学 位 論 文 の 要 旨

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学 位 論 文 名	OPTIMUM SURGICAL SUTURE MATERIAL AND LOCATION OF KNOT FOR TENDON SURGERY
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論 文 内 容 の 要 旨

INTRODUCTION

In repair of a ruptured tendon, the resistivity of the suture is important relative to its tolerance of dynamic motion. Whereas, several in vivo and clinical studies have shown that an early mobilization program following flexor tendon repair improved healing process, and thus the functional outcomes of the injured digits. Since a suture failure tends to occur near the knot, we considered the strength of the sutured site may depend on the strength of the knot. Therefore, we experimentally investigated the optimum combination of suture materials and knot formation methods, and whether the location of a single core suture knot affects the biomechanical properties of the tendon repair.

MATERIALS AND METHODS

Firstly, we examined the basic tensile strength of five suture materials (nylon multifilament, polyester multifilament, nylon monofilament, polydioxanone monofilament, polyethylene and polyester multifilament) when a knot was formed.. An experienced orthopaedic surgeon formed a loop with a knot using USP2-sized five different suture materials (0.5 - 0.599 mm in diameter), then pulled each loop at a speed of 20 mm/min using a tensiometer..

Secondly, we examined an optimum location of a knot for tendon suture. Total 42 transected bovine tendons (male Japanese black cattle, 24 months old) of the medial gastrocnemius (9-11mm × 14-16mm in diameter) were sutured with the side-locking loop technique using a USP2-sized polyethylene and polyester multifilament suture (n = 21) or a polyester multifilament suture (n = 21). For achievement of very high tensile strength, based on our preliminary study, eacheach knot was made using 7 simple square ties (a surgeon's knot plus 5 ties) at either one of three locations; 1) on the loop, 2) between the tendon stumps, or 3) between the loops burying the knot in the tendon. The sutured specimens were loaded with tension using a tensiometer at a speed of 300 mm/min by gradually increasing the force from 10 to 100 N (with a 1.0-1.5 second cycle), repeating the loading 10,000 times, then the gap occurring at the repair site was measured. After the repetitive loading test, specimens were again loaded until suture failure occurred, in order to measure the ultimate strength. After the tests, the suture threads were removed from the tendons and carefully observed to determine the modes of suture failure.

RESULTS AND DISCUSSION

Regarding the experiment of tensile strength with a knot, the polyethylene and polyester multifilament suture provided the highest tensile strength when a large number of throws was applied at a knot. With the conventional surgical suture knot of three throws (addition of one throw on a surgeon's knot), a nylon multifilament suture yielded the highest tensile strength.

Depending on the suture materials and the location of the knot, thethe gap occurring after the termination of the loadings and the ultimate tensile strength varied significantly. The gap was most decreased and the ultimate strength was most increased when the knot was located between the loops using the polyethylene and polyester multifilament suture. When the knot was located between the stumps or on the loop, all repairs failed at the knot. When the knot was located between the loops, some repairs failed at the point where the vertical component of the suture kinked with the transverse component. Cross-sectional area of the sutured tendon showed the ratio of the buried knot relative to the entire sliced tendon stump was only 1.6 to 2.3%, and the polyethylene and polyester multifilament suture was proved very durable against frictional abrasion.

Our study results indicate that the location of a core suture knot significantly influences the biomechanical properties of the repair. The reason for the differences in gap length and ultimate strength was partly due to the difference in the inherent elasticity of each suture material. The gap length and ultimate strength were also significantly influenced by the location of the knot. When locating the knot between the loops, the tensional discrepancy between the bilateral longitudinal components of the suture most decreased, because the tension applied on suture by tying the knot was equally distributed from the transverse component through the locking loops to the both longitudinal components. In addition, the knot between the loops received less load, because the tensile force was transmitted from the longitudinal components by way of the locking loops, and finally to the knot. Therefore, it was considered that the gap was most decreased and the ultimate strength was most increased when the knot was located between the loops.

CONCLUSION

A polyethylene and polyester multifilament suture is the strongest suture material for a site where application of a large number of throws at a knot is clinically possible. Regarding the location of the knot, we found that formation of a knot between the loops (burying it in the tendon) yielded an optimum condition for bovine tendon suture, when applying the side-locking loop suture technique using a polyethylene and polyester multifilament suture

別紙

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論　文　名	1.	Optimum surgical suture material and methods to obtain high tensile strength at knots: problems of conventional knots and reinforcement effect of adhesive agent
	2.	Optimum location of knot for tendon surgery in side-locking loop technique.
発表雑誌名 (巻、初頁～終頁、年)	1.	Journal of Orthopaedic Science 11, 70-74, 2006
	2.	Clinical Biomechanics 22, 112-119, 2007
著　書　名	1.	Fumito Komatsu, Ryuji Mori, Yuji Uchio
	2.	Fumito Komatsu, Ryuji Mori, Yuji Uchio, Hitoshi Hatanaka