

The importance of individualized, anatomic anterior cruciate ligament (ACL) reconstruction—for *Annals of Joint* Special ACL Edition

Surgical treatment of anterior cruciate ligament (ACL) injuries has improved in leaps and bounds over the past several decades. Surgeons have progressed from extra-articular tenodesis procedures that over-constrained the knee and reduced motion, to intra-articular reconstruction techniques that more accurately recreate the native ACL (1). Recently, tunnel and graft placement has improved to make ACL reconstruction even more anatomic, further improving the kinematics and joint health in reconstructed knees (2,3).

However, the rate of ACL injuries continues to rise (4), and return to play and revision rates after primary ACL reconstruction continue to be less than ideal (5). Therefore, it is crucial that surgeons continue their quest to further improve outcomes after ACL reconstruction. Our continuing research on ACL anatomy, physiology, histology, structural properties, and function demonstrates that the ACL is more complex than previously appreciated. This makes our job of restoring native ACL anatomy even more challenging. For these reasons, ACL surgery cannot be a “one size fits all” endeavor. Rather, each patient must be appreciated as a unique individual, and medical and surgical treatment should be designed appropriately.

The individualized approach to ACL reconstruction takes into consideration patient activity level, expectations, functional demands, bony morphology, native ACL anatomy, medical and systemic conditions, concomitant injuries, and preoperative knee laxity. At our institution, we assess tibial and femoral insertion site sizes, insertional area, native ACL angle and trajectory, notch width, notch height, notch morphology, and other factors. We choose the type of graft, size of graft, and shape of the tunnels based upon these factors. We also carefully address any concomitant injuries, while realizing that the ACL is the primary contributor to rotatory knee stability. By providing this type of individualized approach we are able to deliver the best possible care for each and every patient. A “one size fits all” approach may appropriately treat 80% of patients, but the 20% located outside of the bell curve will receive suboptimal treatment. Therefore, we believe the extra effort of individualized care is more than worth it.

As ACL reconstruction continues to evolve, there will inherently be new procedures championed as turnkey solutions to restore rotatory stability. While change is inevitable and in many cases necessary, surgeons must be critically cautious about all new surgical procedures. Patient safety and well-being must be the foremost consideration, and early data should be skeptically evaluated until sufficient reproducibility and long-term follow-up is proven.

For instance, the pendulum has recently swung back to favoring extra-articular procedures similar to the tenodesis procedures once popular for ACL injury. While some clinical results have been promising, little long-term follow-up data is available. Biomechanics data questions the contribution of anterolateral structures to rotatory knee stability and suggest that extra-articular lateral reconstruction could over-constrain the lateral compartment and accelerate osteoarthritis. We do not have the long-term clinical data to know whether these concerns will materialize. Furthermore, extensive cadaveric and biomechanical studies from our institution have shown that the anterolateral knee structures are much more complex than traditionally appreciated. However, early studies have suggested that these lateral sided procedures combined with a well-performed ACL reconstruction may improve outcomes in a subset of patients with excessive rotatory laxity. Currently, surgical indications and the ideal patients for these lateral tenodesis and reconstruction procedures are not known. As the knowledge about the anterolateral knee anatomy and procedures advances, surgeons should consider injuries to the anterolateral complex as part of their individualized ACL reconstruction work-up and preoperative planning.

This special ACL-focused edition of *Annals of Joint* contains pertinent, well-written articles which reinforce the overriding concept of individualized ACL reconstruction and demonstrate some of the many aspects of ACL surgery that must be considered to provide patients with truly individualized care. Musahl *et al.* described the role of the anterolateral complex/anterolateral ligament in rotatory knee laxity (6), and Fu *et al.* discussed the role of bony morphology in knee stability (7). Miller *et al.* explained the decision making behind revision ACL reconstruction and the ideal management of

bony deficiency, including an excellent description of their technique using allograft bone dowels (8). Brophy *et al.* provided a microscopic view of the ACL and elegantly highlighted the clinical relevance of these findings (9). Shino *et al.* discussed two different methods to ream anatomic femoral tunnels, which is crucial to achieve optimal knee stability (10). Johnson *et al.* had previously reported that allograft augmentation of hamstring autografts was a cost effective option for a subset of young patients (11). In this edition, they explored the utility of augmenting grafts in older, potentially less demanding patients (12). Musahl *et al.* reported on a type of meniscus injury that can be detrimental to knee stability if not identified and properly treated (13). The core has become increasingly implicated in knee injuries, and Noehren *et al.* reviewed the importance of hip and trunk function in ACL injury prevention and rehabilitation (14), while Fink *et al.* provided a review of functional assessments that can be utilized to make return-to-play decisions (15). Makhni *et al.* built upon his previous studies and expertise in patient reported outcomes (PROs) to highlight the importance and feasibility of collecting PROs in ACL patients. This article provides an excellent summary of the most commonly utilized PROs and should be reviewed by all ACL surgeons (16).

The concept of individualized anatomic ACL reconstruction can best be summarized by the senior author's recent summary statement on the ACL: *"The ACL is a dynamic structure, rich in neurovascular supply and comprised of distinct bundles, which work synergistically to facilitate normal knee kinematics in concert with bony morphology. Characterized by individual uniqueness, the ACL is inherently subject to both anatomic and morphological variations as well as physiologic aging."*

Acknowledgements

Dr. Fu and Dr. Burnham would like to thank all of the authors included in this special ACL edition for their important contributions to this journal and to the field of ACL research.

References

1. Davarinos N, O'Neill BJ, Curtin W. A Brief History of Anterior Cruciate Ligament Reconstruction. *Advances in Orthopedic Surgery* 2014;2014:1-6.
2. Middleton KK, Muller B, Araujo PH, et al. Is the native ACL insertion site "completely restored" using an individualized approach to single-bundle ACL-R? *Knee Surg Sports Traumatol Arthrosc* 2015;23:2145-50.
3. Hussein M, van Eck CF, Cretnik A, et al. Individualized anterior cruciate ligament surgery: a prospective study comparing anatomic single- and double-bundle reconstruction. *Am J Sports Med* 2012;40:1781-8.
4. Mall NA, Chalmers PN, Moric M, et al. Incidence and trends of anterior cruciate ligament reconstruction in the United States. *Am J Sports Med* 2014;42:2363-70.
5. Joreitz R, Lynch A, Rabuck S, et al. Patient-Specific and Surgery-Specific Factors That Affect Return to Sport after Acl Reconstruction. *Int J Sports Phys Ther* 2016;11:264-78.
6. Lucidi GA, Hughes JD, Herbst E, et al. Role of the anterolateral complex in rotatory instability of the anterior cruciate ligament deficient knee. *Ann Joint* 2017;2:35.
7. Burnham JM, Pfeiffer T, Shin JJ, et al. Bony morphologic factors affecting injury risk, rotatory stability, outcomes, and re-tear rate after anterior cruciate ligament reconstruction. *Ann Joint* 2017. [Epub ahead of print].
8. Laidlaw MS, Buyukdogan K, Werner BC, et al. Management of bone deficiency in revision anterior cruciate ligament reconstruction. *Ann Joint* 2017;2:38.
9. Skelley NW, Lake SP, Brophy RH. Microstructural properties of the anterior cruciate ligament. *Ann Joint* 2017;2:19.
10. Shino K, Iuchi R, Tachibana Y, et al. Anatomical femoral tunnel creation: outside-in versus anteromedial portal. *Ann Joint* 2017;2:34.
11. Jacobs CA, Burnham JM, Makhni E, et al. Allograft Augmentation of Hamstring Autograft for Younger Patients Undergoing Anterior Cruciate Ligament Reconstruction. *Am J Sports Med* 2017;45:892-899.
12. Jacobs CA, Malempati CS, Makhni EC, et al. Allograft augmentation of hamstring autografts was not a cost-effective treatment option for middle aged patients undergoing primary anterior cruciate ligament reconstruction. *Ann Joint* 2017;2:24.
13. Pfeiffer TP, Murphy CI, Arner JW, et al. Identification and treatment of RAMP lesions in anterior cruciate ligament-injured

knees. Ann Joint 2017;2:17.

14. Hickey Lucas KC, Kline PW, Ireland ML, et al. Hip and trunk muscle dysfunction: implications for anterior cruciate ligament injury prevention. Ann Joint 2017;2:18.
15. Herbst E, Wierer G, Fischer F, et al. Functional assessments for anterior cruciate ligament reconstruction return to sport. Ann Joint 2017;2:37.
16. Meta F, Lizzio VA, Jildeh TR, et al. Which patient reported outcomes to collect after anterior cruciate ligament reconstruction. Ann Joint 2017;2:21.



Freddie H. Fu



Jeremy M. Burnham

Freddie H. Fu, MD, DSc (Hon), DPs (Hon)

*Distinguished Service Professor, University of Pittsburgh, Pittsburgh, PA, USA;
David Silver Professor and Chairman, Department of Orthopaedic Surgery,
Head Team Physician, University of Pittsburgh Athletics, Pittsburgh, PA, USA.
(Email: ffu@upmc.edu)*

Jeremy M. Burnham, MD

UPMC Center for Sports Medicine, University of Pittsburgh, Pittsburgh, PA, USA.

doi: 10.21037/aoj.2017.07.07

Conflicts of Interest: The authors have no conflicts of interest to declare.

View this article at: <http://dx.doi.org/10.21037/aoj.2017.07.07>

doi: 10.21037/aoj.2017.07.07

Cite this article as: Burnham JM, Fu FH. The importance of individualized, anatomic anterior cruciate ligament (ACL) reconstruction—for *Annals of Joint* Special ACL Edition. Ann Joint 2017;2:46.