EFFECTS OF STRESS DEPRIVATION ON BIOMECHANICAL PROPERTIES OF REGENERATED AND RESIDUAL TISSUES IN THE PATELLAR TENDON AFTER REMOVEL OF THE CENTRAL ONE-THIRD

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INTRODUCTION

The central one-third of the patellar tendon (PT) is commonly used as a substitute for reconstruction of the anterior cruciate ligament. The defect made by the resection of the central portion is filled with regenerated fibrous tissue. We have observed in a rabbit model that the strength and elastic modulus of the residual tissue significantly decreased at an initial stage and then increased thereafter, and that those of the regenerated tissue progressively increased during healing [1]. Mechanical stress is considered to affect the remodeling phenomena in both tissues, because the strength and modulus of the normal PT are very rapidly and markedly decreased by the removal of the stress applied to it (stress shielding) [2].

Therefore, we hypothesized that stress shielding significantly affect the properties of both regenerated and residual tissues after the resection of the central one-third of the PT. The purpose of the present study was to test this hypothesis.

MATERIALS AND METHOD

Skeletally mature female Japanese white rabbits were used. After surgical exposure of the PT in each right knee, the PT was relaxed at all knee angles with a stainless steel wire hooked between the patella and the tibial tubercle, for the complete removal of stress [2]. Then, a full-thick, full-long (about 20 mm), rectangular defect, which had the width (about 3 mm) of one-third of the whole width of the PT, was made in the central portion of the PT. Postoperatively, all animals were applied no immobilization procedure, and were allowed unrestricted activities in cages.

At 3 or 6 wks after the operation, patella-tendon-tibia complexes were excised, and each complex was divided into the medial (residual PT tissue), central (regenerated tissue), and lateral (residual PT tissue) portions. Tensile testing was performed for each specimen in ? ? C saline solution at the rate of 20 mm/min; strain was determined at midsubstance with a video dimension analyzer.

The results from these completely stress-shielded tissues (CSS group) were compared with our previous results obtained from the animals which were made same defects in the PT but were applied no sreess shielding treatment (NSS group) [3], and also .with the results obtained from non-treated normal PTs (Control) [4].

RESULTS AND DISCUSSION

Fibrous tissues were regenerated in the PT defects already at 3 wks in both CSS and NSS groups, but their tensile strengths were very much lower compared to the control PT (Figure 1). The strength increased between 3 and 6 wks, although that at 6 wks was still significantly lower than control value. CSS group had significantly lower strength than NSS group at each period. The tensile strength of the residual PT tissue (average for the medial and lateral tissues) was greatly decreased by the removal of the central portion in both groups, possibly due to overstress applied to the residual tissue [1], and the decrease was significantly larger in CSS than in NSS groups. The elastic modulus showed essentially similar results to the tensile strength in both groups. The strain to failure was significantly larger in CSS and NSS groups than in Control group regardless of experimental period, although there were no significant differences between CSS and NSS groups.

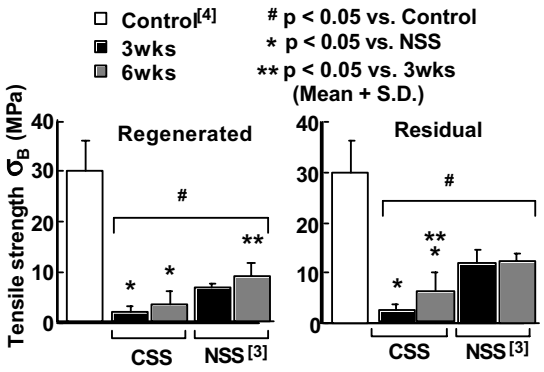

Figure 1 Tensile strength of regenerated and residual tissues after removal of the central one-third of the patellar tendon.

CONCLUSION

These results indicate that stress shielding induces adverse effrects on the mechanical properties of the regenerated tissue and the unresected, residual tendon tissue after the removal of the central one-third portion of the PT as a substitute for ligament reconstruction. This fact implies that adequate stress is prerequisite for the healthy remodeling of not only residual tendon tissue but also newly regenerated fibrous tissue.

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ACKNOWLEDGEMENTS

This work was financially supported in part by the Japan Space Forum for the Ground-Based Research for Space Utilization (no. 181) and by the Grant-in-Aid for Scientific Research (A) (2) (15200036) from the Ministry of Education, Culture, Sports, Science and Technology, Japan.