The Effects of Partial Stimulation for Prevention of Osteoporosis; A Pilot Study

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SUMMARY
This study demonstrated the effect of the partial stimulation (PS) for prevention of osteoporosis. To induce osteoporosis, 8 female rats were ovariectomized for 3 weeks. The right tibiae of rats in stimulation group were stimulated for 6 weeks (3days per week, 1500cycle, 2000 µ strain). From acquiring micro-CT images, structural parameters and bone mineral density for trabecular bone were measured and calculated before and after 6 weeks of stimulation. After stimulation for 6 weeks, BMD, BV/TV, Tb.N, and Conn.Dn were significantly increased, while Tb.Sp was significantly decreased (p<0.05). These results showed that PS could enhance morphological characteristics in osteoporotic bone and thus could be used to prevent osteoporosis.

INTRODUCTION
It was commonly accepted that the mechanical stimuli affect bone metabolism. In many researches, whole body vibration (WBV) was recommended for prevention and treatment of the bone loss in postmenopausal women or spaceflight1. However, the application of WBV was prohibited to the individual with health disorder (cardiovascular disease, arrhythmia, renal stone or migraines) by the Food and Drug Administration2-4, and could cause adverse side effects5.

In this study, we aimed to demonstrate whether PS was used to prevent or treat osteoporosis.

METHODS
All procedures were performed under a protocol approved by the Yonsei University Animal Care Committee (YWC-101117-1).

Eight 12-weeks-old female rats (Sprague-Dawley) were used and allocated randomly into 2 groups; CON, and 20Hz. All rats were ovariectomised (OVX) to induce osteoporosis for 3 weeks. Right tibiae of rats in 20Hz were perpendicularly stimulated for 6 weeks (3days per week, 1500cycle, 2000 µ strain). Right tibiae in each rats were scanned by using in-vivo micro-CT (Skyscan 1076, SKYSCAN N.V., Belgium) at 0week (before stimulation), 3weeks and 6weeks (after stimulation). From acquiring images, structural parameters, (BV/TV (bone volume/total volume, %), Tb.Th (trabecular thickness, mm), Tb.N (trabecular number, mm-1), Tb.Sp (trabecular separation, mm), SMI (structure model index), Conn.Dn (connectivity density, mm-3), and BMD (bone mineral density, g/cm3) were measured and calculated by CTAN (SKYSCAN N.V., Belgium).

RESULTS
The relative variations (1at 0 week) for trabecular bone of the tibia as shown in Figure 1. During experiments, the relative changes in the BV/TV, Tb.N, Conn.Dn and BMD in the 20Hz group (0.48, 0.43, 0.39 and 0.59) were significantly higher than those in the CON group (0.33, 0.31, 0.30 and 0.42, p < 0.05). The relative changes in the Tb.Sp in the 20Hz group (1.47) were significantly lower than those in the CON group (1.68, p < 0.05). There were no significant differences in the relative changes in the Tb.Th and SMI between the groups (p > 0.05). These differences of 3 dimensional microarchitectures were verified visually in Figure 2.

DISCUSSION AND CONCLUSIONS
In this study, we investigated the effects of PS for treatment or prevention of osteoporosis. At 3 weeks after stimulation, morphological characteristics were worsened and BMDs were decreased in all groups. Furthermore, there were no differences of changes in morphological characteristics and BMDs among groups. These results suggested that the PS for 3 weeks might not suppress a loss of bone quantity and quality. At 6 weeks after stimulation, there were significant differences (p<0.05) in the relative variations were shown between two groups. These results showed that PS for 6 weeks might suppress a loss of bone quantity and quality. Taken together, the results showed that PS may suppress the continuous progress of bone deterioration, thinning and disconnection. Therefore, PS might be effective for prevention of bone loss and thus reduction of the risk of bone fracture.

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Figure 1: Relative variations in BMD and structural parameters on the trabecular bone (Mean ± SE), * p<0.05

Figure 2: The 3D images of the right tibiae trabecular bone at 6 weeks

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