

## In-Vitro Anatomic Double-Bundle and Single-Bundle Anterior Cruciate Ligament Reconstructions Demonstrate Equivalent Laxity after Time Zero Cyclic Loading

### SS-12

Thursday, May 1, 11:45 AM

STEPHEN KLINGE, M.D., PRESENTING AUTHOR

PHILIP McCLURE, M.D.

BRYAN VOPAT, M.D.

DAVID PALLER, M.S.

SARATH KORUPROLU, B.S.

BRADEN FLEMING, PH.D.

MICHAEL HULSTYN, M.D.

PAUL FADALE, M.D.

**Introduction:** Previous studies support the hypothesis that “anatomic” graft placement within the anterior cruciate ligament (ACL) footprint, whether done with a double-bundle (ADB) or single-bundle (ASB) technique, provides similar biomechanical stability and clinical outcomes. However, the trend for accelerated activity has raised concern for increased rates of early laxity development. A previous non-arthroscopic biomechanical study found increased laxity with ASB versus ADB reconstruction after cyclic loading. We hypothesized that there would be no difference with regard to laxity development when comparing ADB versus ASB techniques in a controlled biomechanical study.

**Methods:** Twenty-two cadaveric knees (11 matched pairs), mean age 51.7 (range, 36-60), were randomized to either ADB or ASB ACL reconstruction. Fresh bovine knee flexor tendon graft diameters were matched for all reconstructions. For ADB reconstruction, a single 6.5mm looped graft and a single 7.5mm looped graft formed the anteromedial and posterolateral bundles, respectively. Similar 6.5 and 7.5mm grafts were quadrupled (combined diameter 10mm) for the ASB construct. RigidLoops and IntraFix screws/sheaths (DePuy/Mitek) provided femoral and tibial graft fixation, respectively. During arthroscopy, low tolerance tunnels were drilled using anatomic landmarks. Anatomic placement within the femoral/tibial footprints was confirmed using high-resolution computerized tomography imaging. Anterior tibial translation laxity using a 134 N anterior force at 30 degrees of knee flexion was measured in the ACL intact, post-reconstruction and post-cyclic loading (500 cycles of an anterior load, 0 to  $\pm 134$  N, at 15 degrees of knee flexion) conditions. Increased laxity from the post-reconstructed to post-fatigue state was compared using a two-way ANOVA and a Tukey post-hoc test. For the purposes of the study, the threshold for relevant laxity increase was determined to be 3mm a priori.

**Results:** Mean ACL intact laxity at 30 degrees knee flexion was 9.64mm ( $\pm 2.83$ ) for ADB and 8.92mm ( $\pm 1.47$ ) for ASB knees. After reconstruction, mean laxity increased to 11.71mm ( $\pm 2.62$ ) for the ADB versus 10.14mm ( $\pm 2.31$ ) for the ASB group. After cyclic loading, average laxity in the ADB group was 13.96mm ( $\pm 2.83$ ), with an increase of 2.25mm. In the ASB group, mean laxity was 12.64mm ( $\pm 3.90$ ), representing 2.24mm of increased laxity ( $p=0.130$ ). In both groups, 81.8% of

knees (9/11) exhibited less than 3mm of increased anterior laxity. Post cycling, laxity was statistically increased in both groups versus the post-repair state ( $p<0.05$ ).

**Conclusion:** Standard arthroscopic ADB and ASB ACL reconstructions were similar after cyclic loading. When undergoing the equivalent to a Lachman test post-cycling, average laxity in the majority (81.8%) of specimens remained less than 3mm. These results differ markedly from the previous non-arthroscopic study that utilized different fixation devices and other methods, including older, non-matched pair specimens.1 Clinical Relevance: In a limited biomechanical model, arthroscopic ABD and ASB ACL reconstruction are equivalent after a cyclic loading protocol meant to simulate the fatigue of activities in the early post-operative recovery phase. Reference: 1. Nohmi S, et al. Biomechanical comparison between single-bundle and double-bundle anterior cruciate ligament reconstruction with hamstring tendon under cyclic loading condition. Sports Med Arthrosc Rehabil Ther Technol. 2012;4(1):23.

## Anterior Cruciate Ligament Injuries in a Pediatric Population: Delay to Reconstruction and Concomitant Pathology

### SS-13

Thursday, May 1, 11:50 AM

JUSTIN NEWMAN, M.D., PRESENTING AUTHOR

PATRICK CARRY, B.A.

ELIZABETH TERHUNE, B.A.

AUSTIN HEARE, M.D.

MURRAY SPRUIELL, M.D.

MEREDITH MAYO, M.D.

ARMANDO VIDAL, M.D.

**Introduction:** Pediatric anterior cruciate ligament (ACL) injuries are an evolving research interest. We aim to investigate factors that contribute to the prevalence and severity of concomitant chondral and meniscal injuries among patients  $>14$  versus  $\leq 14$  years of age at the time of ACL reconstruction. Also, the number and type of procedures required to address these injuries are investigated. This study further investigates and augments the recently published data describing a delay in pediatric ACL reconstruction and concomitant pathology, which is limited in number and scope. Furthermore, this is the first study that we are aware of that compares skeletally immature patients with a cohort of skeletally mature adolescent patients treated in a children’s hospital.

**Methods:** All subjects that underwent primary ACL reconstruction at a single tertiary pediatric hospital between 2005 and 2012 were retrospectively reviewed. Operative reports and intraoperative imaging were evaluated for location, severity and treatment of all injuries present at time of ACL reconstruction. Chi square tests were used to compare the prevalence of chondral and meniscal injuries in the two cohorts. Multi-variable logistic regression analyses were used to identify factors related to the presence of a concomitant injury that required additional treatment. Kaplan-Meier analyses were used to explore the relation between time to surgery and meniscal injury severity.

**Results:** 231 patients were included, of whom 66 were <14 years of age. Median time from injury to surgery in the younger cohort was 2.6 months compared to 1.7 months in the older cohort. Both groups demonstrated a significant relationship between time to surgery and meniscal injury severity and irreparability ( $p < 0.05$  for all). Time to surgery correlated with severity of chondral injury in the younger cohort ( $p = 0.0343$ ), but not in the older cohort ( $p = 0.8877$ ), while there was no significant difference ( $p = 0.1073$ ) in the overall prevalence of chondral injuries between the younger (21.2%) and older (31.6%) cohorts. The prevalence of meniscal injuries was greater in the older cohort (73.8% vs. 60.6%,  $p=0.0408$ ). Gender, ethnicity, laterality, age and a subjective report of knee instability were not predictive of concomitant injury ( $p > 0.05$  for all) in either population. With multivariable analysis, only a delay in surgery  $>3$  months ( $p = 0.0027$ ) was significantly predictive of the presence of an injury that required additional operative procedures in the younger cohort, while in the older patients only a return to activity prior to surgery ( $p = 0.0034$ ) and obesity ( $p = 0.0381$ ) were significantly predictive.

**Conclusion:** Delay to surgery correlates with increased severity of injury and increased need for procedures in addition to ACL reconstruction. There are significant differences between older and younger patients. A delay in surgery greater than three months was the strongest predictor of the development of a concomitant injury that required additional treatment in the younger cohort. A return to activity and obesity were significantly related to the presence of a concomitant knee injury that required additional treatment in the older cohort. In both cohorts, time to surgery correlated with meniscal injury severity.

### Success of High Tibial Osteotomy in the United States Military

#### SS-14

Thursday, May 1, 11:55 AM

JEFFREY HOFFMANN, M.D., PRESENTING AUTHOR

BRIAN WATERMAN, M.D.

MARK PALLIS, D.O.

PHILIP BELMONT, M.D.

ESTEPHAN GARCIA, M.D.

MATTHEW LAUGHLIN, D.O.

**Introduction:** Historically, high tibial osteotomy (HTO) has been performed to treat isolated medial gonarthrosis with varus deformity. More recently, HTO has been utilized in conjunction with chondral, ligamentous, and/or meniscal procedures in young active patients with subtle varus malalignment. However, occupational outcomes in a high-demand military cohort are largely unknown.

**Methods:** A retrospective analysis of active duty servicemembers undergoing high tibial osteotomy for coronal plane malalignment and/or intra-articular pathology were isolated from the Military Health System Management Analysis and Reporting Tool between 2003 and 2011. Demographic variables such as age, sex, rank, and branch of service were extracted, and extensive medical record

review was performed to identify surgical variables, including the rates of perioperative complications, radiographic findings, secondary surgery (including revision), activity limitations, and medical discharge as confirmed by the U.S. Army Physical Disability Agency database. For the current study, cumulative failure was defined as conversion to knee arthroplasty, or medical discharge with persistent knee dysfunction after index HTO. Univariate and multivariate analysis were performed to identify statistical associations with cumulative failure after HTO.

**Results:** A total of 80 patients with 93 HTOs were identified at an average follow-up of 43.7 months (range, 24-93 months). The mean age of all servicemembers was 35.5 years (range, 20-55), and the majority were males (91%) and of enlisted rank (76%). Approximately 92% of surgeries involved plate fixation, while the remainder utilized circular or monolateral external fixation. Concomitant or staged procedures were performed in 45 servicemembers (56%), including 29 ligamentous, 24 meniscal, and 21 chondral procedures. Complications necessitating unplanned reoperation occurred in 10 cases (11%), including infection ( $n=3$ ), nonunion ( $n=2$ ), fracture ( $n=2$ ), hardware failure ( $n=1$ ), dehiscence ( $n=1$ ), and flexion contracture ( $n=1$ ). Additionally, symptomatic hardware was noted after 18 surgeries (19%) and occasional knee pain was noted in 26 extremities (28%). When considering those individuals remaining on active duty, 21(26%) servicemembers were unable to return to full duty and required permanent activity limitations. Of the 80 servicemembers, 7 individuals received medical discharge for persistent knee pain or disability, and an additional 7 underwent conversion to total knee arthroplasty. The cumulative failure rate for all servicemembers was 18% at 2-8 year follow-up.

**Conclusion:** In a young, active military population, HTO is moderately effective for the treatment of medial unicompartamental disease with associated intra-articular knee pathology. At early to mid-term follow-up, 82% of patients returned to military duty and were free from conversion knee arthroplasty. High tibial osteotomy is a useful in the treatment of medial unicompartamental disease and has demonstrated success in an active US military population at a minimum of 2-year follow-up.

### Patient-Centered Outcomes 10 Years Following ACL Reconstruction

#### SS-15

Thursday, May 1, 12:00 PM

KAREN BRIGGS, M.P.H., M.B.A., PRESENTING AUTHOR

RACHEL ABRAMS, M.D.

J. RICHARD STEADMAN, M.D.

**Introduction:** Reconstruction of the Anterior Cruciate Ligament (ACL) is one of the most commonly performed procedures in orthopaedic surgery. Long-term outcomes following ACL reconstruction are not well documented. Additionally, it is poorly understood how associated injuries, such as meniscal pathology or chondral defects, affect patient outcomes following ACL reconstruction. The purpose of this study was to document ten year outcomes