Vitamin K2 on 3-D trabecular microarchitecture in ovariectomized rats

Introduction: Two types of vitamin K occur in nature: vitamin K1 (phyloquinone, 2-methyl-3-phytyl-1,4-naphthoquinone), which is derived from plants, and vitamin K2 (menaquinones), a series of vitamers with multiple isoprene units. Several articles have been devoted to the study of vitamin K2 treatment and its role in osteoporosis. However, there have been few studies of the effect of vitamin K2 on 3-D trabecular microarchitecture induced by ovariectomy and a calcium-deficient diet. The objective of this study is to quantify the effect of vitamin K2 on 3-D trabecular microarchitecture using an animal model for postmenopausal osteoporosis induced by ovariectomy and a calcium-deficient diet. In this study, we assessed the effects of menatetrenone on 3-D trabecular microarchitecture.

Method: Forty-two 12-week-old Fisher 344 breeder female rats weighing 156.1 ± 6.3 g were purchased and maintained at the animal research facility. After a 1-week acclimation period, the rats were randomized by weight into four treatment groups: the ovariectomized (OVX-MK4) group (n=14), fed a calcium-deficient diet and treated with menatetrenone, the ovariectomized (OVX untreated) group (n=14), fed a calcium-deficient diet and untreated, the sham-operated (Sham+MK4) group (n=7), treated with menatetrenone and the sham-operated and untreated (Sham untreated) group (n=7). Both the ovariectomy and sham operations were performed at an age of 13 weeks, and the animals were kept in pairs at 22°C with a 12 hour/12 hour light/dark cycle until they were 21 weeks old. During the 8-week period, the animals were given free access to food and water. Ovariectomized rats were given food containing 0.2% calcium, and the sham-operated rats were given a regular diet containing 0.5% calcium. Rats in the menatetrenone-treated groups were given food containing commercially available menatetrenone for 8 weeks from the day after the operation. Body weight and food intake were measured once a week. To examine whether the expected dose of menatetrenone had been taken, menatetrenone intake from the regular diet was calculated from these data. Thus, menatetrenone intake was adjusted to the previously decided dose, which was finally normalized over the 8-week period.

Results: All animals tolerated the experiment without complications. Intra- and inter-observer reliability for scans measured in 9 days averaged 90% and 92% respectively for BTV/T, trabecular volume, and inter-observer variability of the total length of the tibia in each group was observed.

Discussion: This study suggests that an 8-week administration of menatetrenone protects against the loss of trabecular bone volume and its connectivity in the osteoporotic rat model induced by ovariectomy and a calcium-deficient diet, when the treatment is started just after the ovariectomy. Despite this apparent protection, further study should attempt to clarify whether it is possible to re-establish trabecular bone connectivity if therapeutic intervention occurs after the connectivity has been lost.

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Figure: 3-D reconstructed Micro-CT images. (x10)

EFFECT OF VITAMIN K2 ON 3-D TRABECULAR MICROARCHITECTURE IN OVARIECTOMIZED RATS

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