Biomechanical Investigation of Different Preparation Techniques of Tripled Soft Tissue ACL Grafts

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Aims and Objectives: The purpose was to investigate biomechanical properties of different preparation techniques of tripled soft tissue ACL grafts to avoid early mechanical graft failure.
It was hypothesized that 1) a graft with a quadrupled femoral portion results in higher load to failure and stiffness compared to a uniformly tripled graft, and 2) a Krackow stitch technique is superior to both baseball stitch and whipstitch technique.

Materials and Methods: Forty-eight bovine flexor tendons (eight per group) with a final graft length of 8 cm were used for the present study and randomly assigned to the two graft configuration groups: A) quadrupled femoral portion with a tripled tibial portion, and B) uniformly tripled soft tissue graft. Within the two groups, three different stitching techniques were applied: 1) Whipstitch technique, 2) Krackow stitch, and 3) Baseball stitch.
After preconditioning, the grafts were cyclically loaded for 1000 cycles between 50 and 200 N (1 Hz) with consecutive load to failure testing using a constant elongation of 30 mm/min. During biomechnical testing, graft elongation was evaluated with an optical tracking system.
For statistical analysis a two-way analysis of variance with a post-hoc Holm-Sidak test was performed. To evaluate the failure mode the Fisher's exact test was used. The significance level was set at p #CHR:lesslike# 0.05.

Results: Considering load to failure, quadrupling the femoral portion of the graft significantly increased the load to failure ($p = 0.003$) while varying the stitching technique had no influence ($p = 0.998$). Additionally, graft elongation was lower in group A, but difference was not significant ($p = 0.058$). Lowest graft elongation was observed when a Krackow stitch was applied, followed by the baseball stitch, and the whipstitch technique ($p = 0.035$).
In group A, all the constructs (graft including sutures) failed at the suture, whereas in group B the failure mode was a slippage of the free femoral graft strand in seven of eight grafts ($p = 0.005$).

Conclusion: When using tripled ACL soft tissue grafts in combination with an extracortical fixation device, the femoral portion should be quadrupled whereas the stitching technique does not have a significant influence on the biomechanical properties. To achieve a higher load to failure with less graft elongation at time zero, the free femoral strand of the tendon graft should be wrapped around the femoral graft tendon loop. This could reduce early graft failure due to slippage of the third free femoral graft strand.

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