

Editorial Commentary: Major Technical Advances in Knee Anterior Cruciate Ligament Reconstruction Address Anatomy, Biomechanics, and Healing



Nikolaos K. Paschos, M.D., Ph.D., Associate Editor

Abstract: The surgical techniques in knee anterior cruciate ligament (ACL) reconstruction continue to evolve significantly. Improved understanding of the anatomy, biomechanics, and healing of the ACL has offered the foundation for several advances. The goal of these innovations is to successfully restore the native anatomy and biomechanical function of the native ligament, provide a stable and pain-free knee joint, allow return to prior level of activity, prevent rerupture, and prevent osteoarthritis. Taken in sum, these are lofty goals. The shift toward anatomic ACL reconstruction, development of diverse graft options and configurations, and the addition of reinforcement techniques, such as the anterolateral ligament reconstruction and lateral tenodesis techniques, are major advancements in ACL reconstruction.

See related article on page 1969

The surgical techniques for anterior cruciate ligament (ACL) reconstruction have continued to evolve significantly over recent years. Improved understanding of the anatomy, biomechanics, and healing of the ACL has offered the foundation for several technical advances. Indeed, the shift toward anatomic ACL reconstruction, the use of multiple graft options and configurations, and more recently the addition of reinforcement techniques, such as the anterolateral ligament reconstruction and lateral tenodesis techniques, are a few examples of the major advancements in ACL reconstruction.

All the above innovations are attempts to successfully reach the main goal of every ACL reconstruction: to restore the native anatomy and biomechanical function and provide a stable and pain-free knee joint that allows patient's return to prior level of activity for several years. Technically, this goal translates to the following questions:

- Does the ACL graft reinstate native ACL biomechanics in terms of joint stability in all planes?

The author reports the following potential conflict of interest or source of funding: N.K.P reports personal fees from AANA. Full ICMJE author disclosure forms are available for this article online, as [supplementary material](#).

© 2022 by the Arthroscopy Association of North America
0749-8063/22110/\$36.00

<https://doi.org/10.1016/j.arthro.2022.01.028>

- Is there a flexion or extension deficit because of malposition of the graft or abnormal strain?
- Are the ACL graft and its fixation strong enough to withstand loading during athletic activities?

Obviously, the surgical technique plays a major role in all these questions. Therefore identifying the key elements in this complex surgical technique is of paramount importance.

In their article, "Anterior Cruciate Ligament Patellar Tendon Autograft Fixation At 0° Versus 30° Results in Improved Activity Scores and a Greater Proportion of Patients Achieving the Minimal Clinical Important Difference for Knee Injury and Osteoarthritis Outcome Score Pain: A Randomized Controlled Trial",¹ Chahal, Whelan, Hoit, Theodoropoulos, Ajrawat, Betsch, Docter, and Dwyer compared 0° and 30° of flexion for ACL graft fixation in a randomized controlled study and found that fixation of the graft in full extension resulted in improved outcome in terms of Knee Injury and Osteoarthritis Outcome Score and activity level without any difference in terms of stability or stiffness. This information, coming from a study with high level of evidence, provides more insight in the controversy surrounding the best angle for tibial fixation of the ACL graft. The notion has been that fixing the graft at 30° may add the benefit of additional stability with the potential risk of loss of extension, but this study suggests a beneficial outcome with tibial fixation at full extension.^{2,3} However, the discussion is more

challenging because the parameters involved are far more complicated.

The native ACL is an anisometric structure and biomechanically behaves as 2 distinct bundles. A portion of the ACL (anteromedial bundle) tightens in flexion and a portion (posterolateral bundle) is relatively lax; the opposite happens in knee extension. A single-bundle ACL reconstruction may be difficult to restore this complex biomechanical behavior.

The biomechanical behavior of ACL reconstruction cannot always accurately predict clinical outcome. For instance, double-bundle ACL reconstruction did not result in clinically significant improved outcomes despite biomechanical superiority,⁴ especially if one of the main objectives is to minimize the risk of knee osteoarthritis after ACL injury.

In theory, isometric ACL reconstruction may ensure minimal changes in ACL graft strain during range of motion; however, there is not a true isometric area through flexion.⁵ Anatomic “non-isometric” ACL reconstruction appears to control better rotational stability. However, in certain cases this may not be enough, and augmentations of an ACL reconstruction with lateral stabilization technique may offer a solution.⁶

More importantly, not all ACL reconstructions are the same. There are so many different steps and techniques that it is irrational to consider that there are fixed rules that apply to all ACL reconstructions, particularly when there is such variability among our patients.

Even though the quest for the impeccable ACL reconstruction makes us think many times, like Socrates, “All I know is I know nothing,” we need also to

remember Plato: “Excellence is not a gift, but a skill that takes practice. We do not act rightly because we are excellent. In fact, we achieve excellence by acting rightly.”

References

1. Chahal C, Whelan DB, Hoit G, et al. Anterior cruciate ligament patellar tendon autograft fixation at 0° versus 30° results in improved activity scores and a greater proportion of patients achieving the minimal clinical important difference for Knee Injury and Osteoarthritis Outcome Score pain: A randomized controlled trial. *Arthroscopy* 2022;38:1969-1977.
2. Ohuchi H. Editorial commentary: Full extension or 30° flexion in graft fixation for anatomic anterior cruciate ligament reconstruction. Is this surgeons' preference? *Arthroscopy* 2016;32:2329-2330.
3. Debandi A, Maeyama A, Hoshino Y, et al. The influence of knee flexion angle for graft fixation on rotational knee stability during anterior cruciate ligament reconstruction: A biomechanical study. *Arthroscopy* 2016;32:2322-2328.
4. Mayr HO, Benecke P, Hoell A, et al. Single-bundle versus double-bundle anterior cruciate ligament reconstruction: A comparative 2-year follow-up. *Arthroscopy* 2016;32:34-42.
5. Forsythe B, Lansdown D, Zuke WA, et al. Dynamic 3-dimensional mapping of isometric anterior cruciate ligament attachment sites on the tibia and femur: Is anatomic also isometric? *Arthroscopy* 2018;34:2466-2475.
6. Kunze KN, Manzi J, Richardson M, et al. Combined anterolateral and anterior cruciate ligament reconstruction improves pivot shift compared with isolated anterior cruciate ligament reconstruction: A systematic review and meta-analysis of randomized controlled trials. *Arthroscopy* 2021;37:2677-2703.