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ORIGINAL ARTICLE

Effect of 4-week Whole Body Vibration on Distal Radius Density△

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Key words: whole body vibration; mechanical loading; distal radius; osteoporosis

Objective To assess the effects of high-frequency loading using whole body vibration on distal radius density in adults.

Methods The volunteers diagnosed with osteoporosis or osteopenia in the First Hospital of Jilin University from January 2011 to December 2014 were recruited. All the subjects performed foot-based, whole body vibrations on the vibration platform (35 Hz, 0.25 g) once a day, for 15 minutes per session over a period of 4 weeks. The bone mineral density of distal radius (rBMD) was measured using dual-energy X-ray absorptiometry at before, 2-week, and 4-week after the vibration treatment. Blood pressures were measured at the end of the vibration treatment.

Results A total of 114 volunteers were enrolled. The average rBMD before the treatment was 0.331 ± 0.014 g/cm^2. It was reached 0.337 ± 0.019 g/cm^2 at the end of the fourth week, increased by 1.79% ($P<0.05$). Whole body vibration increased rBMD of men and women respectively (1.77% and 1.80%, $P<0.05$). Blood pressures did not change in any of the groups.

Conclusion A 4-week whole body vibration was feasible and contributed to increase of rBMD.

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OSTEOPOROSIS is a skeletal systemic disorder characterized by low bone mass and a micro architectural deterioration of bone with increased incidence of fragility fractures. Now, there are about 84 million osteoporosis patients in China.[1] The incidence of fractures caused by osteoporosis is 9.6%, and it has a trend of increase year by year.[1] Distal radial fracture is the most frequent fragility fractures,[2] which can cause wrist chronic pain and stiffness, seriously affecting the hand function. When distal radius fracture occurs, it contributes to considerable disability, increases dependence for the injured patient and has become a public health issue.

Current clinical guidelines[3] to treat bone loss have been focusing on anti-resorptive medication, healthful dietary intake, and traditional impact exercise, but these interven-

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tions sometimes have low patient compliance and can cause adverse side effects or may have an inherent risk of fall. Whole body vibration (WBV) therapy has been proposed as an alternative or adjunctive intervention. Evidence was provided in an animal model that low-risk, high-frequency mechanical accelerations might have a strong osteogenic effect.[4] Several clinical studies showed that WBV training contributed to improve the bone health in human spine and hip.[5, 6] However, the effect of WBV on distal radial density has not yet been evaluated. The aim of this study was to evaluate changes in bone mineral density (BMD) at the distal radius using WBV.

PATIENTS AND METHODS

Participants

The volunteers with osteoporosis or osteopenia in the First Hospital of Jilin University from January 2011 to December 2014 were recruited. The protocol and study design were reviewed and approved by the human use committee of the First Hospital of Jilin University (NO. 2010-010). Informed consent was obtained from volunteers who agreed to participate in the study.

Inclusion criteria

The BMD of human right wrist joint was measured by dual-energy X-ray absorptiometry (DXA). The diagnosis of inadequate bone mass or osteoporosis was based on the handbook of the World Health Organization (1994 edition).[3] The inclusion criteria also included normal nutritional status (as determined by questionnaire), stable weight maintenance (i.e., no elective weight loss or diet), estimated daily calcium intake of 500 mg/d, and the capability of following the protocol for daily use of the WBV device as well as understanding and providing informed consent.

Exclusion criteria

Individuals were excluded with (1) any prolonged immobilization of the axial or appendicular skeleton within the last 3 years; (2) consumption of excessive alcohol (2 drinks/day); (3) heart disease or cerebrovascular disease; blood pressure higher than 21.3/16.7 kPa under medication; systolic blood pressure less than 12.0 kPa; (4) epileptics; (5) thrombosis or a history of thrombosis within the past 6 months; (6) body implants or heart stents; (7) lumbar disc herniation or spondylolisthesis, spinal nerve canal stenosis or oppression; (8) symptoms of imbalance or vertigo; (9) any pharmacologic intervention for osteopenia in the last 6 months; and who were (10) un-recovered from surgical operations; (11) engaged in high-impact activity at least 3 times per week.

Grouping and intervention protocol

The subjects were assigned into the male group and female group according to gender and 45-54 age group, 55-64 age group, ≥65 age group according to age.

All the subjects performed foot-based WBVs on the vibration platform Juvent 1000 (Juvent Medical Co. 300 Atrium Drive, Somerset, USA) once a day, for 15 minutes per session over a period of 4 weeks. During the treatment, the subjects were asked to stand vertically on the vibration platform, lightly holding the handrails of the vibration machine (ZD-10 vibration therapeutic apparatus, Beijing Maidakang Medical Equipment Company, China) with both hands. The vibration created by the platform can safely be transmitted into the extremities and axial skeleton without producing any detrimental skeletal resonances. The frequency of the vibration signals was 35 Hz. The peak vertical acceleration of the vibration platform was 0.25 g.

Blood pressure

The blood pressures were recorded and the subjects were asked for their discomfort at the end of the vibration treatment. All subjects sat quietly for 5 minutes before the blood pressure was measured using a standard automatic sphygmomanometer with cuffs matched to arm size and positioned at the cardiac level.

BMD assessment

At before and 2, 4 weeks after WBV, BMD of the distal radius was assessed by DXA with the GE Lunar Prodigy device (GE Healthcare, Madison WI, USA). All scans were performed with the anterior-posterior position by one same experienced technician. The coefficient of variation (CV) for distal radial DXA measurement in this study was 0.68%.

Statistical analysis

Statistical analysis was performed using SPSS 19.0 software (SPSS Inc., Chicago, IL, USA). Continuous variables of normal distribution were expressed as mean ± standard deviation (SD). The unpaired *t* test was used to test for baseline differences between the male group and the female group. Analysis of variance (*ANOVA*) was used to compare BMD among baseline, 2-week and 4-week groups. $P<0.05$ was considered statistically significant.

RESULTS

General characteristics

A total of 114 cases were enrolled into this study, including