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| 学　位　論　文　名 | Flexor Tendon Repair Using the Two-Strand Side-Locking Loop Technique to Tolerate Aggressive Active Mobilization Immediately After Surgery |
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## 論文内容の要旨

### INTRODUCTION

For digital flexor tendon repair, accelerated rehabilitation exercise after surgery is a prerequisite to improve treatment outcome. Many recently developed suture methods have been able to facilitate active rehabilitation exercise at a stage earlier than previously attempted; however, there remain risks of a large gap formation or a re-rupture at the sutured site. In this study, we investigated whether the two-strand side-locking loop technique, which we previously proposed as a method providing high tensile strength and stiffness, would tolerate aggressive active mobilization immediately after surgery. The results of the two-strand side locking loop technique were compared to the 8-strand repair method, which has hitherto been reported to provide the highest biomechanical tensile strength in a canine experimental model.

## MATERIALS AND METHODS

Twelve flexor digitorum profundus (FDP) tendons of forelimbs of 4- to 5-month-old Landrace pigs (60-75 kg in weight) were used as an experimental model. The FDP tendons were exposed through a distal incision in the digital flexor sheath and transected sharply at about 4 cm proximal from the attachment of the distal phalanx. The FDP tendons were sutured by the two-strand side-locking loop technique with a cross-stitch epitendinous repair (Group A), and by the 8-strand repair method with a simple running suture (Group B). Holding the proximal edges of the flexor tendon with a clamp, 10,000 loading cycles were applied to the specimen with tension ranging from 3 to 50 N. Gaps and residual tensile strength after cyclic loadings were measured. Statistical analysis was performed by the Student *t*-test, and differences with *p* values of less than 0.05 were defined as statistically significant.

## RESULTS AND DISCUSSION

According to Kursa et al. (2006), bending all the fingers until the fingertips lightly touched the palm and then straightening them, required a load on the human flexor digitorum superficialis tendon between 1.3 N and 8.5 N, though it incidentally could reach a maximum of 47 N. Therefore, considering an incidental maximum load during active motion rehabilitation exercises, a tension load of 50 N was in used in this study. Loading cycles of 10,000 rounds each were given on simulated active motions (500 times per day) for 3 weeks after tendon repair.

Gaps after cyclic loading in Group A were 0.5 ± 0.3 and 1.2 ± 0.8 mm while those in Group B were 3.5 ± 0.8 and 5.2 ± 1.2 mm at 3 and 50 N, respectively. Regarding the cleft, Gelberman et al. (1999) have observed in canine flexor tendon sutures that a gap of ≥3 mm at the repair site prevented the accrual of strength and stiffness that normally occurs over time. Therefore, the two-strand side locking loop method is less likely to induce significant delay in healing, even when active movements are executed immediately after surgery.

In addition, the respective residual tensile strength of Groups A and B were 207.1 ± 15.2 and 84.2 ± 18.3 N. According to the previous findings, the in-vivo load of the flexor tendon is 2 - 4 N during unresisted passive flexion, and varies respectively up to 10, 17, 70 and 120 N during active flexion with mild resistance, moderately resisted flexion, strong composite grasp and firm tip-pinch. Noguchi et al. (1993) have reported that the average ultimate strength (structural property) of human flexor tendons measures 213.0 ± 12.0 N. Since the two-strand side locking loop technique yields a tensile strength similar to that of normal human flexor tendons, this useful approach may facilitate safe and active movement immediately after surgery.

## CONCLUSION

A combination of the two-strand side locking loop technique with cross-stitch epitendinous repair served as the optimum suture method in establishing safe and early active mobilization without the aid of a specialized rehabilitation staff.