

Assessment of Balance Disorders in Patients after Ankle Fractures

Cuixiao Wang¹, Shao Chen¹, Meina Qiao¹, Yueqing Xu^{1*} & Jinkui Zhao^{2*}

¹Nursing College of Hebei University, Baoding, Hebei 071000, China

²Taihe Rehabilitation Hospital of Baoding City, Baoding, Hebei 071000, China

ABSTRACT Objective: The objective of the study is to evaluate the balance disorders in patients with surgical treatment of ankle fractures with the use of Sunlight Tetrax. **Methods:** The subjects in the study were 20 patients with ankle fractures treated surgically (after six months of the procedure) and the control group comprised 21 healthy subjects. Two groups compare the general stability index (ST), the high frequency of Fourier transformation (F5-F6), the body weight distribution index (WDI), synchronicity of foot under natural standing on solid surface with eyes opened and natural standing on solid surface with eyes closed and the fall index (FI). **Results:** The fall index (FI) and the stability index (ST) under natural standing on solid surface with eyes opened of two groups were statistically significant differences. The balance of patients with ankle fracture after 6 months with surgical procedure is significantly poorer than healthy subjects.

KEYWORDS

Ankle fractures
Balance
Rehabilitation

1. Introduction

The ankle joint is a joint whose injuries belong to the most frequent traumas of the motor organ and also the most common intra-articular fractures. According to statistics, the incidence of ankle fractures among young and middle-aged is 13-28/10000, the incidence of older women is 16-20/10000. After ankle fracture, activity of ankle joint decreased, accompany with balance lost, more than 50% patients with ankle fracture need surgery [1-2], both conservative treatment and surgical treatment needs to use plywood or with a plaster external fixation for 3 to 6 weeks, to promoting fracture healing and promote reduction, studies have found that external fixation affect ankle itself and the surrounding joints motion, ankle and the surround-

ing joints are still existing rigid a year after fracture [3], ankle fractures and surgical treatment seriously affect the stability of the patients' body posture [4], so the primary goal of the treatment of ankle fracture is recovery the affected joint motion. Postoperative rehabilitation include promoting blood circulation, promote healing of soft tissue and fractured union, strengthen the lower limb muscle strength, restore limb function, increase the lower limb coordination, restore ankle weight-bearing walking ability [5], proprioception and the balance training played an important role in the process of rehabilitation, balance training has positive effect in improving clinical outcomes and also improve the quality of life of patients. Purpose of this study is to evaluate the balance ability of patients with ankle fracture, provides some references to patients for postoperative rehabilitation training.

2. Materials and methods

The study was carried out on a group of patients with ankle fracture hospitalized in the rehabilitation center of Baoding city. The study was performed from October to December 2015. The subjects volunteered to participate in the study.

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*Corresponding author: Yueqing Xu, Nursing College of Hebei University, Baoding, Hebei 071000, China. E-mail: yeqing@163.com; Jinkui Zhao, Taihe Rehabilitation Hospital of Baoding City, Baoding, Hebei 071000, China. E-mail: 956234382@qq.com

The case group qualified for the study were 20 patients within 6-9 months after surgical treatment, at 35.05 +/- 9.50 years of age, 19 males and 1 females, 8 have external ankle fracture, 8 have posterior malleolus, 4 have distal tibiofibula fracture, these patients in rehabilitation centre for 2-3 months of rehabilitation training, the training content including: loose electrical stimulation, balance training, strength training, soft couch training, stretch the achilles tendon and the peroneal tendons ,proprioception training. Control group choose age-matched healthy people without medical history, 19 males and 2 female, at 34.76 +/- 10.89 years of age. General data comparison between the two groups have no difference, as shown in [Table 1](#).

Table 1. General data comparison between the two groups.

Factors	Fractured group	Healthy group		<i>p</i>
Age	35.05±9.50	34.76±10.89	<i>t</i> =0.090	0.929
Gender	Male 19(95%)	Male 19(90.48%)	$\chi^2=0.000$	0.578
	Female 1(5%)	Female 2(9.52%)		

Note: *p* < 0.05 was regarded as statistically significant.

Inclusion criteria are: 1) patients qualified for the study meet the ankle restoration standard; 2) Lower limbs walk straight for 3 minutes, not fewer than 30 in steps without support; 4) Informed and agreed to participate in the study without cognitive impairment and other mental disorders.

Exclusion criteria are: 1) Merging other injury around the ankle, including multiple fractures, undisplaced fractures and compound fracture patients; 2) The correct vision under 4.9.

Balance instrument measurement using Israel Sunlight Tetrax balance testing system of medical equipment company. The equipment has four independent test platforms, subjects stand on them, both first half part and the rest part of their feet with vertical pressure changes, through the pressure sensor will be automatic analysis of mechanical signals into digital signals into the computer processing.

Test subjects were quiet standing on Tetrax test force platform ,double foot heel and toes put into A, B, C, D four test tablet, measure the general Stability (Stability Index, ST), Fourier transform, the weight distribution Index, the synchronicity of heel and toe part stress patterns under the eight kinds of postures (standing under normal condition with eyes opened; standing under normal condition with eyes closed ;standing on the pillow mat with eyes opened; standing on the pillow mat with eyes closed; head to the right with eyes closed; head to the left with eyes closed; head leaned back with eyes closed; low head forward with eyes closed). Before test fully explain test purposes and matters needing attention to the subjects, keeping an appropriate indoor temperature and quiet environment to ensure the participants without interference.

The parameters studied were: the general Stability (Stability

Index, ST), Fourier transform (F5, F6), the weight distribution Index synchrony (WDI), foot (SYN-L, SYN-R), fall Index (FI), under two positions of the general Stability of the two positions of standing under normal condition with eyes opened and standing under normal condition with eyes closed, fall Index (FI) is an indicator that based on all data under the eight positions and then automatic analysis.

Using spss 20.0 software for statistical analysis after double entry data. Measurement data using mean standard deviation expression, count data expressed in percentage. Measurement data of two independent sample mean use independent sample t-test, count data mean comparison using the chi-square test. *p* < 0.05 was regarded as statistically significant difference.

3. Results

The fracture group and healthy group compared the balance function, the fall Index and the general stability under normal condition with eyes opened have significant difference; the general stability under normal condition with eyes closed position, two groups have no significant difference; the Fourier transformation (F5, F6), the weight distribution index (WDI), foot synchronicity (SYN-L, SYN-R) two groups have no significant difference under two positions of normal condition with eyes opened and standing under normal condition with eyes closed ([Table 2](#)).

Table 2. Compare the balance parameters of the two groups.

Balance parameters	Fractured group (n=20)	Healthy group (n=21)	<i>T(t)</i>	<i>p</i>
Fall index	47.35±21.65	29.95±14.59	3.003(<i>t</i>)	0.005
NO ST	0.49±0.89	-0.16±0.91	2.303	0.027
NO F5-F6	1.47±1.78	1.28±1.52	0.372	0.712
NO WDI	1.45±0.99	1.30±1.12	0.457	0.650
NO SYN-L	-0.10±0.77	0.33±1.06	-1.479	0.147
NO SYN-R	0.39±1.34	-0.07±0.91	1.286	0.206
NC ST	-0.20±1.23	-0.40±1.03	0.479	0.635
NC F5-F6	0.46±1.02	0.82±1.39	-0.953	0.346
NC WDI	0.73±1.76	0.78±1.23	-0.107	0.915
NC SYN-L	0.07±1.51	-0.06±0.90	0.327	0.746
NC SYN-R	0.32±1.46	-0.29±0.69	1.719	0.094

4. Discussion

Comparing the healthy people with patients with ankle fracture, the balance has significant difference, healthy people shown a strong ability of balance than the fracture group. The better the balance function, the lesser the risk of falls [7]. Overall stability of the body's ability maintain balance, also has compensation ability for balance disorders. Comparing the healthy people with fracture groups of patients, the general stability has significant difference (*p*=0.027), which has nothing to do with height and weight, the general stability of the fractured patients is weaker than the healthy group, also means the balance of

fractured patients is weaker than healthy people. Fall index is calculated use a patent by the algorithm based on Tetrax testing results, said participants fall risk value. Comparing the fracture groups of patients with healthy people, the Fall index has significant difference ($p=0.005$), Fall index fall in the range from 0-100, with 0 denoting no risk and 100 denoting the most likely to fall. The study showed that the Fall index in the fracture groups is higher and thus the risk of falls is larger, the direct and indirect effects caused by falling damage will bring huge economic burden to family and the society, and also bring mental pressure to patients [8]. After ankle fracture patients will be carried out in different postoperative rehabilitation training, most of patients in the study longer than 6 months after surgery treatment, who have begun to normal work life, but they still have balance disorders, therefore in the process of recovery patients can do some targeted training to improve balance function, such as reinforcing the training of toes, soft couch cushion training and balance training.

Vestibular sense, vision and proprioception together afferent signals to the central nervous system, which issues instructions to adjust the human body, in order to maintain balance. Proprioception receiver is located in the muscles, tendons and joints, more studies have showed that there are a lot of proprioception receivers in the muscles around ankle, which plays an important role in joint control, adjust the body posture for balance [9]. Studies have proved that patients with diabetes peripheral neuropathy training the muscles around, their balance function will have significantly improved through promote the proprioception [10], with proprioception training, patients with fracture will have a significant improve on balance function [11]. The frequency oscillation frequency posture (F5-F6) abnormal is a signal of ontology paresthesia. As above mentioned, there are a lot of proprioception receivers in the muscles around ankle, but two groups have no significant difference in the frequency of Fourier (F5-F6) under the two positions, the fracture patients in this study have reached standard of fracture healing and postoperative more than 6 months, patients can walk independently, two groups did not found significant difference in the frequency of Fourier (F5-F6) may be related to the muscles and tendons around the ankle of fractured patients have recovered well, but the patients' balance function are still not back to normal, the risk of falls is higher than healthy people, this should attract us attention, in treatment and live to prevent them fall.

5. Conclusion

The study has some deficiency as the study sample size is small, the proportion of men is larger than women, most subjects are middle-aged and young, which is related to the incidence of ankle fractures, the incidence of ankle fractures is higher in young and male than elder and female. It is hard

to avoid some bias and in future research the sample size should be increased, and also the elder and female population. After age 50, the balance function of human will decline along with the age increase [12], balance ability decline caused by falling problem has become a hotspot in current researches, so the balance function of elderly patients with ankle fractures should receive more attention and in future research should also be more balanced in age distribution and sex proportion.

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