THE EFFECTS OF THE KNEE JOINT DURING TIBIA LENGTHENING IN RABBITS

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Introduction
Currently, bone elongation is widely-used. However, the development of joint contracture and articular cartilage damage is a serious complication, and the increased mechanical stress can affect the chondrocyte metabolic activity, thus altering the mechanical properties of the cartilage in matrix constituents (3). In short term follow-up studies, joint distraction as treatment for degenerative osteoarthritis has been shown to be clinically effective (1) (2). The purpose of the present study was to investigate the changes that occur in distraction, compression, neutral, and free motion of the knee joint during tibia lengthening at the proximal metaphyseal side.

Materials and Methods
The study was performed on 48 male Japanese white rabbits, weighing between 2 to 2.5 kg. A modified unilateral external fixator with an extra clamp across the knee joint was placed onto the medial aspect of the right tibia (for bone elongation) and distal femur (to distract, compress, and neutral fix of the knee joint in 80º - 90º of flexion) for 7 weeks. There were five equal subgroups: Group A, knee joint distraction (maintaining a joint space between 2 to 3mm); B, compression (until both surfaces made contact); C, neutral (maintaining a normal joint space); D, free knee range of motion; and E, contralateral knee as a control, (n = 60 knees) (Fig. 1).

The passive range of motion (ROM) of the knee was assessed in the anesthetized animals and recorded preoperatively and again after removal of the external fixator. (n = 60) The tibia and fibula were osteotomised at the metaphyseal side, and after a 5-day the tibia was lengthened 1mm in two steps per day for 14 days. Plain radiographs were taken after operation and at the seven-week follow-up to evaluate callus formation and degenerative changes in the knee joint (n = 48). All of the specimens were harvested after seven weeks, and gross visualization of the articular cartilage of the knee joint surfaces in the freshly dissected specimens was performed, and preserved at –80ºC until use. For histological study, specimens were made from cartilage bone-blocks of each knee joint (tibia, femur, patella). For this purpose we used a modified joint system assessment of gross and histologic osteoarthritic changes in rabbit articular cartilage (4) (n = 25). Also cartilage specimens were taken from the tibia, femur, and patella articular surfaces to analyze glycosaminoglycan (GAG) by the carbazole visualization of the articular cartilage of the knee joint surfaces in the

Discussion
Alterations in the mechanical environment of articular cartilage lead to cellular and biochemical changes in the activity of chondrocytes that are associated with cartilage degradation (3)(4)(5). The present data show marked variation of loss of ROM in groups A, B and C, compared with group D, due to the immobilization. The group of joint distraction had mild grade degenerative changes, and the groups of joint compression, neutral, and free showed moderate grade compared with the normal control Group E. But there was a significant reduction in GAG content in Groups A, B, and C compared with control Group E. The low ratio of 4di-6S / 4di-4S in the Groups A, B, and C may reflect the proteoglycan metabolism, and could reveal degenerative osteoarthritis (OA). In conclusion we suggest that the creation of a space between the bony surfaces protected the joint. Therefore, joint distraction during bone elongation reduces mechanical stress from loading strength, protecting the joint cartilage.

Results
46 right tibia were successfully lengthened (mean 10mm), and the 5-day latency period was enough to prevent premature consolidation. Two tibia from group B showed nonunion.

ROM in all groups preoperatively was normal, and the average losses of ROM at follow-up were: Group A, 39º ± 3.5 (mean ± SD); B, 78º ± 2; C, 52º ± 2.5; D, 29º ± 1.4; and E, 0º ± 0; (p<0.0001). The gradation of gross and histological changes observed in the articular cartilage in each group were: Group A, mean grade 0.8 ± 0.4 (grade ± SD); B, 7.8 ± 2.5; C, 3.2 ± 1.3; D, 1.6 ± 1.5; and E, grade 0 ± 0; (p<0.0001). The mean concentrations of GAG were: Group A, 46.20 ± 17.7 µg/mg dry weight (mean ± SD); B, 35.03 ± 20.6; C, 65.25 ± 15.3; D, 72.79 ± 7.6; and E, 103.87 ± 40.9; (p<0.05).

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