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Effect of ball fixing exercise on bone mineral density and balance of female college students

Juncheng Li

Chongqing three Gorges University, Chongqing 404000, China

ABSTRACT. *Objective: to explore the effect of ball fixation on bone mineral density (BMD) and balance ability of female college students. Methods: 36 female college students were randomly divided into control group and experimental group. Bone mineral density (BMD) of distal ulna and radius, lumbar vertebrae 2-4, femoral neck were measured before experiment and 1 month, 3 months and 6 months after exercise intervention. Results: compared with the control group, the distal ulna and radius (main ball holder), L2-4 of lumbar vertebrae, femoral neck bone density, the balance time between the leg standing and eye opening were significantly improved in the experimental group ($P < 0.05$ or $P < 0.01$). Conclusion: skilful ball fixation can effectively improve the bone mineral density and balance ability of female college students.*

KEYWORDS*: skillful ball fixation; female college students; bone mineral density; balance ability*

1. Research purpose

Osteoporosis (OP) is a kind of systemic bone disease characterized by reduction of bone mass and loosening of bone microstructure, accompanied by increased brittleness of bone and increased risk of fracture. Bone mineral density (BMD) is a reliable index for the diagnosis of osteoporosis, the degree of osteoporosis and the risk of fracture in patients with OP[1]. At present, there are more than 100 million OP patients in our country. Due to the ovarian degeneration after menopause, estrogen level has been greatly reduced to become a high incidence and risk population in OP patients[2,3]. In order to slow down the occurrence of OP in postmenopausal women, the most effective method is to increase the bone peak in female early adulthood.

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Normal people are a key stage of bone development before and after puberty. It is important to obtain as high BMD as possible in the development period to slow down the occurrence of osteoporosis[4,5,6,7].

2. Research object and method

2.1 object of study

Thirty-six female college students were randomly divided into experimental group and control group. All subjects did not have bone metabolism, cardiopulmonary function injury, and motor system diseases that affected the ball fixation, and had no regular physical exercise after physical education before the experiment. There was no difference in diet and other living habits between the subjects before the experiment and before the experiment. There was no significant difference in age, weight and height between the two groups (P > 0.05, Table 1).

Table 1 Basic Characteristics of Subjects

	age(year)	weight(kg)	stature(M)
control group	19.3±2.17	55.3±7.38	1.56±7.72
experimental group	19.1±2.28	57.4±6.96	1.55±8.11

there is no significant difference between the two groups (P > 0.05).

2.2 research technique

2.2.1 mode of exercise

At first, 18 subjects in the experimental group were divided into two teams by the coach of physical education college, and then the two teams were studied before the experiment for two weeks, and then the experiment lasted for 6 months.

2.2.2 Index detection

2.2.2.1 The indexes were femoral neck, 1 / 3 of distal ulna and radius (main ball holder), L2-4 bone density of lumbar vertebrae, standing time of standing order leg

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and time of eye opening.

2.2.2.2 Methods: (1) L2-4 of lumbar vertebrae were measured at 1 / 3 distal end of ulna and radius by DPX-L dual energy X-ray produced by LUNAR Company in USA. Bone mineral density (BMD) of femoral neck was measured. (2) the balance machine can use the method of standing order leg and opening eyes. Standing on the side of the body with both hands, eyes closed, standing with one dominant foot, one foot bent off the ground, and the lower leg attached to the knee of the standing leg. Test three times and choose the longest one. Eye opening balance: the subjects stood on 2.5cm × 2.5cm × 30cm wide plank with dominant feet (standing longitudinally, supporting feet and planks on a horizontal plane), and the testers recorded the time of standing.

2.2.3 The collected data are analyzed by SPSS 21.0 software, and the results are represented by mean ±standard deviation (). The experimental data were normal distribution, so the average value and independent t test were used to analyze the data, $P < 0.05$ was significant difference, $P < 0.01$ was very significant difference.

3. Experimental results and discussion Analysis

3.1 experimental result

3.1.1 Comparison of the target data before the experiment between the control group and the experimental group, there was no significant difference in the order leg standing, eye opening balance and bone mineral density (BMD) between the two groups before the experiment ($P > 0.05$), which indicated that the experimental group was reasonable. The data before and after are comparable (table 2).

Table 2 Comparison of the indexes of the two groups of subjects before the experiment(n=18)

test specification	control group	experimental group	t	P
Standing on one leg with eyes closed(s)	11.576±1.497	10.910±1.823	1.002	0.343
Open eye balance(s)	22.602±3.486	21.799±4.936	0.48	0.643

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1 / 3 of distal ulna(g/cm^2)	0.911±0.538	0.920±0.618	-0.284	0.783
1 / 3 of distal ulna(g/cm^2)	0.913±0.059	0.921±0.601	-0.271	0.792
Lumbar 2-4(g/cm2)	0.730±0.054	0.722±0.329	0.436	0.673
neck of femur (g/cm^2)	0.811±0.886	0.822±0.824	-0.558	0.591

3.1.2 Comparison of indexes between the control group and the experimental group after one month Table 3 the results showed that the indexes of the experimental group after one month of training were all rising compared with the control group and there was a significant difference in standing on one leg with eyes closed ($P < 0.01$). The balance of open eyes was improved significantly ($P < 0.05$). The bone mineral density of distal ulna and radius, L2-4 of lumbar vertebrae and femoral neck increased in the experimental group, but there was no significant difference ($P > 0.05$).

Table 3 Comparison of the indexes of the two groups in the 3 months after the experiment(n=18)

test specification	control group	experimental group	t	P
Standing on one leg with eyes closed(s)	11.532±1.271	14.157±1.879	-3.842	0.004
Open eye balance(s)	21.310±4.615	25.963±4.615	-2.56	0.031
1 / 3 of distal ulna(g/cm^2)	0.912±0.594	0.934±0.471	-1.699	0.124
1 / 3 of distal ulna(g/cm^2)	0.911±0.566	0.951±0.65	-1.356	0.208
Lumbar 2-4(g/cm2)	0.731±0.058	0.748±0.332	-0.779	0.456
neck of femur (g/cm^2)	0.812±0.641	0.838±0.077	-0.901	0.391

3.1.3 Comparison of the indexes between the control group and the experimental group after 3 months Table 4 the results showed that the time of standing with eyes closed on one leg and the time of eye opening in the experimental group increased significantly after 3 months compared with the control group ($P < 0.01$). There was significant difference in bone mineral density ($P < 0.05$).

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Table 4 Comparison of the indexes of the two groups in the 6 months after the experiment(n=18)

test specification	control group	experimental group	t	P
Standing on one leg with eyes closed(s)	11.213±1.189	18.157±1.000	-14.545	0.000
Open eye balance(s)	20.913±2.124	29.463±2.795	-9.846	0.000
1 / 3 of distal ulna(g/cm^2)	0.914±0.564	0.950±0.067	-2.647	0.027
1 / 3 of distal ulna(g/cm^2)	0.919±0.054	0.958±0.061	-2.878	0.018
Lumbar 2-4(g/cm2)	0.733±0.567	0.779±0.102	-2.819	0.020
neck of femur (g/cm^2)	0.815±0.735	0.853±0.076	-2.731	0.023

3.1.4 Comparison of the indexes between the control group and the experimental group after 6 months Table 5 the results showed that the bone mineral density (BMD) of the experimental group and the balance time of standing with eyes closed on one leg continued to increase after 6 months compared with the control group. And reached the maximum value of this experiment, but the balance ability of the radiation group had no obvious change, because the female college students did not stop developing at this time, the bone mineral density was still rising slowly, but the rising value was small and there was no obvious change before the experiment. So the BMD difference between the experimental group and the control group was the largest and had significant difference ($P < 0.01$).

Table 5 Comparison of the indexes of the two groups in the 9 months after the experiment(n=18)

test specification	control group	experimental group	t	P
Standing on one leg with eyes closed(s)	12.011±1.184	22.357±1.956	-16.369	0.000
Open eye balance(s)	20.813±3.776	34.263±2.188	-18.292	0.000
1 / 3 of distal ulna(g/cm^2)	0.920±0.056	0.985±0.065	-4.248	0.002
1 / 3 of distal ulna(g/cm^2)	0.923±0.560	0.983±0.603	-4.195	0.002
Lumbar 2-4(g/cm2)	0.741±0.052	0.796±0.032	-4.521	0.001

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neck of femur (g/cm^2)	0.820±0.071	0.893±0.08	-4.133	0.003

3.1.5 The trend of bone mineral density in the two groups was similar in the same part of the experiment. The bone mineral density of the experimental group was increasing steadily and rapidly, while that of the control group was increasing slowly ($P < 0.05$). After 3 months, the difference between the two groups was significant ($P < 0.05$), and the difference was more obvious after the end of the experiment ($P < 0.01$). The results showed that there was a positive correlation between the changes of bone mineral density and the longer the time was, the higher the peak value.

3.2 Discussion and analysis

3.2.1 Effect of ball fixation on bone mineral density of female college students

The main mechanism is that moderate exercise can not only improve the related bone metabolism index, promote estrogen secretion [9], but also cause muscle activity to produce stress on the bone, and increase the bone stress to produce negative pressure potential. It is easy to combine positive calcium ions and promote bone formation [[10]. The results showed that compared with the control group, the bone mineral density (BMD) increased in the first month, the third month and the sixth month in the experimental group and the control group.

3.2.2 Effect of skillful ball fixation on female college students' balance ability

The balancing mechanism is very complex, so far it is not very clear. It is generally believed that there are three links in maintaining human balance: sensory input, central integration, and motor control. Sensory input includes visual, proprioceptive and vestibular information input.

4. Conclusion

Long time regular ball fixation exercises can effectively improve the bone density of distal ulna and radius, L2-4 of lumbar vertebrae, femoral neck and balance ability of female college students. With the extension of the practice time of skillful fixing ball, the enhancement effect is more prominent, which can increase the peak value of bone mineral density in the early stage of adult women, so as to

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slow down the occurrence of osteoporosis and reduce the risk of fall in menopausal women.

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