, with an average age of 30 to 50 years old, both male and female. The experimental process was divided into two stages, each lasting for 3 weeks. The 10 patients in the first stage received a traditional rehabilitation training system treatment plan, which includes physical therapy, exercise training, and rehabilitation guidance. In the second stage, the treatment plan of the optimized rehabilitation system was accepted. On the basis of the traditional rehabilitation

training treatment plan, 10 patients additionally used the motion analysis and simulation training functions of the optimized rehabilitation system for rehabilitation training.

Before the experiment begins, patients need to undergo basic physical functional status testing. It is necessary to evaluate the motor ability of all patients and record various results. To ensure fairness and impartiality in the experiment, all patients were assigned the same rehabilitation training plan and duration at the same stage. During the experiment, the experiment using the traditional rehabilitation system was set as the control group, and the experiment using the optimized rehabilitation system was set as the experimental group. The basic rehabilitation training treatment program that the patients participated in included balance training, muscle Strength training and joint activity training, and the results of the patients' evaluation of each training were recorded. The establishment of evaluation rules is a prerequisite for effective evaluation. The patient rated the difficulty level of various rehabilitation exercises, with an upper limit of 100. The higher the index, the higher the difficulty level. 1-25 represents simplicity, and 26-50 represents mediocrity; 51-75 represents moderate, and 76-100 represents difficulty. Table 1 shows the evaluation results of basic rehabilitation training.

Table 1. Evaluation Results of Basic Rehabilitation Training

	Balance training		Muscle strength training		Joint activity training	
	Control group	Experimental group	Control group	Experimental group	Control group	Experimental group
1	29	46	77	53	32	42
2	37	53	32	56	39	67
3	74	51	39	51	43	65
4	44	64	41	59	47	69
5	52	70	47	67	51	71
6	89	54	48	35	39	62
7	33	47	37	42	42	58
8	26	38	62	77	37	59
9	74	66	58	74	81	61
10	28	72	43	71	33	70

In Table 1, in the control group experiment using the traditional rehabilitation

system, the patients' average estimates of balance training, muscle Strength training and joint activity training were 48.6, 48.4 and 44.4 respectively, all within the general standard range; in the experimental group experiment where the optimized rehabilitation system was applied, the average estimates of patients were 56.1, 58.5, and 62.4, all within the moderate standard range. Compared to traditional rehabilitation systems, the rehabilitation training plan decided by the optimized rehabilitation system based on motion analysis and simulation system functions was more easily accepted by patients in practical applications.

At the end of two rounds of comparative experiments, 10 patients evaluated the application effects of the two rehabilitation systems from four aspects: motion analysis, decision-making speed, rehabilitation progress, and risk response. During the evaluation process, the upper limit of the indicator evaluation was 9. 1-3 was poor; 4-6 was good; 7-9 was excellent. Table 2 shows the comparison of the application effects of traditional and optimized rehabilitation systems.

Table 2. Comparison of Application Effects between Traditional and Optimized Rehabilitation Systems

	Exercise analysis		Decision-making speed		Rehabilitation progress		Risk response	
	Traditional systems	Optimized system	Traditional systems	Optimized system	Traditional systems	Optimized system	Traditional systems	Optimized system
1	5.91	6.43	6.73	6.66	6.10	7.16	6.89	7.49
2	5.42	7.36	5.60	7.21	5.62	6.63	5.50	7.63
3	6.52	6.58	5.90	7.02	5.72	6.10	6.68	7.57
4	6.46	7.30	5.16	7.98	6.14	6.47	6.00	6.84
5	5.08	6.86	5.12	6.37	5.63	7.20	5.46	6.66
6	5.63	6.92	5.72	7.24	5.05	6.21	5.53	6.22
7	5.73	6.38	5.92	7.07	6.50	6.48	6.09	6.97
8	6.99	6.71	5.93	7.47	5.22	6.79	5.61	7.48
9	6.89	7.67	5.58	7.02	6.91	8.00	6.99	6.00
10	6.20	6.27	6.93	6.24	5.14	6.34	6.98	6.94

In Table 2, the average indices of traditional rehabilitation systems evaluated by

patients from four aspects: motion analysis, decision-making speed, rehabilitation progress, and risk response were 6.08, 5.86, 5.80, and 6.17, respectively. The average indices of optimized rehabilitation systems were 6.85, 7.03, 6.74, and 6.98, respectively. Compared to traditional rehabilitation systems, optimized rehabilitation systems based on motion analysis and simulation systems achieved an average improvement of about 15.49% in four aspects.

5. Conclusion

Motion analysis and simulation systems play a crucial role in rehabilitation training, greatly enhancing the potential for development in the field of rehabilitation. Motion analysis can monitor the patient's physical condition in real-time, thereby more efficiently analyzing and evaluating the patient's physical condition, providing rehabilitation practitioners with scientific and accurate rehabilitation training guidance plans. At the same time, simulation systems can provide patients with realistic training environments through virtual reality technology and simulation simulation technology, and enhance their sense of participation and fun in rehabilitation training. These advantages make rehabilitation training schemes based on motion analysis and simulation systems an important development direction in the future. Finally, in order to verify the reliability of the optimized rehabilitation system, a comparative experiment was conducted on 10 patients. Compared to traditional rehabilitation systems, optimized rehabilitation systems that combine motion analysis and simulation systems can better collect patient status information and provide more efficient rehabilitation training plans for patients. Future research and practice would require more in-depth exploration based on motion analysis and simulation systems.

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