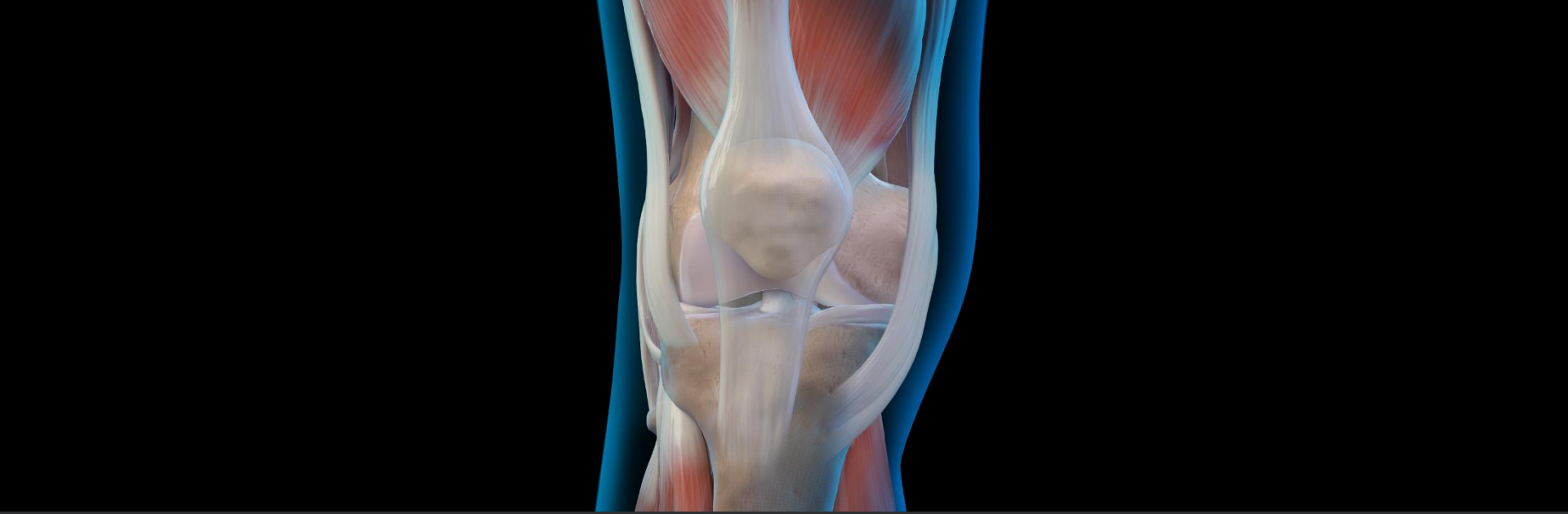

Biomechanical Comparison of 4- and 6-stranded Hamstring Grafts in All-Inside ACL Reconstruction

The Value of Tape-Reinforced Suturing for Inner Graft Limb Fixation

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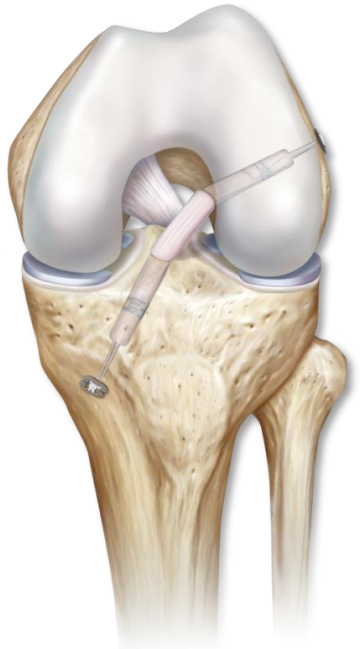
Faculty Disclosure Information

- Employee at Arthrex GmbH

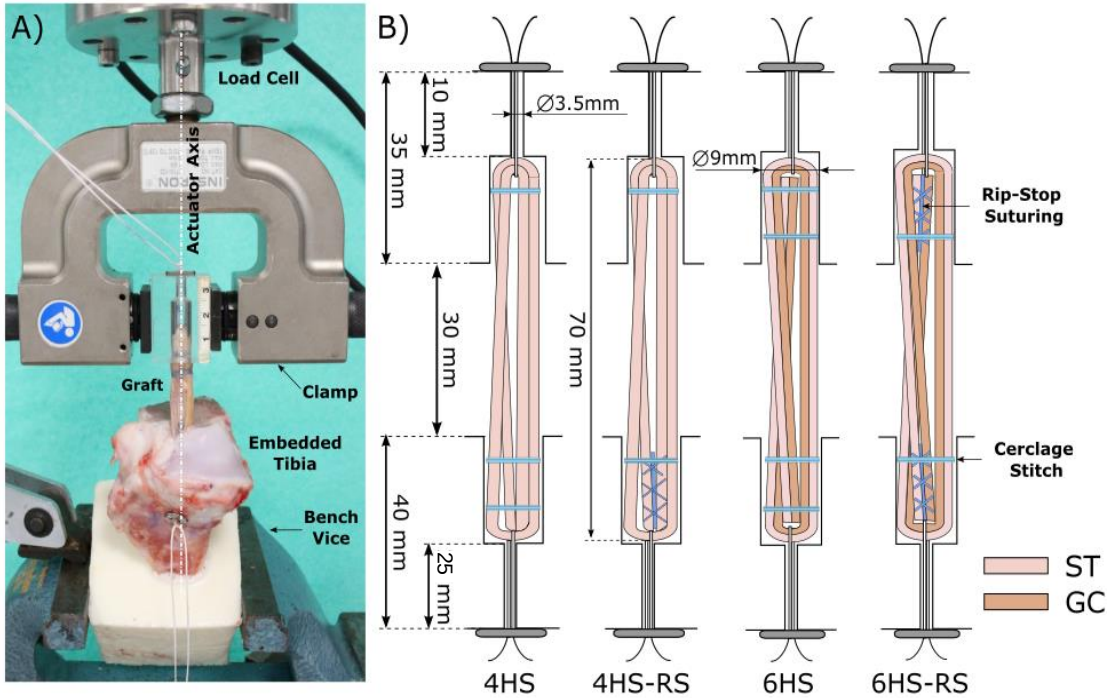
Background

- All-inside **anterior cruciate ligament reconstruction** (ACLR) is widely accepted and popular for treating ACL injuries.[1,2]
- Standard 4- or 6-strand hamstring (HS) grafts are folded over adjustable loop devices (ALDs) with the **free inner graft limbs cerclage-stitched to other tendon loops**.
- **Free graft limb fixation is challenging** and **introduces weak links** in the graft construct, leading to inhomogeneous tension and load distribution.
- Latest ALDs offer additional **direct rip-stop suturing of inner graft limbs to the ALD**, increasing the primary construct fixation.

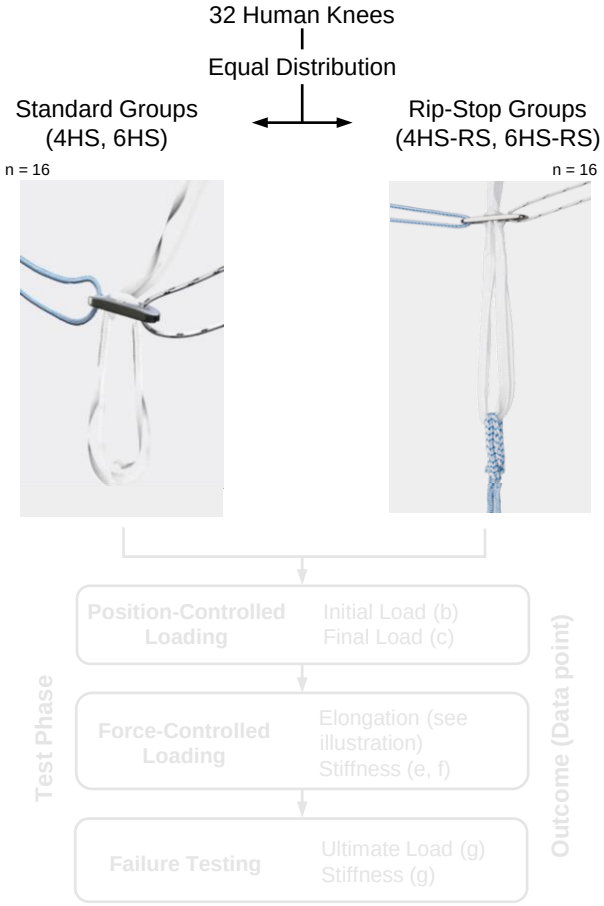


Hypothesis: Direct rip-stop suturing of the free graft limbs to the ALD would increase the force maintenance after primary surgical fixation during simulated knee flexion, reduce construct elongation, and increase stiffness during cyclic loading.

Testing Groups



(A) Experimental test set-up. (B) Schematic illustration of the standard all-inside 4- and 6-strand hamstring groups with cerclage suturing of free graft ends to looped tendons (4HS, 6HS) and additional rip-stop suturing groups with free graft limbs directly attached to the adjustable loop (4HS-RS/ 6HS-RS).



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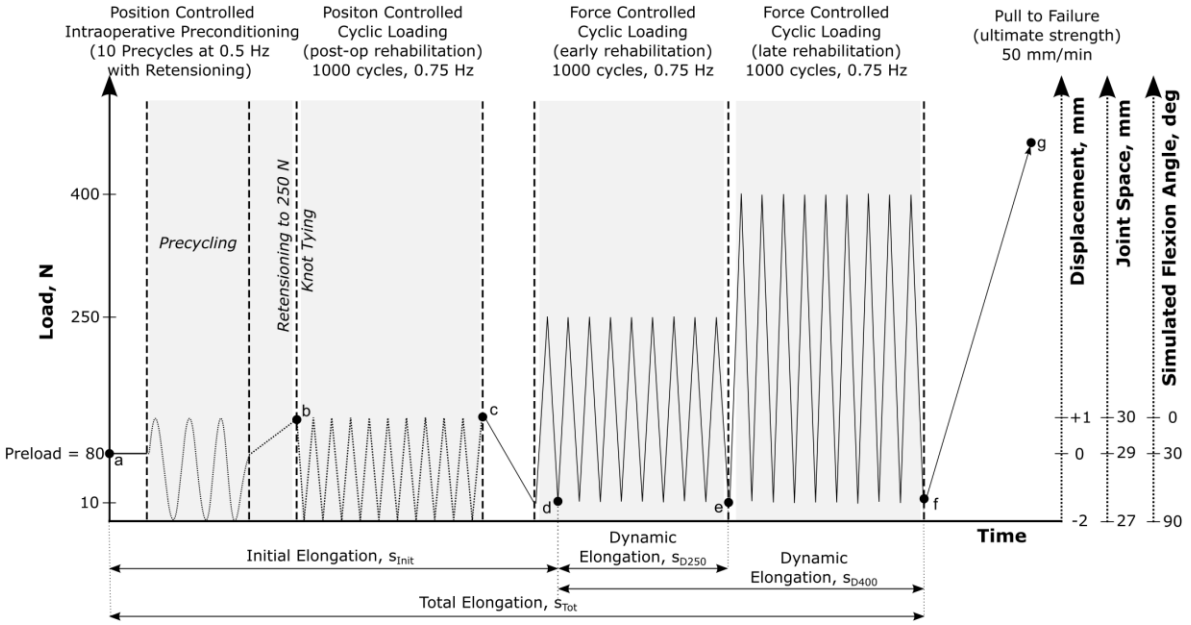
Test Methodology



32 Human Knees

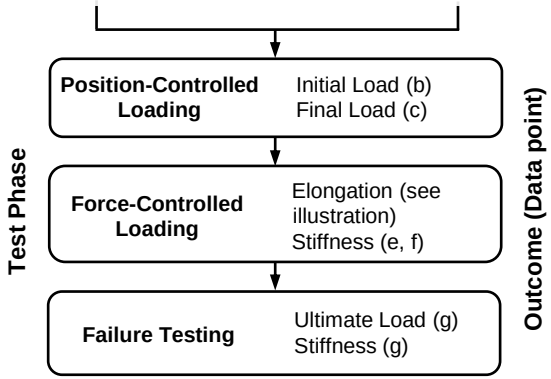
Equal Distribution

Standard Groups
(4HS, 6HS)

Rip-Stop Groups
(4HS-RS, 6HS-RS)

n = 16

n = 16



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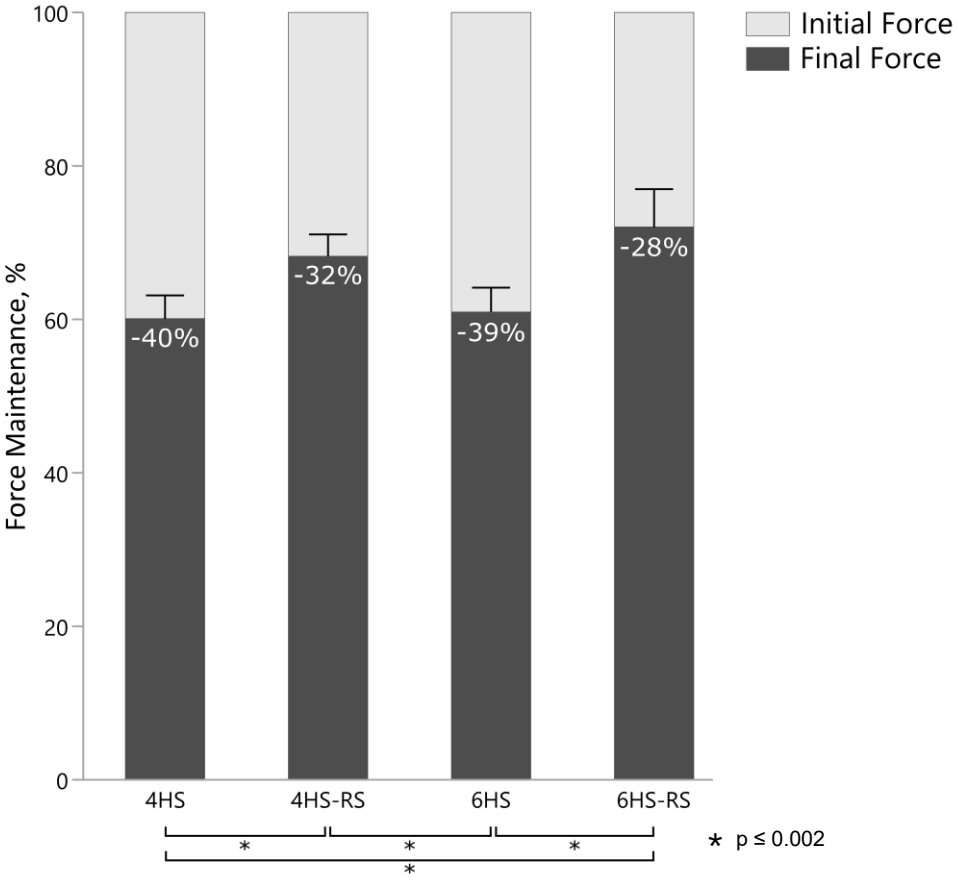
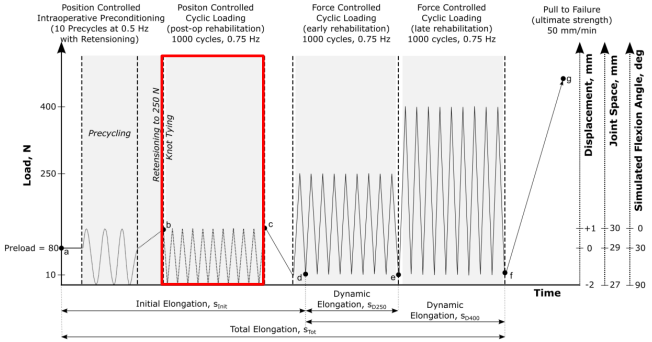
Force Maintenance





Force Maintenance describes the percentage of the graft's remaining force when comparing the first (b) to the last cycle (c) during simulated knee flexion activity (position-controlled loading).

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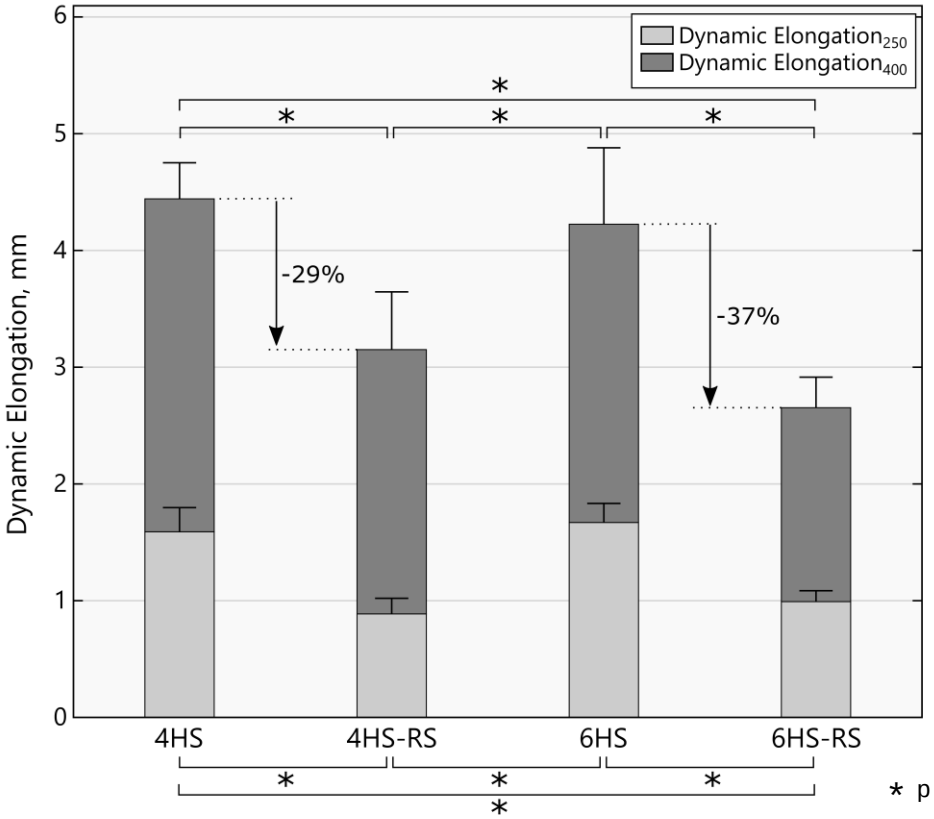
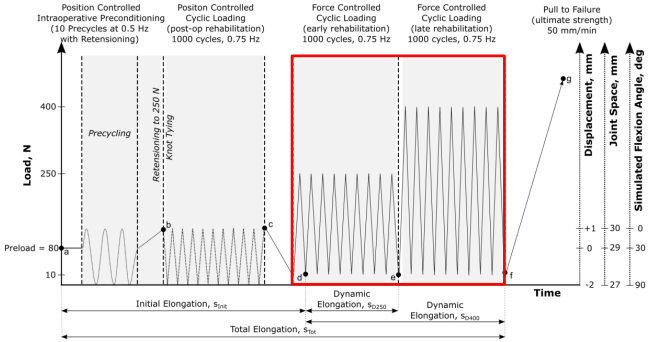
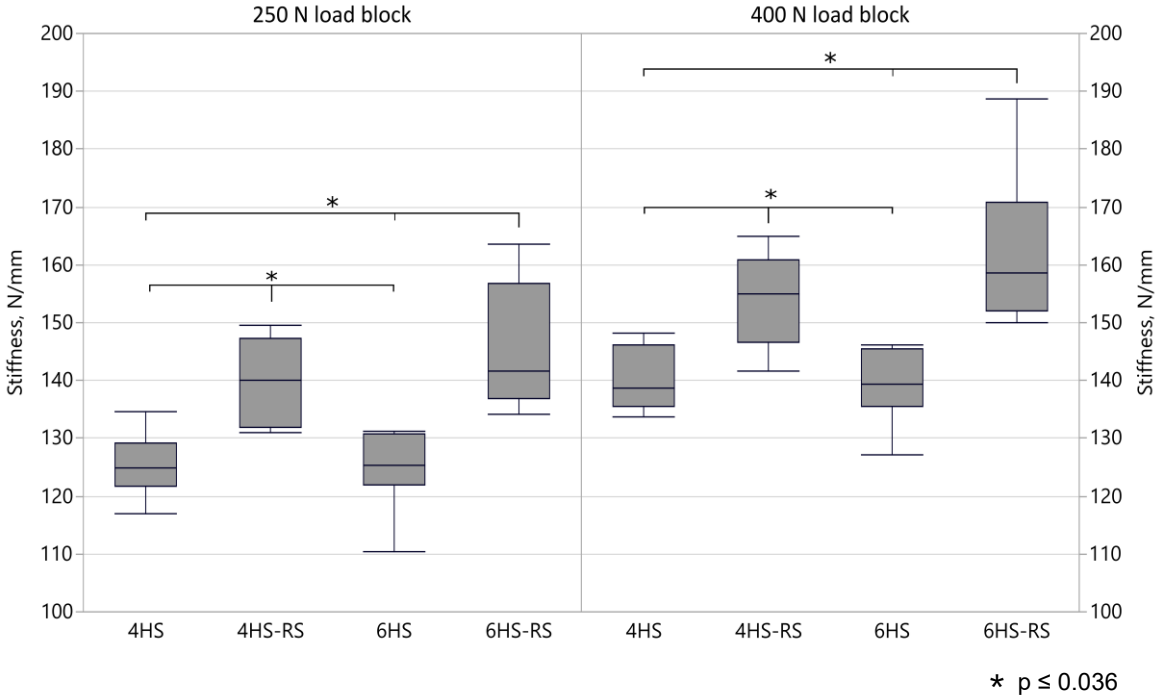
Dynamic Elongation



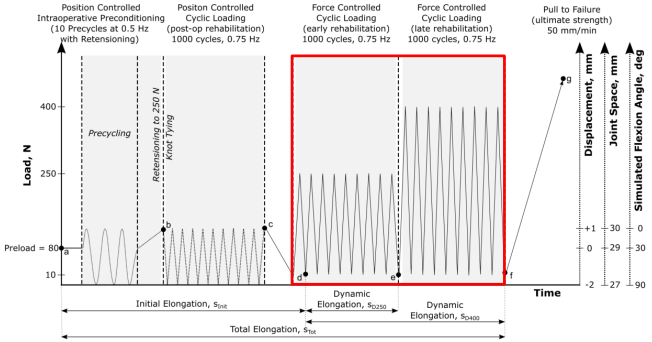


Dynamic Elongation represents the relative valley elongation during force-controlled cyclic loading at the end of peak load level 250 N (s_{D250}, Δde) and 400 N (s_{D250}, Δdf).

Stiffness



* p ≤ 0.036



Stiffness represents the resistance of the ACL graft construct to deformation at the end of peak load levels 250 N (e) and 400 N (f).

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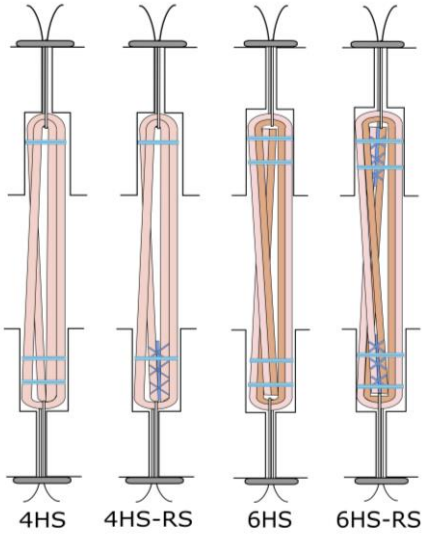
Discussion

- Direct **rip-stop suturing** of free graft limbs to the ALD **improved** biomechanical properties of **4- and 6-stranded hamstring tendon grafts** for all-inside ACLR compared to standard grafts

- Rip-stop suturing **reduced graft tension loss** during simulated knee flexion, **increased construct stiffness** and **reduced elongation** at post-operative loads

- **Interconnected suture stitches** and the **direct ALD attachment** with rip-stop suturing of the free graft limbs ensured **uniform load distribution**, **reduced stress concentration**, and **prevented suture pull-through**, while **mitigating construct lengthening effects**.



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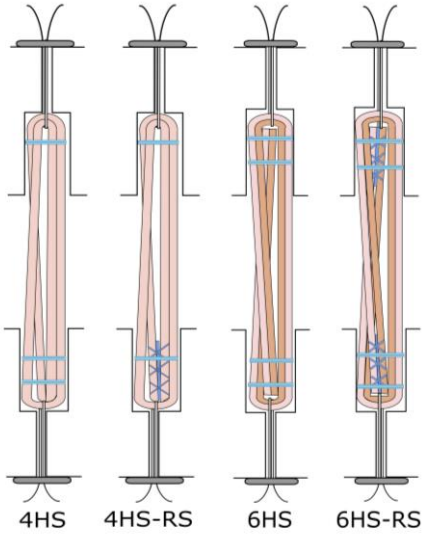
Conclusion

Direct **rip-stop suturing** of the free tendon ends to the adjustable loop **significantly reduced graft tension loss** and **increased resistance to cyclic elongation** in 4- and 6-strand all-inside hamstring tendon grafts compared to standard cerclage suturing groups with tendon ends connected to tendon loops.



Clinical Relevance: An alternative four- and six-strand graft preparation technique for all-inside ACLR with rip-stop suturing of inner graft limbs provided higher construct stability compared to conventional grafts, but the overall clinical significance on healing rates remains unclear.

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References

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2 Torkaman, A., Hosseinzadeh, M., Mohammadyahya, E. et al. All-inside anterior cruciate ligament reconstruction with and without anterolateral ligament reconstruction: a prospective study. BMC Musculoskelet Disord 25, 16 (2024)

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