

Editorial Commentary: Anterior Cruciate Ligament Repair Revisited ... Do We Need A Paradigm Shift?



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Abstract: This commentary discusses a brief history of anterior cruciate ligament (ACL) repair using a variety of techniques, including open primary repair, arthroscopic repair, and bridge-enhanced ACL repair. Concerns are raised about the current reported outcomes of primary ACL repair. There is a need for controlled prospective studies that assess the structural integrity of the repaired ligament using modern imaging techniques, physical examination, and KT-1000 testing. Caution should be used when interpreting published studies that rely solely on patient-reported outcome measures.

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The systematic review published in this issue of *Arthroscopy*, "Primary Repair of the Anterior Cruciate Ligament: A Systematic Review of Clinical Outcomes"¹ by Houck, Kraeutler, Belk, Goode, Mulcahey, and Bravman, describes the history of anterior cruciate ligament (ACL) repair and outlines the results of 6 level II/IV studies. The authors conclude that this technique demonstrates inconsistent results, with reported failure rates at 2 years ranging from 0% to 25%. The authors did their best to determine whether adequate information exists in the literature to support the "rebirth" of ACL repair but discovered that the data are sorely lacking. It is important to note that the review eliminated any studies using a synthetic augmentation device.

As often happens in orthopaedics, a new technique spawns a resurgence of a procedure that has been deemed a failure in the past. This approach is not always negative, as our profession has made enormous strides in understanding the role of rehabilitation principles and the importance of applied load in bone and soft-tissue healing and remodeling. I would,

however, take issue with the statement that advanced arthroscopic techniques may improve the repair of the ACL. The original studies of ACL repair performed through an arthrotomy²⁻⁴ permitted extensive sutures to be placed to optimize re-approximation of the torn ACL, and it is hard for me to envision how arthroscopic suture placement will be significantly different. However, the modern rehabilitation techniques that permit load to be seen by the healing tissue may be beneficial compared with cast immobilization.

There are many factors that may explain the differences in outcomes in the cited literature, most importantly the metrics used to define success. To demonstrate successful healing of a soft-tissue structure, patient-reported outcome measures are inadequate. Studies need to determine the strength and laxity of the repaired construct using instrumented laxity testing and physical examination performed by non-biased examiners. Magnetic resonance imaging (MRI) has the potential to demonstrate the volume and integrity of tissue present following repair. The sequentially published studies performed on ACL repair using the bridge-enhanced ACL repair or BEAR technique⁵⁻⁷ can be contrasted in their methodologic approach with the level II and IV studies in the systematic review and may provide a roadmap for evaluation of a novel technique. This approach has been mandated by the Food and Drug Administration, as the repair technique uses a novel collagen scaffold that required testing for safety and efficacy. The design of these studies mandated a multifactorial assessment of treated patients to determine success, including physical

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examination, patient-reported outcomes measures, KT1000 testing, MRI, and a comparison group treated with a standard hamstring ACL reconstruction. This approach can and should be used as a model for the re-visitation of ACL repair.

The timing of ACL repair also may play a critical role in success or failure. Our laboratory group studied the effects of transection of the ACL in an animal model with specific attention directed to gene expression.⁸ The model was a partial ACL transection in a rabbit. This study demonstrated maintenance of type I collagen expression following ligament transection implicating the possibility of repair but simultaneously demonstrated a rapid upregulation of matrix metalloproteinases and alpha-smooth muscle actin. The combination of myofibroblast-mediated tissue contraction and matrix metalloproteinase–modulated tissue degradation impact involution of the ACL stump, modifying the potential for repair. This concept is reinforced by Margian et al.,⁹ who demonstrated in a porcine model that delay of 2 to 6 weeks between ACL injury and enhanced primary repair had a significant negative effect on anterior–posterior laxity of the knee.

The last issue that is of significant concern to me is the concept that ACL repair is less invasive and therefore permits rapid return to running and pivoting sports in young athletes. We have unfortunately learned that rapid return to sport following ACL reconstruction demonstrates an unacceptable risk of re-injury, particularly in young athletes. In the discussion of the systematic review, it is stated “the use of primary arthroscopic repair with suture anchors may provide a less invasive ACL treatment in this subset” (skeletal immature). While I agree wholeheartedly that a primary ACL repair is less invasive, the current data do not support its use in young athletes. I have significant concern that this less-invasive technique that “does not burn any bridges” may encourage the widespread use of ACL repair with suture bridge augmentation before we have clear, scientific, reproducible evidence to support its use.

Could primary repair be the next wave in successful ACL surgery permitting patients to return to unrestricted activity with minimal morbidity? It remains

very unclear and requires rigorous study documenting not only patient-reported outcome measures but KT-1000, follow-up clinical examination by unbiased observers, return to sport assessment, and potentially MRI to assess the structure of the repaired ligament. With non-biologic augmentation, there remains significant concern that the augmentation may stress shield the healing ligament and carry the load until ultimate failure.

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