学 位 論 文 の 要 旨

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学 位 論 文 名	Biomechanical Differences Resulting from the Combination of Suture Materials and Repair Techniques
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論 文 内 容 の 要 旨

Introduction

Many articles recommend early rehabilitation exercise after repair of the flexor tendon of the hand or the Achilles tendon, not only to quickly resume ordinary lifestyle, but also to promote the biological healing process. However, there is a possibility of re-rupture at the sutured site if heavy mechanical loads are imposed. Therefore, in order to ensure the clinical outcome after surgery with an early rehabilitation exercise, suture with sufficient resistance to gap formation is necessary soon after surgery. The purpose of our study was to find an optimal suture method with greatest resistance to gap formation, through testing the combination of 4 suture materials and 4 repair techniques.

Materials and methods

According to the definition of Hotokezaka, *et al.*, the core suture loop configurations were classified into either “locking” or “grasping”. The authors applied with single locking (locking Kessler suture), multiple locking (Krackow suture), single grasping (grasping

Kessler suture), or multiple grasping technique (Bunnell suture). The gastrocnemius tendons of 24-week-old cattle (diameter 14-16 mm x 9-11 mm) were repaired with application of above-mentioned four repair techniques, using a United States Pharmacopeial Convention (USP) 2 suture thread of either braided polyblend polyethylene, polyester, polydioxanone, or nylon. Therefore, a total of 16 combinations were made, using 8 specimens for each combination. The reason for testing the four suture materials was to focus on the features of each polyester suture and nylon suture are generally applied for the flexor tendon of the hands, polydioxanone is recommended for the Achilles tendon, and braided polyblend polyethylene has very high tensile strength and recently became available for clinical use. The specimen was set in an Instron tensiometer and was loaded with tension for 2-4 seconds at a speed of 200 mm / min by gradually increasing the force from 10 to 100 N. The loading was repeated 500 times. After repetitive loadings, the tension was kept at 10 N, and the gap occurring at the repair site was measured.

Results

With application of the single locking technique, braided polyblend polyethylene provided a significantly decreased gap (4.5 ± 0.5 mm) as compared with all the other combinations of repair techniques and suture materials. No statistically significant difference was observed among the gap length provided by the remaining 3 suture materials

With application of the multiple locking technique, braided polyblend polyethylene and polydioxanone provided significantly larger gaps (11.8 ± 2.0 mm and 12.3 ± 1.6 mm, respectively) as compared with the remaining suture materials ($p < 0.01$). Polyester provided the smallest gap (8.8 ± 1.5 mm), which was statistically less than that when using the two above-mentioned materials.

With application of the single grasping technique, polyester provided a significantly smaller gap (7.7 ± 2.1 mm) as compared with that seen when using braided polyblend

polyethylene (10.0 ± 3.4 mm) and polydioxanone (9.8 ± 1.8 mm).

With application of the multiple grasping technique, the repair using polydioxanone (10.1 ± 2.3 mm) provide

d a significantly larger gap as compared with that when using polyester (8.2 ± 2.0 mm). Note that all suture materials provided a gap of more than 8 mm.

Discussion

Single locking, braided polyblend polyethylene suture provided the smallest gap and has shown that repair with a gap up to 3 mm uneventfully heals with a low risk of rupture. When considering that the specimen used in the current study (bovine gastrocnemius tendon, approximately 15 mm in diameter) is thrice larger than the human flexor tendon (approximately 5 mm in diameter), it is unlikely that a gap up to 9 mm (i.e., three times of 3) can worsen the repair. Thus, the resultant gap of 4.4 mm using the combination of the single locking technique and braided polyblend polyethylene suture, as in the current study, is adequately smaller.

The substantial stiffness of braided polyblend polyethylene is beneficial in the single locking method, although it is a drawback in other suturing methods. On the other hand, the effectiveness of the single locking method is obvious when using a suture thread of substantial stiffness. When we become aware of the biomechanical properties of the combination of suture materials and methods, we may effectively and safely utilize the characteristics in early rehabilitation exercise after tendon repair.

Conclusion

Mechanical properties of each tendon suture depended on the particular combination of suture materials and repair techniques. The combination of braided polyblend polyethylene and single locking technique provided the highest anti-gap strength.