

# Editorial Commentary: Anterior Cruciate Ligament Graft Fixation Strength: Do Ultimate Load and Cyclic Deformation Really Matter?



John W. Xerogeanes, M.D.

**Abstract:** Surgeons, therapists, and industry are very focused on anterior cruciate ligament graft fixation strength, specifically ultimate load and cyclic deformation. Although many publications have focused on the importance of these values, no significant issues with early graft fixation failure or elongation have been recently reported. Thus, instead of focusing on the absolute maximum values, it would be more helpful to define a minimum successful fixation strength, as well as determine how to test for physiologic cyclic elongation.

See related article on page 3069

“Soft-Tissue Fixation Strategies of Human Quadriceps Tendon Grafts: A Biomechanical Study” is a well-constructed study performed and reported by Michel, Domnick, Raschke, Kittl, Glasbrenner, Deitermann, Fink, and Herbort.<sup>1</sup> I need to disclose that I collaborate very closely with the corresponding authors on quadriceps tendon research.

Secure graft fixation is a critical factor in successful anterior cruciate ligament (ACL) reconstruction and is a continued focus of research among ACL surgeons, therapists, and device companies. Despite a paucity of surgeon-reported fixation failures, continued interest has led to multiple studies evaluating technique strength and durability. Within the past 5 years, researchers published at least 40 articles assessing graft fixation techniques. Even broadly defining “fixation failure” as significant increased laxity or early pivot shift within the first 3 months following ACL reconstruction, no outcome study published in *Arthroscopy* within the past 10 years reported any significant incidence of early

fixation failures. In a cohort of soft-tissue grafts fixed with whip stitch sutures, DeAngelis and Fulkerson<sup>2</sup> found no early failures. Our institution presented a cohort of 357 of my soft-tissue quadriceps grafts fixed with looped suture whip stitch and suspensory fixation at the American Orthopaedic Society for Sport Medicine meeting in 2017, where we demonstrated no significant increases in KT-1000 between 6 weeks and 6 months. Furthermore, 98% of the KT-1000 were  $\leq 3$  mm at 12 weeks.<sup>3</sup> Our study corroborates similar findings with respect to early loosening or graft fixation failure among experienced ACL surgeons.<sup>4,5</sup>

However, continued interest in articles analyzing graft fixation techniques and strength remains. Why? Because we live in a culture that asks the question, “what is the strongest?” Although there is substantial utility in understanding ultimate load and cyclic elongation limits, these values can be used as marketing tools to promote industry-related agendas without meaningful positive impact on patient outcomes. Chasing the strongest graft fixation is analogous to swatting a bug with a fly swatter or with a sledge hammer. Both achieve the same goal, but one is overkill!

Perhaps a more meaningful query would direct our investigation toward what is necessary to achieve appropriate graft fixation, instead of simply searching for the strongest fixation possible. The Michel et al. article is, again, a well-designed and well-written study, but we must exercise caution in interpreting their

Emory University

The author reports the following potential conflicts of interest or sources of funding: J.W.X. receives consulting fees/royalties from Arthrex. Full ICMJE author disclosure forms are available for this article online, as [supplementary material](#).

© 2019 by the Arthroscopy Association of North America  
0749-8063/19832/\$36.00

<https://doi.org/10.1016/j.arthro.2019.08.007>

results. We must not be distracted by the individual ultimate load or cyclic elongation numbers. The differences in tissues used, suture technique, loads, and loading speeds make comparisons between previous studies impossible. Rather, we can learn several important lessons by comparing the differences between groups in this study alone. (1) With soft-tissue fixation, having a rip stop or locking stitch mechanism such as Krackow sutures or other newer commercially available suture constructs, leads to higher ultimate loads, and stronger fixation. (2) Cyclic elongation also occurs less with the Krackow types of suture constructs. Although we can make the assertion that the Krackow constructs are better than other suture types or constructs compared in this study, we cannot make sense of the absolute values as eloquently addressed in this article. For example, the constructs using Krakow sutures had mean cyclic elongation values of 10 mm. If we had even 4 mm of elongation of the construct, we should have clinically measurable looseness in our ACL reconstructions.<sup>6,7</sup> (3) Previously, an article similar to this would suggest recommending pretensioning suture graft constructs, but, again, we must exercise caution. Most surgeons are not experiencing any measurable differences or negative outcomes without incorporating a pretensioning regime.

Thus, in the future, it may be helpful to define a minimum successful fixation strength, as well as

determine how to test for physiologic cyclic elongation. Until then, we must be careful not to overreach when forming our conclusions from these types of studies.

## References

1. Michel P, Domnick C, Raschke M, Kittl C, Glasbrenner J, Deitermann L, Fink C, Herbort M. Soft-tissue fixation strategies of human quadriceps tendon grafts: A biomechanical study. *Arthroscopy* 2019;35:3069-3076.
2. DeAngelis JP, Fulkerson JP. Quadriceps tendon—A reliable alternative for reconstruction of the anterior cruciate ligament. *Clin Sports Med* 2007;26:587-596.
3. Xerogeanes J, Godfrey W, Gebrelul A, et al. Clinical outcomes of all soft tissue quadriceps tendon autograft in ACL reconstruction. *Orthop J Sports Med* 2017;5(7 suppl 6): 2325967117S00310.
4. Geib TM, Shelton WR, Phelps RA, Clark L. Anterior cruciate ligament reconstruction using quadriceps tendon autograft: Intermediate-term outcome. *Arthroscopy* 2009;25:1408-1414.
5. Shelton WR, Holt S. Quadriceps tendon anterior cruciate ligament reconstruction (SS-15). *Arthroscopy* 2004;20:7.
6. Barrow AE, Pilia M, Guda T, Kadrmaz WR, Burns TC. Femoral suspension devices for anterior cruciate ligament reconstruction: Do adjustable loops lengthen? *Am J Sports Med* 2014;42:343-349.
7. Daniel DM, Stone ML, Sachs R, Malcom L. Instrumented measurement of anterior knee laxity in patients with acute anterior cruciate ligament disruption. *Am J Sports Med* 1985;13:401-407.