Low-Magnitude, High-Frequency Vibration Treatment Reduces both Fracture risks and Fracture Incidences --- a prospective randomized clinical trial on Community Elderly

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Introduction:

Falls and fall-related injuries are serious among elderly. Fracture is one of the commonest and serious consequences of falls, which accounts for most of the deaths and costs of all fall-induced problems. Poor muscle strength and balancing ability together with low bone mineral density among elderly are the major reasons of fragility fractures. Therefore, fall prevention like strengthening muscle and balancing ability, incorporated with enhancing bone quality are the key strategy to reduce the number of fracture incidences in elderly. However, poor physical conditions and joint degeneration hinder elderly in doing active exercises. Low magnitude high frequency vibration (LMHFV) treatment, which is a non-invasive biophysical modality to provide a whole-body mechanical stimulation, is crucial in maintaining bone mineral density (BMD) and muscle mass[1,2]. In a previous study, 1-year LMHFV treatment was shown to enhance the BMD in spine of postmenopausal women by relative benefit of 3.35% [1]. Whole-body vibration treatment was also reported to be effective in improving the muscle strength and balancing ability in elderly women [2]. Therefore, elderly with poor muscle, balancing ability and low bone quality are beneficiaries of LMHFV. There is no such report addressing the effect of vibration treatment on fracture rate yet. Therefore, a large scale prospective randomized clinical trial is conducted in order to investigate the effectiveness of long-term LMHFV treatment in reducing both fracture risks and the fracture rate in community elderly. We hypothesize that LMHFV treatment can enhance muscle performance and maintain bone mineral density in community elderly, thus reducing the fracture risks and fracture rate.

Materials and Methods:

This is a three-year study in which a total of 704 community elderly were recruited for 18 months. Subjects were recruited from twenty one community centers in Hong Kong and subjected to randomization into either control or intervention group on center-basis. The inclusion criteria include females aged 65 or above, independent and without any osteoporosis treatment. The subjects in intervention group received LMHFV treatment (35Hz, 0.3g) at 20min/day and 5days/week for 18 months [3]. Those in the control group remained sedentary with normal life style. All subjects were assessed at baseline, mid-term (9-month) and end-point (18-month). The occurrence of fractures in both groups was recorded and counted as the primary outcome of this study. Apart from that, secondary outcomes including fall incidence, quality of life, compliance, bone mineral density of hip & spine, muscle strength, balancing ability were measured at fixed time points. All these parameters were compared between groups, in order to evaluate the effects of LMHFV on musculoskeletal system in elderly by repeated measures ANOVA. Human experiments approval was obtained from the Clinical Research Ethics Committee of the Chinese University of Hong Kong (Ref. CRE-2008.067-T), and written consent was obtained from all subjects.

Results:

378 subjects (treatment group age=73.9±5.8; control group age=73.0±5.4, p=0.2) had completed the mid-term assessments, and all data of two groups was compared by independent T-test in this interim report. One fracture case was reported in the treatment group (0.5% fracture rate), while there were three fracture cases in the control group (1.6% fracture rate). The fracture rate was lower in treatment groups after 9-month LMHFV treatment, as compared with controls. 7.88% of treatment group elderly had fall incidences recorded within the first 9 months, while 17.29% of the control groups reported falls in mid-term assessment. The fall rate in treatment group was less than a half of the control groups. Mid-term assessments results showed that the muscle strength of dominant and non-dominant legs of the treatment group were improved by 29.9% and 30.3% respectively, compared with -5.7% ($p<0.0005$) and 0.1% ($p<0.0005$) in controls (Table 1). For balancing ability assessment in terms of limits of stability test, treatment group also showed improvement in end point excursion and maximum point excursion by 6.75% and 2.79% respectively, as compared with -0.83% ($p=0.009$) and -4.64% ($p<0.0005$) in controls (Table 2). However, there was no significant difference for BMD measurement in both groups in the first 9-month period. And up to date, no adverse event was reported from treatment subjects.

Table 1. The percentage change of muscle strength in two groups at 9-month assessments. (% change ±SD)

Group	Dominant leg	Non-dominant leg
Treatment	29.90±54.1	30.32±57.4
Control	-5.72±34.0	0.10±87.5
P value	p<0.0005*	p<0.0005*

Table 2. The percentage change of balance ability in limit of stability test at 9-month assessments. (% change ±SD)

Group	Reaction time	Movement velocity	Endpoint excursion	Maximum Excursion	Directional control
Treatment	1.00±55.7	31.30±93.2	6.75±24.0	2.79±16.6	-4.12±16.2
Control	8.20±51.7	18.95±45.2	-0.83±25.1	-4.64±19.2	-1.76±15.5
P value	p=0.26	p=0.17	p=0.009*	p<0.0005*	p=0.21

Discussion:

In this interim report, treatment group elderly showed an improvement in muscle strength and balancing ability, and a lower fall rate after 9 months LMHFV treatment. The results strongly supported that LMHFV treatment is effective on reducing fall incidences, enhancing the muscle performance and the balancing ability. Based on our previous study, muscle performance and balancing ability after vibration treatment also showed a significant improvement after 3-month treatment [2]. It provides a valuable and solid data to support the long-term applications of LMHFV treatment in reducing fracture risks by improving musculoskeletal system. As we know, poor balancing ability and low bone quality are closely related to the occurrence of fragility fractures in elderly. Though the interim result in 9-month assessments showed that there was no significant difference for BMD measurement in both groups, we will make close observation on the impact of mechanical stimulation on bone quality at 18-month endpoint assessments. The outcomes also imply the effect of vibration on muscle strength is faster than that of bone, as bone remodeling is a relatively slow life process. The primary outcome of the study showed that the fracture rate is lower under LMHFV treatment. So, it will help to push forward the application of LMHFV intervention for elderly to prevent fragility fracture and improve the quality of life of the elderly.

References:

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