

Effects of balance training based on Kinect somatosensory interactive technology on the balance ability of patients with chronic ankle instability

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Abstract: Comparing the effects of balance training based on Kinect somatosensory interaction technology and traditional balance training on the balance function of patients with chronic ankle instability (CAI), it provides new ideas and basis for CAI patients to formulate rehabilitation training programs. 36 male CAI patients were randomly recruited for this trial. The subjects were randomly divided into an observation group and a control group. The training facilities of the two groups were completely the same except for the somatosensory interaction equipment, and the training content of the two groups was completely the same. After 6 weeks of training, the Ankle-Hindfoot Scale scores and Foot and Ankle Ability Measure scores of the observation group were higher than those of the control group, and $P < 0.05$. Compared with traditional balance training, the Kinect somatosensory interaction technology was used for balance training for CAI patients. Better training effect,

1. Introduction

Ankle sprain is one of the common sports injuries, and has a high recurrence rate [1]. Improper handling after ankle sprain and incomplete recovery of ankle joint function will further aggravate the ankle sprain and develop chronic Ankle instability (CAI) [2]. CAI patients have a weakened sense of control over the ankle joint, and they have recurrent ankle joint injury, pain, swelling and other symptoms [3]. Failure to treat in time will lead to limited ankle range of motion, decreased balance function, neuromuscular dysfunction, and gait. Loss of state coordination and other issues [4,5]. Training the patient's proprioception and balance function through balance training is an effective means to treat CAI patients. Training can improve postural control of patients and reduce the recurrence of CAI symptoms [6]. Due to the decline of CAI patients' own exercise ability and the low degree of completion of training actions, it is difficult for traditional balance training to achieve obvious results in a short time [7], while the somatosensory interaction technology integrates games, confrontations, and competitions into balance training. And other elements, increase the fun and intuitive experience of training, and improve patient compliance.

This study aims to compare the effects of balance training based on virtual reality technology and traditional balance training on the balance function of CAI patients, and to provide new ideas and basis for CAI patients to formulate rehabilitation training programs.

2. Method

2.1 Subject Recruitment

A total of 36 male patients with CAI were randomly recruited, aged (14.17 ± 1.21) years old, and body mass index (20.94 ± 1.43). The 36 patients were randomly divided into observation group and control group, with 18 people in each group. The observation group used Kinect and Unity 3D platform to build an unstable virtual environment based on traditional balance training; the control group only performed traditional balance training.

Table 1. Subject characteristics before training

Project	Group		t	P
	Observation group	Control group		
Age	14.06±1.16	14.28±1.27	0.55	0.59
BMI	20.94±1.43	21.05±1.43	0.46	0.65
AOFAS	73.31±3.30	74.13±2.39	0.78	0.43
FAAM	79.78±2.9	80.56±3.85	0.68	0.50

2.1.1 Inclusion Criteria

①Patients diagnosed with CAI;②A questionnaire survey on Identification of functional ankle instability (IdFAI) was conducted, and the results met CAI diagnostic criteria [8].③Patients with positive front drawer test [9];④Ultrasound examination of injuries to the anterior talofibular ligament [10];⑥The patient and his guardian sign the informed consent.

2.1.2 Exclusion Criteria

①Ankle fracture or three-year history of surgery; ②Ankle deformity, lower limb neuromuscular injury, etc.; ③Other movement disorders or movement restriction diseases; ④Patients with systemic diseases in various parts of the body; ⑤Postoperative wounds Completely healed or infected.

2.2.2 Training Methods

Balance training mainly includes four parts: lower limb muscle strength training, proprioception training, general balance training and star balance training, which train the patient's strength, stability, static balance and dynamic balance. The observation group and the control group only differed in the use of virtual reality equipment, and the layout of other facilities, balance training methods, and training intensity of the training site were consistent. The virtual reality equipment adds a virtual unstable environment to the observation group. This virtual environment will make corresponding unstable changes as the patient's limb changes.

The specific training program is shown in Table 2, three times a week (Monday, Wednesday, Friday) for a period of 6 weeks.

Table 2. Balance training program

Project	Content	Frequency
Muscle strength training	1. Squats with one leg 2. Foot dorsiflexion, plantar flexion, varus, valgus movement 3. Lift heel practice	Repeat ten times for each group, three groups each time
Proprioceptive training	1. Perform half squats and one-leg (bilateral) standing exercises with eyes open, one eye, and closed eyes on a balanced ground.	Repeat ten times for each group, three groups each time
General training	1. Balance on one leg 2. Lunge practice 3. Single-leg boxing exercise	Repeat ten times for each group, three groups each time
Star balance training	1. Stand on one leg with your hands on your buttocks, and the other leg to reach the farthest point on the line as far as possible in eight directions: anterolateral, anterior, anterior medial, medial, posterior medial, posterior,	Repeat three times in each direction as a set, and perform three sets for each exercise.

posterolateral, and lateral.

2.2.3 Effect Evaluation

Ankle-Hindfoot Scale (AOFAS) evaluates the patient's ankle and hindfoot function, divided into pain (40 points), function (50 points), alignment (10 points), a total of 100 points, the patient's score is directly proportional to the ankle function.

Foot and Ankle Ability Measure (FAAM) to evaluates the daily life and exercise ability of patients [11]. The scale consists of 21 daily life problems (FAAM-ADL) and 8 sports problems (FAAM-Sport) And 1 proprioceptive problem. Each problem has 5 points. A point of 0 means that it cannot be done. A point of 4 means that there is no sleepiness at all. The patient's score is proportional to the ankle joint function.

Table 3. Comparison of evaluation indexes between the two groups after intervention

Project	Observation group	Control group	t	P
AOFAS	94.60±2.47	90.07±2.02	5.50	<0.05
FAAM	99.67±3.36	93.94±2.96	5.42	<0.001

2.2.4 Statistical Analysis

The data is analyzed using SPSS21.0 statistical software, and the method of mean \pm standard deviation ($\bar{X} \pm S$) is used to express the collected relevant data. First, the normal distribution test is performed on the collected relevant data, use two independent samples t-test for data conforming to normal distribution, when $P < 0.05$, the difference is considered to be statistically significant.

3. Results and Discussion

3.1 Research Results

30 patients were intervened for 6 weeks, and the BBS score and AOFAS score of the observation group and the control group after intervention were compared and analyzed. After 6 weeks of intervention in the observation group, the AOFAS score of the observation group was (94.60±2.47) points, which was higher than the control group (90.07±2.02) points, the difference was statistically significant ($t=5.50$, $P < 0.05$); the observation group's FAAM score It was (99.67±3.36) points, higher than the control group (93.94±2.96) points, the difference was statistically significant ($t=5.42$, $P < 0.001$).

3.2 Discussion and Analysis

Balance training is an important way to treat CAI, which can effectively improve the patient's ankle motion ability, use virtual reality technology to add a virtual unstable environment to the patient, and interact with the patient in the virtual world. The patient's sensory stimulation is increased, and at the same time, according to the patient's action feedback, it can provide the patient with real-time feedback of a variety of virtual scene changes, which greatly improves the patient's exercise effect.

Compared with traditional balance training, CAI patients will perform better balance training with the assistance of virtual reality technology. The mechanism is not clear, but the following factors can be considered: ① Virtual reality technology and patients can form an interaction. When the patient's body shifts, it can continuously provide visual feedback for the patient to train the center of gravity to move [12]; ②The virtual environment provided by virtual reality technology greatly improves the pleasure of training, makes the patient pay more attention, improves patient compliance, and strengthens training motivation And training effects; ③Virtual reality technology stimulates the cognitive function of the patient, which can help improve the cognitive function of the patient; ④ Virtual reality technology provides a way for the patient to be unable to perform cognitive and

exercise in the real environment under the current conditions ⑤Virtual reality technology and the patient's sports performance to achieve real-time feedback, so that patients can personally feel their victory and progress, and enhance self-information; ⑥Virtual reality technology can combine somatosensory information into visual messengers for patients to receive[13] .

The shortcomings of this study: ①the number of samples included in this study is small, and they are all middle school students aged 12-16 who are seeking sports. The samples have certain limitations; ②There are certain differences in the condition of patients, and the training effect is also affected by the patients the impact of exercise ability; ③BBS and AOFAS evaluation is too subjective and lack of objective evaluation methods; ④Currently, CAI has no fixed balance training criteria, so the balance training method in this study may have different effects on different patients.

4. Research conclusions

The addition of virtual reality technology while performing balance training for CAI patients can enable patients to obtain a better training effect, promote the recovery of ankle joint function, and provide CAI rehabilitation workers with a new rehabilitation idea.

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