Electrical Stimulation on Prevention of Osteoporosis due to Microgravity

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Osteoporosis due to microgravity is a major health problem resulting from long-term spaceflight. To preventing such a problem, various protecting techniques have been proposed and developed. However, many of them are not satisfactory either on the results or on the applicability for spaceflight. Since the decreasing of bone density could be irreversible, an effective prevention technique is essential. It has been reported that the electrical stimulation is able to produce loading force on skeletons through muscles contraction and may provide countermeasure to microgravity. There are many performance modes in such a stimulation and need further investigations.

In this work, the effects of electrical stimulation on prevent suspension induced bone material loss in rat hind-limb are investigated. A functional electrical stimulator has been designed and developed. The stimulating current as well as the pulse duration can be justified during application. After several trial experiments, a suitable application current and pulse duration are found and applied in the following experiments. In order to perform the stimulation at the same environment, the stimulation are applied at the same time to all rats. Thus, the stimulator is a multi-channel stimulator. The experiments are performed with rats in three groups. Group A are hind-limb unloaded by using rodent model. Group B are hind-limb unloaded and electrical stimulated. Group C are free and served as control group. The stimulation has been applied every day for 25 days. For Group B, only one hind limb has been stimulated for all rats. After experiments, the bone density distributions of all groups have been obtained and analyzed. By reconstructing the three dimensional bone shape, finite element analysis have also been carried out. Preliminary results indicate that the electrical stimulation can reduce the unloading effects in a certain scale. The bone distributions are different for different groups. The bone densities of both sides in Group B are higher than the group A. This is due to the parallel contractions of the hind limb without stimulation during stimulating the counter side hind limb.

Since the stimulation device is portable and easy to apply, it may have potential to be used for prevention the bone material loss due to micro-gravity during long term space flight. However, the effects of frequency, current, and the pulse duration need further investigations.