INTRODUCTION: The duration of immobilization after Achilles tendon repair is of major concern. Recently, several clinical studies have investigated early active motion after surgical repair of the Achilles tendon rupture (1, 2), and have reported the biomechanical effects of early active motion on the primary repaired Achilles tendon in rabbits (3). The purpose of the present study is to analyze the histology and collagen fibril diameters in the repaired tissue to clarify the optimal duration of immobilization after primary repair of the Achilles tendon.

MATERIALS AND METHODS: Eleven mature Japanese white male rabbits (mean body mass: 3040g) underwent Achilles tenotomies of the left limbs at 1.5cm proximal to the insertion site at the calcaneus under intravenous anesthesia. The ruptured Achilles tendon were immediately repaired by both the modified Kessler and circumferential suture methods using 4-0 nylon. The rabbits were divided into three groups based on the duration of postoperative immobilization. Four animals were allowed unrestricted cage activity after repair (Group A). Four animals underwent 3 week cast immobilization followed by active motion (Group B). Two animals underwent 6 week cast immobilization (Group C). The bilateral Achilles tendons of one animal were served as the control. Four repaired Achilles tendons were harvested at 3 weeks after repair from Groups A and B (2 from each group) and the remainder at 6 weeks from Groups A, B and C. The longitudinal histological sections of the repaired Achilles tendons were stained with haematoxylin and eosin, and examined under light microscopy and polarizing microscopy. The transverse histological sections were examined under transmission electron microscopy. Furthermore, the diameter of each collagen fibril was measured at 3 and 6 weeks using computerized image analysis (NIH image system). The values of collagen fibril diameters at 3 weeks for Group C were considered to be equivalent to those for Group B. For statistical analysis of collagen fibril diameters, the student t-test and a one way analysis of variance were used.

RESULTS: At 3 weeks, the collagen fibers in Group A were oriented more parallel to the axis of the tendon than those in Group B. At 6 weeks, the collagen fibers in Groups A and B were well oriented along the axis of the tendon, while those in Group C were disorganized (Fig.1). At 3 weeks, the crimp pattern in Group A was regular with a small period, whereas that in Group B was highly irregular. At 6 weeks, crimp patterns of various periods were recognized in Groups A and B, however, very few crimp patterns were seen in Group C (Fig. 2). The distribution of the collagen fibril diameters for each group is shown in Fig.3 (a) and (b). The collagen fibril diameters at 3 and 6 weeks were 40.1±4.7nm (mean ± SD) and 40.1±4.1nm for Group A, respectively, 39.9±3.9nm and 46.8±5.7nm for Group B, respectively, and 39.9±3.9nm and 52.3±5.9nm for Group C, respectively, and 161.3±50.5nm for the control (Fig.3 (c)).

DISCUSSION: We have already reported that the mechanical properties of Group B at 6 weeks were the most superior among the three groups (3). Histologically, the collagen fibers in Group A as well as those in Group B had a high degree of organization. However, the collagen fibril diameters in Group B were larger than those in Group A. Therefore, it appears that repaired tissue of the Achilles tendon for Group B matured more efficiently than that of Group A. On the other hand, at 6 weeks, the mechanical properties for Group C were the lowest of the three groups (although the collagen fibril diameters in Group C were the largest). This may be due to both the disarrangement of the collagen fibers and gap formation in Group C. This study showed that limited immobilization was necessary for maturation of collagen fibrils and mobilization was necessary for the appropriate orientation of the collagen fibers. According to our findings, three week immobilization was best in terms of collagenous tissue maturation for the repaired Achilles tendon. Additional investigation is required to determine the optimal duration of immobilization after primary repair with a suture method which withstands early active motion and prevents gap formation.

REFERENCES: