

of this study was to assess the demographics, technique, and results of ACL revision in children and adolescents.

**Methods:** This was a retrospective case series and outcomes assessment of all pediatric/adolescent patients (<18 years) who underwent revision ACL surgery at a single institution. Charts were reviewed for patient demographics, injury characteristics, operative details, surgical complications, and patient outcome. Patient-oriented outcome measures were also sent to all patients and included the Pedi-IKDC, Tegner Activity Scale, Lysholm Knee Score, and a self-designed Physical Activity Survey to assess return to sport.

**Results:** Ninety revision ACL reconstructions were performed in 88 patients. Average patient age at the time of revision was 16.6 years (SD 1.69), and 28.8% were skeletally immature. Time to failure after primary ACL reconstruction was 1.28 years (SD 1.06), and the most common mechanism of failure was noncontact sports injuries. 74.4% had additional intraarticular injuries that required surgical intervention at the time of revision. Revision graft type included allograft (61.1%), patellar tendon (21.1%), hamstring (16.7%), and iliotibial band (1.1%). There was a 20% graft reinjury rate. Additional procedures after revision were required in 25.5% of knees, and 20% of revision reconstructions had contralateral ACL injuries. 50% of patients completed outcome measures with an average time since revision of 5.1 years. The mean outcome scores were: Pedi-IKDC 71.7 (SD 12.6), Lysholm 79 (SD 13.2), Tegner 6.6 (range 6-10). 69% of patients reported returning to sports at an average of 8.9 months (3-36), however, only 55.2% of these reported being able to return to the same level of play.

**Conclusion:** Revision ACL reconstruction in pediatric patients was associated with worse functional outcome, lower activity level, higher rates of graft re-tearing, and lower return to sports rates than primary ACL reconstruction.

### **Biomarker Changes in ACL Deficient Knees Compared with Contralaterals**

#### **SS-11**

April 14, 11:35 AM

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**Introduction:** Though ACLR outcomes are overwhelmingly positive, patients' recovery processes are highly variable, and typically based off generalized time-tables derived from population data. In an attempt to individualize prognostic estimates, we sampled knee joint synovial enzyme concentrations in patients with ACL tears with, and without cartilage injury, and compared them with the contralateral non-injured knee.

**Methods:** 480 patients indicated for knee arthroscopy had samples drawn to form a database. If no pathological history existed in the contralateral knee, samples were drawn as well. For this study, only patients that had confirmed ACL injury on arthroscopy were included.

Samples were drawn 3-12 weeks after initial injury. Associated cartilage injury was noted. Samples were centrifuged, and concentrations were determined using an Elissa test. Concentrations were then compared between the three study groups (ACL tear with cartilage injury (without cartilage injury, and contralateral) using a Welch ANOVA test with pairwise comparisons.

**Results:** The study included samples from 132 knees which included: 34 ACL tears without cartilage damage (mean age 34.00 years); 28 ACL tears with cartilage damage (36.29 years), and 72 contralaterals (41.06 years). ANOVA testing demonstrated significant differences among groups for: MMP-3 ( $p > .001$ ); TIMP-1 ( $p = .001$ ); TIMP-2 ( $p = .015$ ); FGF-2 ( $p = .011$ ); IL-6 ( $p = .001$ ); and MIP-1b ( $p = .001$ ). Pairwise comparisons demonstrated no significant differences between ACL tears with, and without cartilage damage, but did show both types of ACL tears had significantly higher concentrations of MMP-3, TIMP-1, IL-6, and MIP-1b than contralaterals. ACL tears without cartilage damage had significantly lower concentrations of TIMP-2 and FGF-2 (13).

**Conclusion:** The course from repair to symptomatic relief is highly variable. Cytokine concentrations are shown here to be significantly different between ACL tears (+/- cartilage damage) and healthy knees. These validated differences can help establish these biomarkers as a method for injury stratification ultimately providing patient-specific prognostic data.

### **Transphyseal ACL Reconstruction in Skeletally Immature Patients: Does Independent Femoral Tunnel Drilling Place the Physis at Greater Risk Compared to Transtibial Drilling?**

#### **SS-12**

April 14, 11:40 AM

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**Introduction:** The purpose of this study was to radiographically assess differences in physeal disruption between transtibial and independent tunnel drilling techniques following ACL reconstruction in skeletally immature patients.

**Methods:** A retrospective, matched comparative cohort study was performed of skeletally immature patients who underwent transphyseal ACL reconstruction between January 1, 2008 and March 31, 2011. All skeletally immature patients between 10 and 15 years old who underwent independent femoral tunnel drilling and had adequate baseline and post-operative radiographs were analyzed. These patients were matched with a transtibial technique cohort based on age and sex. Demographic characteristics and peri-operative metrics were collected. Radiographic measurements were recorded from pre-operative MRI and post-operative plain radiographs.

**Results:** Twenty patients were analyzed. Between groups, there were significant differences in the

estimated area of physeal disruption (1.64 cm<sup>2</sup> vs. 0.74 cm<sup>2</sup>, P<0.001), femoral (32.1° vs. 72.8°, P<0.001) and tibial (50.1° vs. 60.5°, P=0.003) tunnel drill angles, medial/lateral location of the femoral tunnel (24.2 mm vs. 36.1 mm from lateral cortex, P=0.001), and distance from the lateral aspect of the distal femoral physis and the femoral tunnel exit (4.7mm vs. 26.7mm from the perichondrial ring, P<0.001). All patients who underwent femoral tunnel drilling at an angle of greater than 25° from the transverse axis experienced a <6% disruption of physeal area.

**Conclusion:** With femoral tunnel drilling techniques that create more oblique tunnels, the area of physeal damage is larger, more eccentric and closer to the perichondrial ring. Since most studies noting the safety of transphyseal ACL reconstruction have utilized a vertical femoral tunnel, surgeons should be aware that if an independent femoral tunnel drilling technique is utilized during transphyseal ACL reconstruction, the physis is at greater risk when drilling at more horizontal angles. Angles greater than 25° from the transverse axis may safely create <6% physeal area damage.

### A Matched-pair Comparison of Patient-reported Outcomes following Primary ACL Reconstruction with Hamstring Autograft vs Hybrid Graft

#### SS-13

April 14, 11:45 AM

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**Introduction:** With the relatively recent introduction of hybrid autograft-allograft grafts for anterior cruciate ligament reconstruction (ACLR), few studies have compared outcomes between autografts versus hybrid grafts. The purpose of this study is to compare patient-rated outcomes between hamstring autografts and hybrid grafts for ACLR.

**Methods:** At a minimum two-year follow-up, patients who had undergone primary ACLR with hamstring autograft (A) or hybrid (H) graft (hamstring autograft with peroneus longus or tibialis posterior allograft) were contacted to fill out a survey containing the Knee injury and Osteoarthritis Outcome Score (KOOS), Subjective IKDC score, Single Assessment Numeric Evaluation (SANE), SF-12, and visual analog scale (VAS) for activity level prior to injury and at follow-up. A matched-pair analysis was performed by matching patients in each group by gender and by age at the time of surgery within three years. Paired t-tests were used to compare outcomes between groups.

**Results:** Twenty matched-pairs were formed, including nine males and eleven females in each group. Average age at surgery was 34 years (range, 13-57 years). Average follow-up was 3.3 years. No significant differences were found in any of the KOOS subscale scores, Subjective IKDC

(A: 75, H: 77), SANE (A: 86, H: 90), SF-12 Physical (A: 53, H: 53) or Mental (A: 53, H: 52) component scores, or activity level prior to injury (A: 7.5, H: 7.4) or at time of follow-up (A: 6.7, H: 6.2).

**Conclusion:** Patients undergoing primary ACL reconstruction with a hybrid graft (hamstring autograft plus allograft) have similar subjective outcomes to those with a hamstring autograft. Further studies are needed to determine patient characteristics which favor the use of hybrid grafts.

### Allograft/Autograft Anterior Cruciate Ligament Reconstruction Equal Outcomes at All Ages With No Anterior Knee Pain: Average 7 Year Follow-Up

#### SS-14

April 14, 11:50 AM

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**Introduction:** Anatomic ACLR yields superior outcomes by restoring knee kinematics and stability though optimal graft source remains controversial. Bone-patellar-tendon-bone (BPTB) autograft ACLR is superior to hamstring for stability; however, anterior knee pain has been reported. Additionally, allografts are associated with higher risks of failure and infection. We hypothesize that allograft BPTB ACLR using biointerference screw will yield successful return to sports comparable to autograft ACLR without anterior knee pain.

**Methods:** Patients with allograft (17-58 years) and autograft (15-50 years) ACLR by a single surgeon (N=153) underwent evaluations including knee ROM, stability testing, Lysholm, IKDC, and Tegner questionnaires. Radiographic evaluation included preoperative plain film knee series and MRI, and postoperative MRI and CT scans. Allograft source was <40years of age and non-irradiated. Modified rehabilitation programs included return to pivoting sports at ≥6months. 2x2 ANOVA and independent samples t-test evaluated differences in outcomes (p<0.05).

**Results:** Follow-up was 7.2±5.4years (range:2-15). Functional scores (Lysholm:87±18 vs. 87±15, p=0.974; IKDC:80±18 vs 82±15, p=0.618) and KT-1000 measurements (30lbs p=0.926; manual maximum p=0.490) were not statistically significant between groups. Activities associated with anterior knee pain were not difficult for either group and all patients returned to moderate and vigorous sports. There were two autograft failures (1.3%) after 5 years due to unknown reasons and four allograft failures (2.6%) due to traumatic reinjuries at an average of 3.8 years postoperatively. All but one underwent revision allograft ACLR without recurrence. To date, there is no evidence of lysis from the interference screws.

**Conclusion:** Allograft and autograft single-bundle ACLR successfully return individuals to high level sports (e.g. skiing, soccer) and restore knee stability. Allograft is an acceptable option for ACLR in patients >16 years of age