

Comparison of Mechanical Property between Two Different Suture Methods with Tie-grip Technique for Meniscus Radial Tear

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Introduction: Radial tear at the midbody of the meniscus cause remarkable deformation (widening at the tear site) and mechanical dysfunction of the meniscus. We have performed inside-out (IO) repair for radial tears with tie-grip technique against the tear gap widening¹⁾. However, unsatisfactory healing after repair with this technique, which might be attributed to insufficient fixation by the repair suture through the soft capsule, was reported²⁾. Recently, all-inside suture (AIS) repair method, which directly re-attach the torn edges by side-to-side without passing the suture through the capsule, has been available due to the advancement of arthroscopic repair devices^{3,4)}. The hypothesis of this study was AIS repair for meniscus radial tear would be superior to IO repair in terms of biomechanical behaviors. The purpose of this study was to compare the mechanical property of the repairing method with tie-grip technique for radial tear of the meniscus between AIS and IO repairs.

Methods: Fresh frozen porcine lateral menisci were randomly assigned into two groups: AIS (n=3), and IO (n=3). A complete radial tear was created at the midbody of the meniscus, equidistant from the anterior and posterior horns. Radial tear was repaired with tie-grip technique using nonabsorbable suture materials (2-0 Ethibond®). Anterior and posterior grip sutures were placed with a 5mm distance from each torn edge horizontally to the radial tear. Two tie sutures were placed on inner and outer third of the meniscus width to hold both grip sutures parallelly to the radial tear. In AIS group, the tie-sutures were passed only inside the meniscus, whereas the tie sutures were passed through the meniscus and surrounding capsule in horizontal mattress fashion in IO group (Fig.1). The repaired meniscus was set in a tensile testing machine (SHIMADZU AUTOGRAPH) with traction sutures on the anterior and posterior horns (Fig.2). Tensile test by pulling the anterior and posterior traction sutures was conducted at 5mm/min. The distance between the anterior and posterior entry points of the inner and outer tie sutures was calculated by a video analysis and the displacement was defined as the change of the distance from the initial state to the moment just before failure. The ultimate failure load and was also recorded. The Wilcoxon rank sum test was utilized for statistical analysis between the 2 groups with a significance level of 0.05.

Results: The inner displacement (mm, mean \pm standard deviation) was 4.0 ± 0.8 in AIS group and 8.9 ± 1.0 in IO group with a significant difference ($p < 0.05$). On the other hand, the outer displacement was 3.6 ± 0.9 in AIS group and 4.8 ± 0.9 in IO group without a significant difference. The ultimate failure load (N, mean \pm standard deviation) was 101.5 ± 12.5 in AIS group and 121.2 ± 1.3 in IO group, and no significant difference was detected.

Discussion: This study indicates that the tie-sutures with AIS method in repairing meniscus radial tears with tie-grip technique can provide the lesser widening of the tear gap compared to IO method, which is supposed to be derived from direct grasping of the meniscus body without passing the sutures through capsule, though the ultimate failure load was not different between the two methods. Because the torn edges in meniscus radial tear split in antero-posterior direction, more stable fixation by the tie sutures is needed in tie-grip repair technique. For the repair of radial tear at the midbody of the meniscus, AIS method might be suitable for tie sutures in tie-grip technique due to a superior mechanical property and could lead to improved healing (synovial coverage) of the repaired meniscus.

Significance/Clinical Relevance: Radial tear of the meniscus significantly deteriorates its mechanical function and causes consequently degenerative and osteoarthritic change of the knee joint. Promoting healing after repair for meniscus radial tear by utilizing more stable fixation with AIS tie sutures in tie-grip technique would restore the mechanical function of the meniscus and improve clinical outcomes⁵⁾.

References:

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Figures:

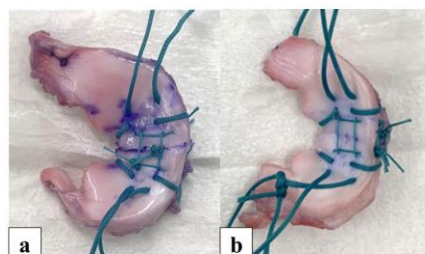


Fig.1 Repair constructs and sutures. a A sutured meniscus using all inside suture technique. b A sutured meniscus using inside-out technique.

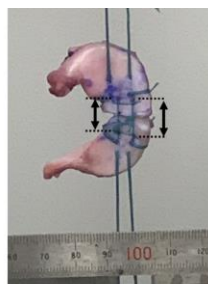


Fig.2 Repair meniscus setted in a tensile machine. The distance between the anterior and posterior entry points of the inner and outer tie sutures was recorded, respectively.