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Bone Mineral Density Characteristics of Paraplegic Patients Wearing Paraplegic Walking Apparatus

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Abstract: In order to observe and compare the changes of bone mineral density (BMD) of paraplegic patients before and after wearing paraplegic walking device, as well as the influence of age, height, weight and wearing years on BMD, 124 paraplegic patients were tested by quantitative CT (QCT) in Sichuan Rehabilitation Hospital (Sichuan Bayi Rehabilitation Center). The results showed that patients wearing paraplegic walkers had higher bone mineral density than those not wearing paraplegic walkers. BMD decreased with age, but decreased significantly in paraplegic walkers than in non-paraplegic walkers. Height had little effect on BMD, and only patients younger than 20 years old or 31-45 years old had significant influence ($P<0.01$). Body weight and wearing years were positively correlated with BMD. Conclusions: BMD of paraplegic walkers was significantly different from that of non-paraplegic walkers ($P<0.01$), the paraplegic walker can increase the stress stimulation to bone, effectively reduce the loss of bone minerals in paraplegic patients, and maintain the BMD in a relatively normal range.

Keywords: BMD, Paraplegic Walking Apparatus, QCT

1. Introduction

Spinal cord injury (SCI) is caused by direct or indirect external causes, resulting in a variety of motor and sensory dysfunction. Spinal cord injury is the most serious complication of spinal cord injury. In clinical rehabilitation, injury sites are mostly below the first thoracic vertebra, resulting in damage or loss of motor and/or sensory functions in thoracic, lumbar or sacral segments of spinal cord (excluding cervical segment) [1], which is called paraplegia. Paraplegia is the most common spinal cord injury. The prevention, treatment and rehabilitation of spinal cord injury have become an important topic in medical research. Paraplegic patients are unable to stand alone for a long time, resulting in reduced stress on the bone, and the loss of bone minerals that exacerbate motor and sensory dysfunction. BMD is the most vital standard for bone mineral loss. After reviewing relevant literature, it was found that no scholars have studied the BMD of paraplegic patients. Therefore, this paper aims to observe and compare the changes of BMD in paraplegic patients after wearing paraplegic walking apparatus, and clarify the relationship between BMD and patients' age, height, weight and years of wearing paraplegic walking apparatus. It is hoped to provide theoretical basis and data support for rehabilitation treatment of patients with clinical spinal cord injury.

2. Research Object and Method

2.1. Research Object

In this paper, 124 paraplegic patients (95 males and 29 females) were selected from the Spinal cord Rehabilitation Department of Sichuan Rehabilitation Hospital from 2014 to 2019 as research subjects, and their basic information is shown in Table 1. In this study, the influence of other factors (fracture, implant, obesity, etc.) on the experiment was eliminated through questionnaire survey, and informed consent was signed with the patients and approved by the Ethics Committee of Sichuan Rehabilitation Hospital.

Table 1. *Basic Information of subjects (X±S).*

	N	Age	Height (cm)	Weight (kg)
A	62	38.4±1.9	166.5±7.2	59.8±10.3
B	62	39.6±1.7	167.8±7.9	61.2±9.8

2.2. Research Method

2.2.1. Experimental Test Method

The subjects were divided into two groups: group A wore paraplegic walker, and group B did not wear paraplegic walker. The two groups had the same population of 62. The paraplegic walker selected in the experiment is shown in Figure 1. Bone density instrument used quantitative CT (QCT) bone density tester. Test method: The patient was supine on the CT scanning bed, and the QCT special bone model was placed directly under the hip (waist) and closely attached. When scanning hip joint (lumbar spine), the body model can be scanned at the same time (QCT special bone model can also be scanned separately). Then, the positioning image was scanned from the upper part of the acetabulum to the lower part of the femoral lesser trochanter in a range of 1-2cm (when scanning the lumbar spine, vertebral body L1-L4). The scanning level was fixed at the midpoint of the upper and lower endplates of each vertebra, parallel to the endplates. Finally, the scanned tomography images were sent to QCT special measurement software for analysis.

2.2.2. Mathematical Statistics

The subjects were divided into 12 groups according to age (Table 2). The measured data will be processed and analyzed by SPSS22.0 software. Independent sample T test was used to analyze the data of group A and group B. Pearson correlation analysis (r-value) was used for correlation between different measurement indexes. P<0.01 had a significant criterion. P>0.01 did not have a significant criterion.

Figure 1. *Paraplegic Walker.*

3. Research Results

3.1. Relationship Between Age and BMD in Paraplegic Patients

Age and BMD test results of paraplegic patients (Table 2) showed that BMD in the hips and waist of paraplegic patients decreased with age [2]. There was no statistical significance between group A and group B at the age of 10-15 years old and 16-20 years old (P<0.01). There were significant differences in A and B of other age groups (P<0.01).

Table 2. *BMD T-value in paraplegic patients (X±S).*

Age	A		B	
	Hip	Waist	Hip	Waist
10-15	0.62±0.99	0.63±1.12	0.65±1.09	0.74±0.96
16-20	0.73±1.02	0.70±1.14	0.71±0.98	0.82±1.07
21-25	-0.94±1.36*	-1.08±1.13*	-1.19±1.31	-1.26±1.11
26-30	-0.96±1.03*	-0.89±1.06*	-1.23±1.05	-1.18±1.51
31-35	-0.99±1.15*	-0.79±1.23*	-1.34±1.16	-1.26±1.19
36-40	-1.02±1.21*	-0.91±1.20*	-1.39±1.59	-1.35±1.22
41-45	-1.12±1.16*	-1.11±1.14*	-1.59±1.35	-1.36±1.03
46-50	-1.30±1.09*	-1.23±1.29*	-1.77±1.26	-1.44±1.24
51-55	-1.33±1.41*	-1.29±1.37*	-1.90±1.38	-1.59±1.29
56-60	-1.45±1.32*	-1.37±1.33*	-1.97±1.25	-1.89±1.38
61-65	-1.52±1.07*	-1.45±1.28*	-2.12±1.01	-1.92±1.02
66-70	-1.65±1.22*	-1.58±1.43*	-2.21±1.51	-2.07±1.49

Note: * means P < 0.01, the following are the same.

3.2. Relationship Between Body Weight, Height and BMD in Paraplegic Patients

The correlation analysis of height, weight and BMD T-value of paraplegic patients was shown in Table 3. Age groups were 16-20 years old, 31-35 years old, 36-40 years old, height and bone mineral density were positively correlated (P<0.01). There was no statistical significance in height, weight and BMD T-value in other age groups (P<0.01). The age groups were 10-15 years old, 16-20 years old, 31-35 years old, 36-40 years old, body weight and bone mineral density T value had significant difference (P<0.01). There was no significant difference in body weight and BMD T value in other age groups.

Table 3. *Relationship between body weight, height and BMD in paraplegic patients.*

Age	height		weight	
	r	p	r	p
10-15	-0.305	0.213	-0.117	0.005*
16-20	-0.502	0.009*	-0.080	0.001*
21-25	-0.041	0.215	-0.121	1.203
26-30	-0.064	0.321	-0.351	0.094
31-35	-0.056	0.002*	-0.152	0.006*
36-40	-0.094	0.004*	-0.173	0.007*
41-45	-0.038	2.153	-0.048	2.030
46-50	-0.061	1.364	-0.194	0.715
51-55	-0.082	0.984	-0.095	3.019
56-60	-0.040	1.592	-0.082	1.257
61-65	-0.076	4.351	-0.031	1.008
66-70	-0.049	1.369	-0.029	0.928

3.3. Relationship Between Years of Wearing Paraplegic Walker and BMD

The results of years of wearing paraplegic walkers and BMD T-value in paraplegic patients are shown in Table 4. The results showed that wearing years were positively correlated with BMD T-value [3].

Table 4. BMD of patients wearing paraplegic walkers for different years.

h	Hip	Waist	r	p
1	-1.56±0.45	-1.48±0.37	-0.043	0.023
2	-1.27±0.16	-1.19±0.31	0.101	0.003*
3	-1.01±0.46	-0.85±0.57	0.426	0.005*
4	-0.79±0.54	-0.81±0.29	0.154	0.006*
5	-0.56±0.78	-0.37±0.41	0.208	0.001*

4. Analysis and Discussion

4.1. The Relationship Between BMD and Age in Paraplegic Patients

According to the results of this study, BMD T-value of paraplegic patients decreased with age. The reason for this is related to the physiological decrease in bone mass of adults as BMD increases with age [4, 5]. This conclusion is also consistent with that obtained by Zhao Hongxiao [6] et al. However, there is still a difference: when the age of paraplegic patients is 10-20 years old, the BMD T-value does not decrease with the increase of age, which may be related to the age of the patients. Between 10 and 20 years old, the body is developing rapidly. Their body auxin secretion is exuberant, bone synthesis growth is also in a more exuberant period, so bone density is not reduced but increased [7]. In healthy individuals, the increase in age after adulthood may lead to calcium loss due to inadequate or decreased calcium intake, resulting in decreased BMD [8]. The subjects of this study were paraplegic patients with long-term insufficient physical activity, who could not walk normally without rehabilitation AIDS [9], and the decline of BMD was also an inevitable trend.

4.2. Analysis of the Relationship Between BMD and Body Weight and Height in Paraplegic Patients

Within a certain range, weight gain exerts a certain amount of stress [10], which is beneficial to bone growth. However, if paraplegic patients do not have paraplegic walking devices to help them stand and walk normally, bone mineral loss will be significantly faster than normal people. In this study, height was significantly associated with BMD when paraplegic patients were younger than 20 years old. The reason is that the body is in its prime growth period before the age of 20. The increase in height is due to bone growth, a significant increase in bone density [11].

4.3. Analysis of the Relationship Between BMD and Years of Wearing a Walker in Paraplegic Patients

This study showed that BMD of paraplegic patients increased slowly with the increase of wearing years. Patients who did not wear a paraplegic walker had no significant change in BMD and were at risk for decline. Related studies have shown that paraplegic patients can recover practical walking function and improve ADL ability after wearing a walking device [12]. Therefore, it is a theoretical discussion to study the relationship between BMD and walking apparatus wearing in paraplegic patients on this basis. Whether the increase in bone density is due to the presence of a walker, which helps the patient better walk independently. Experiments have shown that the more time spent wearing a walker, the better the patient's bone density. In theory, it can prevent or slow osteoporosis and reduce the risk of falls [13].

In this paper, the relationship between age and BMD was discussed based on relevant literature, but the sample size was small. Changes in body composition, such as obesity and weight loss, have a complex effect on dual-energy X-ray absorption (DXA) measurements of bone mineral density (BMD) [14]. Therefore, dual-energy X-ray method was not used in this study to measure the change of patient density. CT (QCT) quantitative measurement of BMD localization is more accurate [15], more accurate data. Theoretically, gender differences in the subjects of this study also have an impact on BMD. Female paraplegic patients due to physiological period and menopause with the increase of age, the impact of bone density is also an important factor that cannot be ignored [16]. Therefore, later research will further improve the above shortcomings, in order to make a modest contribution to the clinical rehabilitation of many paraplegic patients.

5. Conclusion

Age and BMD test in paraplegic patients showed that BMD T-value decreased with age in paraplegic patients. There was no statistically significant difference between the two groups at 10-15 years old and 16-20 years old ($P>0.01$). There were significant differences in other age groups ($P<0.01$). When paraplegic patients were less than 20 years old, there was a significant correlation between height and BMD T-value. Before the age of 20, the body is in the prime period of growth and development, and bone density increases significantly. Height had little effect on BMD, and only patients younger than 20 years old or 31-45 years old had significant influence ($P<0.01$). Body weight and wearing years were positively correlated with BMD. When the age group was 10-15 years old, 16-20 years old, 31-35 years old, 36-40 years old, body weight and BMD T-value had significant difference ($P<0.01$), there was no significant difference in body weight and BMD T-value in other age groups. BMD decreased with age. However, BMD of paraplegic patients increased slowly with the increase of wearing years. Patients who did not wear a paraplegic walker had no significant change in BMD and were at risk for decline. Paraplegic walkers can increase stress stimulation to bone, effectively reduce the loss of bone minerals in patients with paraplegia, and maintain the bone mineral density in a relatively normal range.

References

[1] Jianjun Li, Fangyong Wang. International Standard for neurological Classification of Spinal Cord Injury (revised in 2011) [J]. Chinese rehabilitation theory and Practice, 2011, 17 (10): 963-972.

[2] Zeyu Zhao. Study on the correlation between femoral cortical thickness index and osteoporosis [D]. Kunming Medical University, 2020. DOI: 10.27202/d.cnki.gkmyc.2020.000156.

[3] Guangyan Cao. The influence and correlation of physical activity level on bone mineral density and body composition in middle-aged and elderly people [D]. Shandong Sport University, 2020. DOI: 10.27725/d.cnki.gsdty.2020.000069.

[4] Zhongqun Zhu. Analysis of bone mineral density in 393 adults [J]. Zhejiang Preventive Medicine, 2000, (3): 57.

[5] Hongtao Sun, Jianjun Sun, Yongkang Su, etc. A preliminary study using bone mineral density values to infer age in male adolescents aged 13-18 years [J]. Criminal technology. 1997, (4); 8-9.

[6] Hongxiao Zhao, Feifei Shao. Analysis of influencing factors of bone mineral density examination and clinical effect of nursing intervention in middle-aged and old people [J]. Electronic journal of Practical clinical Nursing [4], 2020, 5 (05): 113+119.

[7] Biver, Emmanuel; Salliot, Carine; Combescure, Christophe. Influence of Adipokines and Ghrelin on Bone Mineral Density and Fracture Risk: A Systematic Review and Meta-Analysis [J]. JOURNAL OF CLINICAL ENDOCRINOLOGY & METABOLISM. 2011, 9 (96): 2703-2713.

[8] Bingtian Su, Minwei Deng, Ze Xu, etc. Chinese men's 100m sprint in the New Era: Retrospect and Prospect [J]. Sports science, 2019, 39 (2): 22-28.

[9] He Li. Effect of walking exercise based on step frequency control on exercise blood pressure and vascular function in female patients with essential hypertension [D]. Shanghai Sport University, 2019. DOI: 10.27315/d.cnki.gstyx.2019.000013.

[10] Kangjie Cheng. Optimization design and preparation of composite implants for mandibular defects [D]. Zhejiang University of Technology [8], 2020. DOI: 10.27463/d.cnki.gzgyu.2020.000015.

[11] Bin Guo. Bone mineral density and body composition in normal children and adolescents [D]. Jinan university, 2010.

[12] Zhengquan Zhao, Jie Huang, Min Lu, Xiangdong Chen, Qiang Su. Analysis of training and ability of daily living activities in paraplegic patients after assembly of walking apparatus [J]. Chinese journal of Physical Medicine and Rehabilitation, 2003 (03): 46-47.

[13] Clinical handbook of Osteoporosis in Chinese population (2007 edition) [J]. Chinese journal of Osteoporosis, 2007 (S1): 1-67.

[14] Yu, EW; Thomas, BJ; Brown, JK; Finkelstein, JS. Simulated increases in body fat and errors in bone mineral density measurements by DXA and QCT. JOURNAL OF BONE AND MINERAL RESEARCH [J]. 2012, 1 (27): 119-124.

[15] Xiaoguang Cheng, Liang WAng, Qiang Zeng, Jing Wu. Chinese quantitative CT(QCT) guidelines for the diagnosis of osteoporosis [J]. Chinese Journal of Osteoporosis [11], 2019, 25 (06): 733-737.

[16] Shiwei Yu. Study on the relationship between bone mineral density and body mass index in type 2 diabetes mellitus in Shanghai [D]. Shanghai Institute of Physical Education, 2019. DOI: 10.27315/d.cnki.gstyx.2019.000168.