Reduction of Fracture Risks and Fall Incidences in Community Elderly by Low-Magnitude, High-Frequency Vibration Treatment --- A Prospective Randomized Clinical Trial

Leung, KS; Li, CY; Chan, SY; Qin, L; Cheung, WH
+Department of Orthopaedics and Traumatology, The Chinese University of Hong Kong

louis@ort.cuhk.edu.hk

Introduction:
Falls and fall-related injuries are serious among elderly. Fracture is one of the most common 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 causes of fragility fractures. Therefore, fall prevention like strengthening muscle and balancing ability, as well as enhancing bone quality are the key strategies 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. In a previous study, 1-year LMHFV treatment was shown to enhance the BMD in spine of postmenopausal women by a 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 [2,3]. Therefore, elderly with poor muscle strength, balancing ability and low bone quality are beneficiaries of LMHFV. There is no such a report addressing the effect of vibration treatment on fall and 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, as well as fall and 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, fall incidence and fracture rate.

Materials and Methods:
This is a three-year study in which a total of 704 community elderly were recruited. 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. 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 rate, quality of life, 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 systems of elderly and related fractures. A randomized controlled trial (RCT) design was used. The failure rate of 32% was interviewed among community elderly. Bone health and QOL questionnaire affected by age and gender were measured. The QOL questionnaire was developed by the Clinical Research Ethics Committee of the Chinese University of Hong Kong (Ref. CRE-2008-067-T), and written consents were obtained from all subjects.

Results:
To date, 412 subjects (176 treatment subjects, age=73±6.3; 236 control subjects, age=72±6.0; P=0.052) had completed the study, 18.8% treatment group subjects reported fall, while 27.4% control subjects had fall incidence(s) recorded throughout the 18-month study period. The fall rate was significantly different between two groups; it was 32% lower in the treatment group as compared with controls (IRR=0.68, 95% CI=0.472-0.991, p=0.04). Four fracture cases (2.3%) were reported in the treatment group, while there were six fracture cases (2.5%) in the control group. It showed a trend of slightly lower fracture rate in the treatment group compared with controls, but the difference was not significant (IRR=0.89, 95% CI=0.26-3.12). Results of knee extensor muscle strength of both dominant and non-dominant leg showed significant improvement in treatment group as compared with controls (+23% and +21% respectively, p<0.001 for both). For balancing ability assessment in terms of limit of stability, significant improvement was found in reaction time (+51%, p<0.001), movement velocity (+54%, p<0.001), endpoint excursion (+49%, p<0.001), and maximum point excursion (+9.9%, p<0.001). For the quality of life, significant increase in the physical health summary score (+7.3%, p=0.006) and mental health summary score (+4.4%, p=0.009) of SF-36 QOL questionnaire were found in treatment group as compared with the controls. However, there was no significant difference for hip and spine BMD measurement in both groups. Up to date, no serious adverse event was reported from treatment subjects.

Table 1. Fall rate (% of subjects reported fall) of treatment and control groups during 18-month study period

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Control</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 fall</td>
<td>17.6%</td>
<td>21.5%</td>
</tr>
<tr>
<td>2 or more</td>
<td>1.1%</td>
<td>5.9%</td>
</tr>
<tr>
<td>Total</td>
<td>18.7%</td>
<td>27.4%</td>
</tr>
</tbody>
</table>

Discussion:
In this study, the subjects receiving low-magnitude high-frequency vibration treatment have shown significant improvement in muscle strength and balancing ability, and these are closely associated with the risk of fall. These substantiate a previous study that reported enhanced muscle strength and postural control [3]. In addition, significantly lower fall rate of 32% and a slightly lower fracture rate were found in the treatment group throughout the study period. Reducing fall incidence is the key to prevent fragility fracture and other fall-related injuries. But due to the low incidence of fracture occurrence, interim analysis does not have sufficient power to draw a solid conclusion on fracture prevention.

Besides physical performance, significant improvement was found in the physical health summary and mental health summary score of SF-36 QOL assessment in treatment subjects. QOL of elderly is affected by mobility, fear of fall and confidence in daily activities. Enhanced muscle performance and lower fall rate may positively affect elderly subjects’ activity level, fear of fall, and thus the quality of life. However, there was no significant difference for BMD measurement in both groups. These also imply that neuromuscular system may be more sensitive to mechanical stimulation than bones in elderly.

In summary, this study confirms the beneficial effects of LMHFV treatment in improving muscle strength, as well as balance abilities. Most importantly, the direct effect of LMHFV is proven to significantly reduce fall rate among community elderly. No serious adverse event was reported from treatment subjects, indicating that LMHFV treatment is safe for application on elderly.

Significance:
Low-magnitude, high-frequency vibration is effective in improving muscle strength, balancing ability and reducing fall rate among community-dwelling elderly.

References:

Acknowledgements: General Research Fund (Ref: 469508) ClinicalTrials.gov ID: NCT00973167