



**Issue 54.3, Arthroscopy, February 2019**

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## Upper extremity

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### **Determination of Threshold Scores for Treatment Success After Arthroscopic Rotator Cuff Repair Using Oxford, Constant, and University of California, Los Angeles Shoulder Scores**

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Arthroscopy, Volume 35, Issue 2, Received: February 7, 2018; Accepted: July 31, 2018

<https://doi.org/10.1016/j.arthro.2018.07.047>

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#### **Purpose**

To determine the threshold scores for the Constant-Murley score (CMS); University of California, Los Angeles (UCLA) shoulder score; and Oxford Shoulder Score (OSS) that determine treatment success after arthroscopic rotator cuff (RC) repair.

#### **Methods**

Patients who underwent unilateral arthroscopic double-row RC repair by a single surgeon between 2010 and 2015 were prospectively followed up and assessed preoperatively and at 6, 12, and 24 months postoperatively. Perceived pain was measured with a visual analog scale, and functional outcome was assessed by the CMS, UCLA score, and OSS. Treatment success was defined as simultaneous fulfillment of 3 criteria: improvement in pain, expectations for surgery met, and patient satisfied with surgery. Threshold scores were determined by receiver operating characteristic (ROC) analyses, using the various scores as predictors and the defined treatment success as the criterion.

#### **Results**

The study included a total of 214 patients (96 male and 118 female patients) with a mean age of  $60.1 \pm 10$  years. Most patients showed improvement in pain ( $\geq 88\%$ ) and high satisfaction ( $\geq 93\%$ ) and expectation fulfillment ( $\geq 80\%$ ) postoperatively. Of the patients, 73% had treatment success at 6 months; 85%, at 12 months; and 80%, at 24 months. ROC analyses showed good prediction of treatment success using the CMS, UCLA score, and OSS at all 3 follow-up time points (area under the ROC curve [AUC]  $> 0.70$ ), with excellent prediction using the UCLA score at 12 months and 24 months (AUC, 0.811 and 0.805, respectively) and the OSS at 12 months (AUC, 0.820). The following threshold scores were identified: CMS of 59, UCLA score of 21, and OSS of 42 at 6 months; CMS of 61, UCLA score of 26, and OSS of 43 at 12 months; and CMS of 65, UCLA score of 30, and OSS of 46 at 24 months.

#### **Conclusions**

The CMS, UCLA score, and OSS have good predictive value in defining treatment success after arthroscopic RC repair. The cutoff scores are time dependent.

#### **Level of Evidence**

Level II, development of diagnostic criteria.

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## **Arthroscopic Findings and Clinical Outcomes in Patients 40 Years of Age and Older With Recurrent Shoulder Dislocation**

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Arthroscopy, Volume 35, Issue 2, Received: April 12, 2018; Accepted: August 12, 2018

<https://doi.org/10.1016/j.arthro.2018.08.041>

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### **Purpose**

The present study investigates the intra-articular findings and clinical outcomes after arthroscopic surgery in patients after age 40 with chronic anterior shoulder instability.

### **Methods**

Fifty patients older than 40 years who underwent arthroscopic stabilization for recurrent anterior shoulder dislocation were analyzed.

### **Results**

The mean age at the time of surgery was 44.8 years (range, 40-72 years), and the mean duration of follow-up was 45 months (range, 28-150 months). The mean visual analog scale score for pain with motion significantly improved from 4.1 preoperatively to 1.7 at the last follow-up ( $P < .001$ ). The range of motion in the affected shoulder revealed limitations of 9.4° in forward flexion and 17.8° in external rotation compared with the unaffected shoulder. Both the Constant and Rowe scores significantly improved ( $P < .001$  and  $P < .001$ , respectively). Recurrence, which includes dislocation and subluxation, occurred in 14% postoperatively. Anteroinferior labral lesion was seen in 92% of patients. Associated lesions included superior labrum anterior to posterior lesion (22%), midsubstance capsular tear (10%), and Hill-Sachs lesion (92%). Rotator cuff tears were found in 18%—partial-thickness tear in 10% and full-thickness tear, which was repaired with suture anchor, in 8%. Among the intra-articular lesions, there was no significant relation with recurrent instability or functional outcome as a single factor.

### **Conclusions**

In patients with chronic anterior shoulder instability who were older than 40 years, the clinical results after arthroscopic surgery showed statistically significant improvement with good muscle strength recovery. The quality of labral lesion, size of the Hill-Sachs lesion, and glenoid defect showed positive correlation with the number of preoperative dislocation. The intra-articular pathologies were varied, however no single articular lesion had significant impact on the recurrence rate.

### **Level of Evidence**

Level IV, case series.

## **Preoperative Injections May Be an Iatrogenic Cause of Reoperation After Arthroscopic Rotator Cuff Repair**

Avinesh Agarwalla, B.S.a, Richard N. Puzzitiello, B.S.a, Randy Mascarenhas, M.D., F.R.C.S.C.c, Shelby Sumner, M.P.H.a, Anthony A. Romeo, M.D.b, Brian Forsythe, M.D.

Arthroscopy, Volume 35, Issue 2, Received: March 14, 2018; Accepted: August 16, 2018

<https://doi.org/10.1016/j.arthro.2018.08.042>

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### **Purpose**

To determine whether an association exists between preoperative shoulder injections and reoperations in patients undergoing arthroscopic rotator cuff repair (aRCR).

### **Methods**

The PearlDiver Patient Records Database was reviewed for Humana-insured patients undergoing aRCR after a shoulder injection. Two matched groups were created: aRCR within 1 year of injection (n = 12,054) and aRCR without prior injection within 1 year of surgery (n = 12,054). Reoperation rates within 3 months, at 3 to 6 months, and at 6 to 12 months postoperatively were assessed. Statistical analysis was performed with the  $\chi$ -square test.

### **Results**

The rate of reoperation within 3 months of the index procedure was higher in the control group (3.7% vs 3.1%,  $P = .01$ ); however, 3 to 6 months after the index procedure, the rate of reoperation was higher in patients who received an injection within 1 year of the index procedure (1.8% vs 1.4%,  $P = .03$ ). During the same intervals, the rate of revision rotator cuff repair (RCR) within 3 months of the index procedure was higher in the control group (2.9% vs 2.6%) and the rate of revision RCR 3 to 6 months after the index procedure was higher in patients who received an injection within 1 year of the index procedure (1.1% vs 0.9%); however, these results were not statistically significant ( $P = .3$  and  $P = .8$ , respectively). The incidence of revision RCR (1.6% vs 1.1%; odds ratio, 1.4;  $P = .003$ ) and incidence of subacromial decompression (1.5% vs 1.1%; odds ratio, 1.3;  $P = .01$ ) 6 to 12 months after the index procedure were significantly higher in patients receiving an injection within 1 year before surgery.

### **Conclusions**

Preoperative shoulder injections may increase the risk of revision RCR and subacromial decompression by up to 150% in patients 6 to 12 months after index surgery compared with patients who did not receive a preoperative injection. However, the absolute increase in these revision procedures is only 0.5%.

### **Level of Evidence**

Level III, comparative study.

## **Morphologic Factors Related to Repair Outcomes for Delaminated Rotator Cuff Tears: A Minimum 2-Year Retrospective Comparison Study**

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Arthroscopy, Volume 35, Issue 2, Received: March 19, 2018; Accepted: August 16, 2018

<https://doi.org/10.1016/j.arthro.2018.08.040>

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### **Purpose**

To evaluate clinical outcomes and repair integrity after en masse transosseous-equivalent suture bridge repair for delaminated rotator cuff tears and to analyze the morphologic factors related to clinical outcomes and repair integrity.

### **Methods**

This study included 99 patients who underwent the technique of en masse transosseous-equivalent suture bridge repair for delaminated rotator cuff tears. Morphologic factors were estimated using magnetic resonance imaging, and clinical outcomes were evaluated using the University of California, Los Angeles score; American Shoulder and Elbow Surgeons score; and Constant shoulder score. The morphologic factors included the shape of delamination, retraction length of the bursal and articular layers, gap distance between the layers, and length of the intrasubstance cleavage. According to follow-up magnetic resonance imaging, cases were categorized into the intact or retear group. The morphologic factors were compared between the 2 groups, including the correlation between the morphologic factors and postoperative outcomes.

### **Results**

Retears occurred in 26 of 99 cases (26%). In both the intact and retear groups, the University of California, Los Angeles, American Shoulder and Elbow Surgeons, and Constant scores improved postoperatively ( $P < .0001$ ). The most common delamination shape was that of a more retracted articular layer in retears. We found no differences in retears in terms of the retraction length of the bursal layer, gap distance, and length of the intrasubstance cleavage. However, the retraction length of the articular layer differed significantly between the groups ( $P < .0001$ ). No correlation between the morphologic factors and clinical outcomes was found.

### **Conclusions**

Arthroscopic en masse transosseous-equivalent suture bridge repair is a useful technique in delaminated tears to achieve optimal repair outcomes. In addition, although there was no correlation between the morphologic factors and postoperative clinical outcomes, the retraction length of the articular layer was identified as a significant factor influencing repair integrity. We recommend emphasizing the reduction of tension within the articular layer during the repair procedure.

### **Level of Evidence**

Level III, retrospective comparison study.

## **Early Arthroscopic Repair of Acute Traumatic Massive Rotator Cuff Tears Leads to Reliable Reversal of Pseudoparesis: Clinical and Radiographic Outcome**

Christian Spross, M.D.a, Gerrit Behrens, M.D.a, Tobias Johannes Dietrich, M.D.b, Chan-Hi Olaf Kim, M.D.b, Gábor J. Puskás, M.D.a, Vilijam Zdravkovic, M.D.a, Bernhard Jost, M.D.

Arthroscopy, Volume 35, Issue 2, Received: March 19, 2018; Accepted: August 16, 2018

<https://doi.org/10.1016/j.arthro.2018.08.048>

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### **Purpose**

It was the aim of this study to analyze the clinical and radiographic outcome after early arthroscopic repair regardless of the age of patients.

### **Methods**

Patients with massive traumatic cuff tear and clinical pseudoparesis for forward elevation treated by subsequent early arthroscopic repair from 2011 until 2014 were included in this retrospective study. Exclusion criteria were Goutallier grade  $\geq 3$  fatty infiltration and prior shoulder problems or surgery. Magnetic resonance imaging (MRI), radiographs, and functional assessments were performed preoperatively and at follow-up.

### **Results**

A total of 21 patients (male/female 15/6; age range: 30-83) were included. Preoperative MRI showed complete 2 tendon tears in 7 patients, 3 tendon tears in 13 patients and all tendons ruptured in one patient. All patients had full passive range of motion and the mean active elevation was  $35.7^\circ$  (range:  $0^\circ$ - $60^\circ$ ). Nine patients also had a pseudoparesis for external rotation (mean:  $10^\circ$ , range:  $-30^\circ$  to  $40^\circ$ ). The mean delay until surgery was 33 days (range: 13-60). At follow-up (mean: 39 months, range: 24-60) all patients showed reversal of pseudoparesis, mean elevation of  $165.2^\circ$  (range:  $110^\circ$ - $180^\circ$ ) and mean external rotation of  $49.3^\circ$  (range:  $-20^\circ$  to  $80^\circ$ ). The mean Constant score was 82 points (range: 56-95), and the mean subjective shoulder value was 93% (range: 50-100). The overall retear rate was 20% (n = 4). Fatty infiltration increased at least 1 grade in patients who had a retear and in 56% of patients (n = 9) without retear. Age was not a predictor for retear.

### **Conclusions**

This study shows that early arthroscopic repair of traumatic massive RCT with pseudoparesis may lead to successful results regardless of patients' age. A complete restoration of the function can be expected even in patients with retear. The retear rate is low and the increase of fatty infiltration minimal.

### **Level of Evidence**

Level IV, case series.

## **Reconstruction of the Superior Glenoid Labrum With Biceps Tendon Autograft: A Cadaveric Biomechanical Study**

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Arthroscopy, Volume 35, Issue 2, Received: May 7, 2018; Accepted: August 30, 2018

<https://doi.org/10.1016/j.arthro.2018.08.049>

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### **Purpose**

To describe 2 superior labral reconstruction techniques using long head of the biceps (LHB) autograft and to investigate the ability of the 2 reconstruction techniques to restore superior restraint to the glenohumeral joint compared with superior labrum-deficient models.

### **Methods**

In this biomechanical study, 10 cadaveric shoulders were cycled on a servohydraulic machine while the force required to cause superior subluxation was recorded. Each specimen was cycled under 4 conditions: intact labrum, SLAP tear, posterior (9- to 12-o'clock position) labral reconstruction using LHB autograft (superior labral reconstruction 1 [SLR1]), and 180° (9- to 3-o'clock position) labral reconstruction using LHB autograft (superior labral reconstruction 2 [SLR2]).

### **Results**

The mean peak force required to cause superior subluxation in the intact labrum was 32.75 N versus 19.75 N in the SLAP tear ( $P = .0120$ ). SLR1 required a mean peak force of 31.23 N versus 44.09 N for SLR2 ( $P = .0175$ ). SLR1 required 94.96% of the force needed in the intact labrum to cause subluxation, whereas SLR2 required 140.6%. SLR1 and SLR2 required 34.21% higher ( $P = .0074$ ) and 79.84% higher ( $P = .0033$ ) forces, respectively, to generate subluxation compared with the SLAP tear state.

### **Conclusions**

Both proposed superior labral reconstruction techniques increased the force needed for humeral head superior migration in the setting of a labral tear. SLR1 (posterior labral reconstruction) closely matched the constraint of an intact labrum, whereas SLR2 (180° labral reconstruction) provided greater superior constraint than an intact labrum.

### **Clinical Relevance**

The natural history of irreparable rotator cuff tears results in superior glenohumeral escape and eventual arthrosis. The superior glenoid labrum is an important contributor to superior glenohumeral constraint and is often degenerated in this setting. Clinical application of the 2 described superior labral reconstruction techniques may improve glenohumeral superior stability in patients with rotator cuff disease and superior labral deficiency.

## Is the Instability Severity Index Score a Valid Tool for Predicting Failure After Primary Arthroscopic Stabilization for Anterior Glenohumeral Instability?

Mattia Loppini, M.D., Ph.D., Giacomo Delle Rose, M.D.b, Mario Borroni, M.D.b, Emanuela Morengi, Ph.D.c, Dario Pitino, M.D.b, Cristián Domínguez Zamora, M.D.d, Alessandro Castagna, M.D.a,b

Arthroscopy, Volume 35, Issue 2, Received: April 25, 2018; Accepted: September 8, 2018

<https://doi.org/10.1016/j.arthro.2018.09.027>

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### Purpose

To assess the validity of the Instability Severity Index Score in predicting the rate of recurrence of dislocation in patients undergoing arthroscopic Bankart repair.

### Methods

The inclusion criteria were recurrent anterior traumatic glenohumeral instability and a minimum follow-up of 5 years. According to the preoperative Instability Severity Index Score, patients were divided into the following groups:  $\leq 3$  points (A), 4 to 6 points (B), and  $> 6$  points (C). The recurrence rate was determined by telephone interviews. The estimated overall rate of success at 5 years was defined as the estimated overall percentage of patients free of recurrence at 5 years.

### Results

Six hundred seventy patients (572 men and 98 women) were included. The average age was 27 years (range, 18 to 39 years) at the time of surgery. One hundred fourteen of 670 patients had a recurrence of instability, with an overall recurrence rate of 17% (95% confidence interval [CI] 14.2%-19.9%). The Instability Severity Index Score had a significant association with recurrence. Compared with patients in group A, those in group B had double the risk of recurrence (hazard ratio [HR] = 2.43, 95% CI 1.38-4.28,  $P = .002$ ), and patients in group C a 9 times greater risk of recurrence (HR = 9.42, 95% CI 5.20-17.7,  $P < .001$ ). The estimated overall rate of success at 5 years was 84.8% (95% CI 81.8-87.3). The rate of success with an Instability Severity Index Score  $\leq 3$  points was 93.7% (95% CI 89.6-96.2), but it dropped to 85.7% (95% CI 81.7-88.9) in those with an Instability Severity Index Score of 4 to 6 points and became 54.6% (95% CI 42.8-64.9) in those with an Instability Severity Index Score  $> 6$  points. On multivariable analysis, the Instability Severity Index Score was found to significantly affect the risk of recurrence, corrected by type of sport and glenoid bone loss.

### Conclusions

The Instability Severity Index Score is a validated tool with which to assess the recurrence rate of dislocation after arthroscopic surgery in patients with shoulder instability. Arthroscopic stabilization in patients with an Instability Severity Index Score  $\leq 3$  is associated with a significantly lower risk of recurrence of glenohumeral instability compared with that in patients with an Instability Severity Index Score  $> 3$  points.

### Level of Evidence

III, case-control study.

## Proximity of the Coracoid Process to the Neurovascular Structures in Various Patient and Shoulder Positions: A Cadaveric Study

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Arthroscopy, Volume 35, Issue 2

<https://doi.org/10.1016/j.arthro.2018.09.031>

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### Purpose

To examine and compare the distances from the anteromedial aspects of the coracoid base and the coracoid tip to the neurovascular structures in various patient positions.

### Methods

The experiment was conducted in 15 fresh-frozen cadavers. We dissected 15 right and 15 left shoulders to measure the distances from the anteromedial aspects of the coracoid base and the coracoid tip to the lateral border of the neurovascular structures in the horizontal, vertical, and closest planes. The measurements were performed with the cadavers in the supine, lateral decubitus, and beach-chair positions. With cadavers in the beach-chair position, we evaluated 5 arm postures (arm at side, 45° of abduction, 90° of abduction, 45° of forward flexion, and 90° of forward flexion).

### Results

The shortest distance from the coracoid base to the neurovascular structures was found in the beach-chair position with arm at side in the horizontal plane ( $27.4 \pm 4.9$  mm) and 90° of abduction in the vertical ( $21.8 \pm 4.2$  mm) and closest ( $19.5 \pm 4.2$  mm) planes. The distances in each plane were statistically significant compared with the supine and lateral decubitus positions ( $P < .005$ ). Between the coracoid tip and the neurovascular structures, the shortest distance was found in the beach-chair position with 90° of abduction, with  $29.3 \pm 7.7$  mm,  $20.8 \pm 4.9$  mm, and  $18.5 \pm 5.1$  mm in the horizontal, vertical, and closest planes, respectively. The distances were statistically significant in all planes compared with the supine and lateral decubitus positions ( $P < .005$ ).

### Conclusions

Shoulder surgery in the area of the coracoid process is safe, especially with the patient in the supine position. The distance from the coracoid process to the neurovascular structures was closest in the beach-chair position with 90° of arm abduction.

### Clinical Relevance

This study determined the distances between the coracoid process and the neurovascular structures during surgery around the coracoid process.

## Arthroscopic Interposition Tendon Arthroplasty for Stage 2 Scapholunate Advanced Collapse

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Arthroscopy, Volume 35, Issue 2, Received: May 9, 2018; Accepted: October 28, 2018

<https://doi.org/10.1016/j.arthro.2018.10.134>

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### Purpose

To report and analyze the functional outcomes of arthroscopic interposition tendon arthroplasty (AITA) in stage 2 scapholunate advanced collapse (SLAC).

### Methods

Sixteen patients with stage 2 SLAC who underwent AITA between 2009 and 2014 with a minimum of 24-month follow-up were retrospectively evaluated. Medical records were assessed for preoperative and postoperative range of motions, grip strength, visual analog scale, disabilities of the arm, shoulder, and hand (DASH) score, scapholunate angle, and scaphoid fossa-to-scaphoid space.

### Results

After exclusion of 2 patients, 14 patients were available for this study. At final follow-up, improvements were found for the following variables: extension (preoperative mean, 49.29°; VS postoperative mean, 61.07°;  $P = .025$ , 95% confidence interval [CI], 1.74-21.85), radial deviation (preoperative mean, 6.43°; postoperative mean, 17.14°;  $P < .001$ , 95% CI, 6.06-15.36), grip strength (preoperative mean, 18.93 kg; postoperative mean, 29.64 kg;  $P < .001$ ; 95% CI, 6.81-14.61), visual analog scale (preoperative mean, 8.07; postoperative mean, 2.50;  $P < .001$ ; 95% CI, -6.52 to -4.61), and DASH (preoperative mean, 60.39; postoperative mean, 10.28;  $P < .001$ , 95% CI, -43.04 to -57.28), scapholunate angle (preoperative median, 67.50°; postoperative median, 55.00°,  $P = .002$ ,  $Z = -2.831$ ), and scaphoid fossa-to-scaphoid space (preoperative median, 0.00 mm; postoperative median, 1.00 mm;  $P < .001$ ,  $Z = -3.145$ ). There was no improvement in flexion (preoperative mean, 40.00°; postoperative mean, 50.00°;  $P = .025$ ; 95% CI, -4.45 to -24.45), ulnar deviation (preoperative median, 25.00°; postoperative median, 30.00°;  $P = .063$ ,  $Z = -2.060$ ), or flexion-extension arc (preoperative mean, 89.28°; postoperative mean, 111.07°;  $P = .067$ ; 95% CI, -1.79 to -45.36) following AITA. Nine of 13 patients were satisfied with the procedure, 3 were moderately satisfied, and 1 was not satisfied.

### Conclusions

Arthroscopic interposition tendon arthroplasty is an acceptable procedure for stage 2 SLAC. This procedure preserves motion, yields acceptable functional outcome, and reduces pain.

### Level of Evidence

Level IV, therapeutic case series.

## **Subacromial Spacer Implantation for the Treatment of Massive Irreparable Rotator Cuff Tears: A Systematic Review**

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Arthroscopy, Volume 35, Issue 2, Received: April 6, 2018; Accepted: August 2, 2018

<https://doi.org/10.1016/j.arthro.2018.08.006>

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### **Purpose**

To synthesize and report the early clinical and radiographic outcomes associated with subacromial spacer use in patients with massive irreparable rotator cuff tears.

### **Methods**

A systematic search on MEDLINE, Embase, and Cochrane Library databases was performed during February 2018. Included studies were evaluated regarding the level of evidence and quality using the methodological index for nonrandomized studies. Patient demographics, intraoperative findings, clinical and radiographic outcomes, and complications were recorded for each of the included studies.

### **Results**

Seven eligible studies including 204 shoulders from 200 patients with subacromial spacer implantation were identified (6 Level IV studies and 1 Level III study). The mean methodological index for nonrandomized studies score for noncomparative studies was 11, whereas that of comparative studies was 15. The mean age of patients was 67.6 years, and the mean reported follow-up time was 19.4 months. All patients had Goutallier stage 3 and 4 fatty infiltration on magnetic resonance imaging. All studies reported consistent improvement in the total Constant score or American Shoulder and Elbow Surgeons score over the duration of follow-up. A total of 6 (3%) complications were reported in the included studies. Two studies detailed radiographic outcomes, with discrepant changes in the acromiohumeral interval.

### **Conclusions**

Patients undergoing subacromial spacer implantation for the treatment of massive irreparable rotator cuff tears have satisfactory outcomes at the 2- to 3-year follow-up with a low rate of complications.

### **Level of Evidence**

Level IV, systematic review of 1 Level III and 6 Level IV studies.

## **Arthroscopic Remplissage for Anterior Shoulder Instability: A Systematic Review of Clinical and Biomechanical Studies**

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Arthroscopy, Volume 35, Issue 2, Received: April 21, 2018; Accepted: September 7, 2018

<https://doi.org/10.1016/j.arthro.2018.09.029>

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### **Purpose**

To examine the clinical outcomes and biomechanical data supporting the use of the remplissage procedure.

### **Methods**

A query of the Embase, PubMed, Scopus, and Web of Science databases was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines from 2000 to 2017. Data were extracted from included studies for a qualitative review of both clinical and biomechanical outcomes.

### **Results**

After review, 18 clinical and 10 biomechanical studies were available for analysis; 10 of 18 clinical studies (55.6%) were Level IV evidence. Within the clinical studies, there were 567 patients (570 shoulders) evaluated with follow-up ranging from 6 to 180 months. Overall, 5.8% of shoulders (33 of 570) displayed recurrent instability after arthroscopic remplissage. Of the shoulders with recurrent instability, 42.4% of shoulders (14 of 33) underwent further surgical management. In all studies evaluating pre- and postoperative patient-reported outcomes, the arthroscopic remplissage procedure improved patient-reported outcomes a statistically significant amount postoperatively. Within individual clinical studies, external rotation with the arm in neutral was the most consistently limited range of motion (ROM) parameter, with deficits compared with the contralateral shoulder ranging from 9° to 14°. Biomechanical analysis appeared to corroborate the clinical results, although significant conclusions were limited by heterogeneity of reporting.

### **Conclusions**

Arthroscopic remplissage performed in conjunction with arthroscopic Bankart repair is a safe and effective procedure for patients with engaging Hill-Sachs lesions and subcritical glenoid bone loss. Although both the included clinical and biomechanical studies would suggest minimal changes in glenohumeral ROM following the remplissage procedure, strong conclusions are limited by the heterogeneity in reporting ROM data and lack of comparative studies.

### **Level of Evidence**

IV, systematic review.

**Monocortical fixation of the coracoid in the Latarjet procedure is significantly weaker than bicortical fixation**

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KSSTA, January 2019, Volume 27, Issue 1, pp 239-244

<https://doi.org/10.1007/s00167-018-4837-2>

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**Purpose**

A crucial step of the Latarjet procedure is the fixation of the coracoid process onto the glenoid. Multiple problems associated with the fixation have been described, including lesions of the suprascapular nerve due to prominence of the screw or bicortical drilling. The purpose of the present study was to evaluate whether monocortical fixation, without perforating the posterior glenoid cortex, would provide sufficient graft stability.

**Methods**

Coracoid transfer was performed in 14 scapula models (Sawbones®, Composite Scapula, 4th generation). Two groups were assigned: in one group, fixation was achieved with two screws that did not perforate the posterior cortex of the glenoid neck (monocortical fixation), in the other group, fixation was achieved with perforation of the posterior cortex (bicortical fixation). The ultimate failure load and mode of failure were evaluated biomechanically.

**Results**

Monocortical fixation was a significantly weaker construct than bicortical fixation (median failure load 221 N, interquartile range 211–297 vs. median failure load 423 N, interquartile range 273–497;  $p = 0.017$ ). Failure was either due to a pullout of the screws from the socket or a fracture of the glenoid. There was no significant difference in the mode of failure between the two groups (n.s.).

**Conclusion**

Monocortical fixation was significantly weaker than bicortical fixation. However, bicortical drilling and overly long screws may jeopardize the suprascapular nerve. Thus, anatomic knowledge about the safe zone at the posterior rim of the glenoid is crucial. Until further research has evaluated, if the inferior stability is clinically relevant, clinicians should be cautious to use a monocortical fixation technique for the coracoid graft.

## **Minimally invasive fascia lata harvesting in ASCR does not produce significant donor site morbidity**

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KSSTA, January 2019, Volume 27, Issue 1, pp 245-250

<https://doi.org/10.1007/s00167-018-5085-1>

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### **Purpose**

The aim of this study was to prospectively evaluate donor site morbidity in arthroscopic superior capsular reconstruction using a minimally invasive harvested fascia lata autograft.

### **Methods**

Fifteen consecutive patients underwent arthroscopic superior capsular reconstruction by the senior author using a fascia lata autograft harvested in a minimally invasive fashion. All patients were prospectively evaluated at 1 week, 6 and 18 months postoperatively. The subjects' body mass index, age, actual or previous corticosteroid therapy history and active smoking habits were evaluated. Functional outcomes were assessed by the non-arthritic hip score applied to the harvested and contralateral thighs. Every patient completed standardized subjective satisfaction questionnaires at all evaluations. The median patient age was 65.5 years (range 47–77). Nine patients (60%) were females, and six (40%) were males. One patient (6.7%) was within the normal range of weight, nine (60%) were overweight, four (27%) were obese, and one (6.7%) was extremely obese. Two patients (13%) were active smokers. No patients had an active or previous record of corticosteroid therapy. No patients required postoperative lower limb physical therapy.

### **Results**

In terms of overall and cosmetic satisfaction, most patients reported that they were satisfied or very satisfied at all evaluations, and the proportion of very satisfied patients increased over time ( $p < 0.001$ ). The harvested thigh's functional scores were 91% ( $p = 0.003$ ) and 94% ( $p = 0.008$ ) of the healthy thigh's score at 6 and 18 months, respectively. The complications reported were mild, and their proportions decreased in the first 18 months after surgery ( $p = 0.04$ ).

### **Conclusions**

The minimally invasive fascia lata harvesting technique for arthroscopic superior capsular reconstruction leads to donor site satisfactory subjective results and good functional outcomes at 18 months after surgery. According to these findings, donor site morbidity is not a valid argument against the use of this autograft for arthroscopic superior capsular reconstruction.

### **Level of evidence**

Case series, level IV.

## **Increasing the deltoid muscle volume positively affects functional outcomes after arthroscopic rotator cuff repair**

Ismail Turkmen, Guray Altun

KSSTA, January 2019, Volume 27, Issue 1, pp 259-266

<https://doi.org/10.1007/s00167-018-5135-8>

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### **Purpose**

The aim of this study was to determine the effect of changes in deltoid muscle volume (DMV) on the clinical outcomes of patients who underwent arthroscopic repair due to chronic rotator cuff rupture.

### **Methods**

A total of 54 patients (35 females, 19 males) between 40 and 70 years of age who underwent single-row arthroscopic repair due to chronic rotator cuff tears were compared via preoperative (preop) and postoperative (postop) (6–12 months) magnetic resonance imaging (MRI) to determine the total DMV (tDMV). A clinical evaluation was performed with American Shoulder and Elbow Surgeons (ASES) and Constant scores in both the preop and postop groups. tDMV values were also measured in a randomly selected control group (50 patients). A standardized rehabilitation program was recommended for all patients.

### **Results**

Positive correlations were found between the change in tDMV ( $\Delta$ tDMV) and ASES and Constant scores ( $p < 0.03$  and  $p < 0.032$ , respectively). The preop tDMV value was significantly lower in the patient group than in the control group ( $p < 0.02$ ). Significantly lower  $\Delta$ tDMV and body mass index (BMI)-adjusted tDMV values [ $\Delta$ (tDMV/BMI)] were observed in patients who had rerupture at the postop MRI.

### **Conclusions**

According to the present study, changes in DMV impact clinical outcomes after rotator cuff repair. Rehabilitation of the DMV or increasing the preop DMV values positively affects postop clinical outcomes. In addition, if the DMV is below the cutoff value during the preop period, there is insufficient improvement in clinical scores. The clinical relevance of this study is the finding that in patients with a chronic rotator cuff tear and a hypotrophic deltoid muscle, increasing the preop DMV could help achieve better functional outcomes.

### **Level of evidence**

Prognostic, Level 3, case–control study.

## **Long-term outcome of arthroscopic remplissage in addition to the classic Bankart repair for the management of recurrent anterior shoulder instability with engaging Hill–Sachs lesions**

Emmanouil Brilakis, Grigoris Avramidis, Michael-Alexander Malahias, Apostolos Stathellis, Anastasios Deligeorgis, Ioannis Chiotis, Elias Mataragas, Efstathios Chronopoulos, Emmanouil Antonogiannakis

KSSTA, January 2019, Volume 27, Issue 1, pp 305-313

<https://doi.org/10.1007/s00167-018-5261-3>

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### **Purpose**

The evaluation of the long-term outcome of the arthroscopic remplissage performed in addition to the classic Bankart repair for the primary management of recurrent anterior shoulder instability with engaging Hill–Sachs lesion without inverted pear appearance of the glenoid during arthroscopy.

### **Methods**

During a 6-year period, from 2007 to 2012, 65 patients whose average age was  $30.1 \pm 7.6$  years were operated on in our department and satisfied the inclusion criteria of this study. They all had a positive apprehension sign preoperatively. Among them, 51 patients (82%) were available for long-term evaluation. The mean follow-up period was  $8.1 \pm 1.8$  years (range 5.6–10.6).

### **Results**

Three patients (5.6%) had suffered a new dislocation. The remaining patients (94.4%) were satisfied with the surgical result and returned to their previous daily activities, whereas 71% continued to participate in sports without restrictions. The ASES score increased from 72.5 (range 18–100) preoperatively to 100 (range 85–100) postoperatively ( $p < 0.01$ ). The modified Rowe score increased from 40 (range 15–70) to 100 (range 70–100) ( $p < 0.001$ ), and the Oxford Instability score from 29 (range 9–47) to 48 (range 36–48) ( $p < 0.001$ ). No significant restriction in the shoulder range of motion was documented.

### **Conclusions**

The combination of the arthroscopic remplissage with the classic Bankart repair was proven to be a safe and effective procedure for the treatment of “engaging” Hill–Sachs lesions without inverted pear appearance of the glenoid. This combination has long-term outcomes in terms of the recurrence rate and does not significantly influence the range of motion of the shoulder.

### **Level of evidence**

Therapeutic Study—Case series with no comparison group, Level IV.

## **No neurovascular damage after creation of an accessory anteromedial portal for arthroscopic reduction and fixation of coronoid fractures**

Paolo Arrigoni, Davide Cucchi, Enrico Guerra, Francesco Luceri, Simone Nicoletti, Alessandra Menon, Pietro Randelli

KSSTA, January 2019, Volume 27, Issue 1, pp 314-318

<https://doi.org/10.1007/s00167-018-4926-2>

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### **Purpose**

Arthroscopic reduction and internal fixation for coronoid process fractures has been proposed to overcome limitations of open approaches. Currently, arthroscopy is most frequently used to assist insertion of a retrograde guide wire for a retrograde cannulated screw. The present anatomical study presents an innovative arthroscopic technique to introduce an antegrade guide wire from an accessory anteromedial portal and evaluates its safety and reproducibility.

### **Methods**

Six fresh-frozen cadaver specimens were obtained and prepared to mimic an arthroscopic setting. The coronoid process was localized and a 0.9 mm Kirschner wire was introduced from an accessory anteromedial portal, located 2 cm proximal to the standard anteromedial portal. At the end of the procedure, a lateral radiograph was taken to verify the Kirschner wire position and open dissection was conducted to evaluate possible damage to neurovascular structures.

### **Results**

The Kirschner wire was drilled without complications in the coronoid process of all six specimens. Damage of the brachial artery, the median nerve, and the ulnar nerve did not occur in any specimen. A corridor between the brachialis muscle, the median intermuscular septum, and the pronator teres could be identified as suitable for the wire passage.

### **Conclusion**

This study presents a safe and reproducible technique combining the possibility to introduce a guide wire from the anteromedial part of the coronoid, under direct visual control, with a completely arthroscopic approach. This wire can guide the introduction of a retrograde cannulated screw from the dorsolateral ulna to the tip of the coronoid. This new arthroscopic approach permits to obtain improved visual control over coronoid process fixation, without endangering neurovascular structures.

## **A combination of an anteromedial, anterolateral and midlateral portals is sufficient for 360° exposure of the radial head for arthroscopic fracture fixation**

Davide Cucchi, Enrico Guerra, Francesco Luceri, Andreas Lenich, Simone Nicoletti, Pietro Randelli, Dieter Christian Wirtz, Denise Eygendaal, Paolo Arrigoni, ESSKA Elbow and Wrist Committee 2016–2018

KSSTA, January 2019, Volume 27, Issue 1, pp 319-325

<https://doi.org/10.1007/s00167-018-5077-1>

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### **Purpose**

Arthroscopic fixation of radial head fractures is an alternative to open reduction and internal fixation; the latter, however, presents the advantage of minimal soft-tissue damage. The exposure of the radial head for adequate screw placement can be technically challenging. The aim of this study was to evaluate the inter-observer agreement on the effective contact arc in the axial plane of the radial head of three different elbow arthroscopy portals.

### **Methods**

A fresh-frozen cadaver specimen was obtained and prepared in an arthroscopic setting. Standard anterolateral (AL), anteromedial (AM), and midlateral (ML) portals were established and a circular reference system was marked on the radial head. Ten orthopaedic surgeons were then asked to move the forearm from maximal supination to maximal pronation and indicate with a Kirschner wire from each portal the extension in which they would feel confident in placing a cannulated screw passing through the centre of the articular plane of the radial head (axial contact arc). The Shapiro–Wilk normality test was used to evaluate the normal distribution of the sample. A coefficient of variation (CoV) was calculated to determine agreement among observers.

### **Results**

The average arc of axial contact arc that could be contacted from the AM portal measured  $150 \pm 14.1^\circ$ , or 41.7% of the radial head circumference; the one from the AL portal measured  $257 \pm 29.5^\circ$ , or 71.4% of the radial head circumference; that from the ML portal measured  $212.5 \pm 32.6^\circ$ , or 59.0% of the radial head circumference. Considering all three portals, the whole radial head circumference could be contacted. The AM portal showed the smallest CoV (9.4%) as compared to the AL (11.5%), and the ML (15.3%) portals.

### **Conclusions**

With an appropriate use of the standard AL, AM, and ML portals, the whole radial head circumference can be effectively exposed for adequate fixation of radial head fractures. The contact arc of the AM portal presents the smallest variability among different observers and the AL portal shows a superiority in axial contact arc. This information is important for pre-operative planning, and helps to define the limits of arthroscopic radial head fracture fixation.

## **Superior Capsule Reconstruction for Reinforcement of Arthroscopic Rotator Cuff Repair Improves Cuff Integrity**

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First Published December 31, 2018; pp. 379–388

<https://doi.org/10.1177/0363546518816689>

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### **Background**

Retear of repaired rotator cuff tendons worsens patient outcome and decreases patient satisfaction. Superior capsule reconstruction (SCR) was developed to center the humeral head and thus restore the force couple for patients with rotator cuff tears.

### **Purpose**

To evaluate whether SCR for reinforcement before arthroscopic rotator cuff repair (ARCR) improves cuff integrity.

### **Study Design**

Cohort study; Level of evidence, 3.

### **Methods**

Thirty-four consecutive patients (mean age, 69.1 years) with severely degenerated but reparable rotator cuff tears underwent SCR with fascia lata autografts for reinforcement before ARCR. All tears were medium (1-3 cm) or large (3-5 cm), and the number of torn tendons was 2 (supraspinatus and infraspinatus) in 29 shoulders and 3 (supraspinatus, infraspinatus, subscapularis) in 5 shoulders. To assess the benefit of SCR for reinforcement, all data were compared with those after ARCR alone among 91 consecutive patients with medium or large rotator cuff tears (mean age, 63.6 years). The American Shoulder and Elbow Surgeons (ASES) and Japanese Orthopaedic Association (JOA) scores, active shoulder range of motion, and cuff integrity (Sugaya magnetic resonance imaging classification) were compared (t test and chi-square test) between ARCR with and without SCR, as well as before surgery and at final follow-up.

### **Results**

All 34 patients who underwent SCR before ARCR had neither postoperative retear nor type III cuff integrity, whereas those treated with ARCR alone had a 4% incidence (4 of 91) of retear and 8% incidence of type III cuff integrity. ASES and JOA scores, active elevation, active external rotation, and active internal rotation increased in both treatment groups ( $P < .001$ ). Postoperative ASES score and active range of motion did not differ between groups, although the Goutallier grade of the supraspinatus was higher for ARCR with SCR (mean, 2.8) than ARCR alone (mean, 2.1;  $P < .0001$ ).

### **Conclusion**

SCR for reinforcement prevented retear at 1 year after ARCR and improved the quality of the repaired tendon on magnetic resonance imaging. Functional outcomes were similar between groups, even though degeneration of the torn tendons was greater among patients who underwent ARCR with SCR.

## **Comparison of Clinical and Radiographic Outcomes of Vertical Simple Stitch Versus Modified Mason-Allen Stitch in Arthroscopic Bankart Repairs: A Prospective Randomized Controlled Study**

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First Published December 31, 2018; pp. 398–407

<https://doi.org/10.1177/0363546518816679>

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### **Background**

In spite of the probable advantages of Bankart repair with modified Mason-Allen technique, there has been no study to evaluate the clinical outcomes of the modified Mason-Allen technique for Bankart repair.

### **Purpose**

To prospectively compare the anatomic and clinical outcomes between the vertical simple stitch and the modified Mason-Allen stitch with respect to the labral height, retear rate, redislocation/apprehension, and various functional outcome scores.

### **Study Design**

Randomized controlled trial; Level of evidence, 2.

### **Methods**

Patients who underwent arthroscopic Bankart repair with double-loaded suture anchors were randomly allocated to 1 of 2 groups: the vertical simple stitch method (SS; n = 45) or the Bankart repair using modified Mason-Allen technique (BRUMA; n = 41). All patients underwent computed tomography arthrography at 6 months postoperatively and various functional outcome measurements at least 2 years postoperatively. The labral height and width at the 3-, 4-, and 5-o'clock positions were measured preoperatively and at 6 months after surgery on axial computed tomography arthrography; the redislocation/apprehension rate, the retear rate, and various functional outcome scores were evaluated at each follow-up visit.

### **Results**

Postoperative labral height and width were significantly increased at all locations (all  $P < .001$ ) in both groups, but they were not statistically different between groups (all  $P > .05$ ). Two patients in the SS group (4.4%) and 2 in the BRUMA group (4.9%) experienced redislocation after surgery, and 4 patients in the SS group (8.9%) and 2 in the BRUMA group (4.9%) group showed apprehension after surgery. Additionally, 5 patients in the SS group (11.1%) and 2 in the BRUMA group (4.9%) showed retear at 6 months ( $P = .239$ ). There were no differences in any functional outcome scores (all  $P > .05$ ).

### **Conclusion**

There was no difference in the radiologic outcomes at 6 months and the clinical outcomes assessed at least 2 years after surgery between the groups.

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## Lower Extremity

Arthroscopy, Volume 35, Issue 2

### **Reliability of the Tönnis Classification and Its Correlation With Magnetic Resonance Imaging and Intraoperative Chondral Damage**

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Arthroscopy, Volume 35, Issue 2, Received: April 4, 2018; Accepted: August 8, 2018

<https://doi.org/10.1016/j.arthro.2018.08.036>

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#### **Purpose**

To evaluate the reliability of the Tönnis classification in the setting of femoroacetabular impingement (FAI) hips without dysplasia.

#### **Methods**

Forty-nine patients with FAI underwent preoperative radiography and magnetic resonance imaging (MRI). Radiographs were evaluated in 2 separate settings by 5 observers and graded according to the Tönnis classification. Interobserver and intraobserver reliability was calculated using the  $\kappa$  coefficient. Intraoperative chondral damage was assessed, and chondral damage to the acetabulum (acetabular labrum articular disruption [ALAD] classification) and to the femur (Outerbridge classification) was graded. The Spearman coefficient was computed to quantify the degree of correlation between the Tönnis grade and MRI-detected chondral damage, as well as intraoperative chondral damage.

#### **Results**

The average intraobserver reliability of the Tönnis classification was moderate ( $\kappa = 0.472$ ), and the interobserver reliability was fair ( $\kappa = 0.287$ ). Statistically significant positive correlations were found between the Tönnis classification and the ALAD classification ( $P = .0087$ ) and between the Tönnis classification and femoral chondral damage detected by MRI ( $P = .0247$ ). A statistically significant correlation was not found between the Tönnis grade and the intraoperative Outerbridge classification of the femur ( $P = .4969$ ), between the Tönnis grade and acetabular chondral damage on MRI ( $P = .4969$ ), or between the Tönnis grade and the ability to detect a chondral flap on MRI ( $P = .2160$ ). No statistically significant correlation was found between the ALAD classification and the presence or absence of a chondral flap on MRI ( $P = .3538$ ), between the ALAD classification and MRI-detected chondral damage to the acetabulum ( $P = .103$ ), or between the Outerbridge classification and the degree of chondral damage observed on MRI of the femur ( $P = .1922$ ).

#### **Conclusions**

The Tönnis classification and MRI have substantial limitations when evaluating nondysplastic hips with FAI for the degree of chondral damage and arthritis.

#### **Level of Evidence**

Level III, retrospective comparative study of prospective data.

[BACK](#)

## **Minimal Clinically Important Difference and Substantial Clinical Benefit Values for the 12-Item International Hip Outcome Tool**

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Arthroscopy, Volume 35, Issue 2, Received: June 4, 2018; Accepted: September 7, 2018

<https://doi.org/10.1016/j.arthro.2018.09.028>

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### **Purpose**

To define minimal clinically important difference (MCID) and substantial clinical benefit (SCB) values for the 12-item International Hip Outcome Tool (iHOT-12) in patients undergoing hip arthroscopy for intra-articular pathology.

### **Methods**

This was a retrospective review of prospectively collected data on patients who underwent hip arthroscopy. On initial assessment and follow-up between 335 and 395 days after surgery, subjects completed the iHOT-12 and a categorical self-rating of function (severely abnormal, abnormal, nearly normal, or normal). One-half the standard deviation (SD) of the change in 1-year iHOT-12 scores was used to calculate the MCID. Receiver operator characteristic analysis was performed to determine SCB values. A change in SCB value was determined based on an improvement in the categorical rating of function. Absolute postoperative SCB scores were calculated to determine scores that would be associated with normal function ratings or with abnormal or severely abnormal function ratings.

### **Results**

Of 1,034 eligible patients, 733 (71%) met the inclusion criteria. The subjects consisted of 537 female patients (73%) and 196 male patients (27%), with a mean age of 35.3 years (SD, 13 years). At a mean of 352 days (SD, 21 days) after surgery, 536 patients (73%) were in the "improved" group and 197 (27%) were in the "not improved" group. The MCID was 13 points. An SCB change score of 28 points was able to identify patients who improved with high sensitivity (0.79) and specificity (0.72). Scores of 86 points or greater and 56 points or less were the cutoff values found to identify subjects who rated their function as normal and abnormal, respectively, with high sensitivity (0.74 and 0.90, respectively) and specificity (0.82 and 0.86, respectively).

### **Conclusions**

This study provides information to help interpret iHOT-12 scores for a follow-up period ranging between 335 and 395 days with MCID and SCB values of 13 and 28 points, respectively. In addition, a patient who scored 86 points or better was likely to have a normal rating of function, whereas a patient with a score of 56 points or less was likely to have an abnormal rating of function.

### **Level of Evidence**

Level III, retrospective comparative study.

## **Do Femoral Head Osteochondral Lesions Predict a Poor Outcome in Hip Arthroscopy Patients? A Matched Control Study With Minimum 5-Year Follow-Up**

Lyall Ashberg, M.D.a,b, Mary R. Close, B.S.a, Itay Perets, M.D.a,c, Edwin O. Chaharbakhshi, B.S.a,d, John P. Walsh, M.A.a,e, Mitchell R. Mohr, B.S.a, Benjamin G. Domb, M.D.

Arthroscopy, Volume 35, Issue 2, Received: October 30, 2017; Accepted: August 22, 2018

<https://doi.org/10.1016/j.arthro.2018.08.053>

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### **Purpose**

To determine whether the presence of femoral head (FH) lesions affects patient-reported outcomes (PROs) of patients undergoing hip arthroscopy for labral tears.

### **Methods**

Data were prospectively collected and retrospectively reviewed for all patients who underwent hip arthroscopy for labral tears at our institution from April 2008 to March 2011. Patients with FH lesions were matched to those without (control) for age, body mass index, sex, and lateral center-edge angle. The inclusion criteria were FH lesions, labral tears, and minimum 5-year follow-up. The exclusion criteria were previous hip surgery, prior hip conditions, inflammatory arthritis, Workers' Compensation claims, and Tönnis grade greater than 1. PRO scores, including the modified Harris Hip Score, Non-Arthritic Hip Score, and Hip Outcome Score–Sports Specific Subscale, were collected preoperatively and postoperatively. Visual analog scale (VAS) scores for pain and patient satisfaction were recorded.

### **Results**

We matched 96 hips with FH lesions to 96 control hips. The FH group had slightly longer follow-up (71.4 months vs 67 months,  $P = .004$ ). Patients with FH lesions tended to have higher-grade acetabular lesions (grade 4 acetabular labrum articular disruption and Outerbridge grade 4 acetabular lesions). All PRO scores, VAS scores, and patient satisfaction ratings were statistically improved at latest follow-up in both groups. No statistical difference in improvement ( $\Delta$ PRO and  $\Delta$ VAS scores) was noted between groups. However, patients with FH lesions had a higher rate of conversion to arthroplasty (32% vs 16%,  $P = .0027$ ). Patients in the control group underwent more secondary arthroscopies (14% vs 5%,  $P = .05$ ).

### **Conclusions**

Finding an FH chondral lesion at arthroscopy does not necessarily portend a worse clinical outcome or conversion to total hip arthroplasty, when controlling for other variables. Patients with FH lesions were, however, found to have worse intra-articular hip pathology. When combined with these factors, patients with FH lesions had lower outcome scores and double the rate of conversion to arthroplasty than patients without them.

### **Level of Evidence**

Level III, case-control study.

## **Clinical Outcomes After Hip Arthroscopy for Patients With Rheumatoid Arthritis: A Matched-Pair Control Study With Minimum 2-Year Follow-Up**

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Arthroscopy, Volume 35, Issue 2, Received: October 30, 2017; Accepted: August 22, 2018

<https://doi.org/10.1016/j.arthro.2018.08.054>

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### **Purpose**

This study analyzed minimum 2-year hip arthroscopy outcomes in rheumatoid arthritis (RA) patients and non-RA control patients. It also examined whether disease-modifying antirheumatic drugs (DMARDs) affected RA patient outcomes. We hypothesized that patients with RA undergoing hip arthroscopy would have lower reported outcome scores.

### **Methods**

Data were prospectively collected on all hip arthroscopies performed from 2009-2013. The indications for surgery were patients with hip pain and with physical examination and imaging studies confirming intra-articular pathology in whom conservative management had failed. The exclusion criteria were previous ipsilateral hip conditions and Tönnis grade greater than 1. Patients with at least 2 years of follow-up and preoperative RA diagnoses were matched (1:2 ratio) to controls without RA (based on age  $\pm$  5 years, body mass index  $\pm$  5, and lateral center-edge angle [18°-25°, 26°-39°, or >39°]). RA cases were further analyzed based on DMARD use. Patient-reported outcome (PRO) scores were collected preoperatively and postoperatively at 3 months, as well as annually thereafter. The outcomes collected included the modified Harris Hip Score, Non-Arthritic Hip Score, Hip Outcome Score—Sports Specific Subscale, visual analog scale (VAS) score for pain, satisfaction rating, future procedures, and complications.

### **Results**

We matched 26 hips in 20 RA patients to a control group of 52 hips in 52 patients. At a minimum of 2 years of follow-up, RA patients reported no significant improvements except in the Non-Arthritic Hip Score, whereas the control group significantly improved in all PRO and VAS scores. Preoperative PRO and VAS scores between the RA and control groups were not significantly different, but postoperatively, all scores were lower in RA patients at a minimum of 2 years, whether they were taking DMARDs or not. Patients taking DMARDs showed slightly more improvement in PRO and VAS scores. There was a greater trend toward more secondary arthroscopy procedures for RA patients (19.2% vs 7.7%,  $P = .47$ ), but total hip arthroplasty rates were similar. Complication rates were low in both groups.

### **Conclusions**

Patients undergoing hip arthroscopy who have a diagnosis of RA had less improvement in PRO and VAS scores and were less satisfied than a matched control group of patients without RA at a minimum 2-year follow-up. Patients who were taking DMARDs had slightly better improvement in their PRO and VAS scores than nonmedicated patients. With this early follow-up, we could not show a difference in the rate of conversion to total hip arthroplasty, although RA patients required more revision arthroscopies than controls. Patients with a diagnosis of RA who undergo hip arthroscopy should be counseled about the potential for lesser degrees of postoperative improvement and should have their expectations managed accordingly.

### **Level of Evidence**

Level III, comparative trial.

[BACK](#)

## **Outcomes of Hip Arthroscopy in Patients With Previous Lumbar Spine Surgery: A Matched-Pair Controlled Comparative Study With Minimum Two-Year Follow-Up**

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Arthroscopy, Volume 35, Issue 2, Received: June 26, 2018; Accepted: September 3, 2018

<https://doi.org/10.1016/j.arthro.2018.09.007>

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### **Purpose**

The purpose of this study was to conduct a matched-pair analysis to determine the effect of prior lumbar spine surgery (LSS) on clinical outcomes of hip arthroscopy.

### **Methods**

Data were prospectively collected on all patients undergoing hip arthroscopy during the study period from April 2008 to December 2012. Patients were excluded if they had previous hip conditions or had undergone prior hip surgery. Patients in the LSS group (history of LSS) were matched in a 1:1 ratio to a control group (no history of LSS) according to age  $\pm$ 5 years, gender, body mass index categories, Tönnis grade, and labral treatment. The following outcomes were recorded in each group: modified Harris Hip Score, Non-Arthritic Hip Score (NAHS), Hip Outcome Score–Sports Specific Subscale, Hip Outcome Score–Activities of Daily Living, and visual analogue scale (VAS) score for pain, patient satisfaction, and rates for revision hip arthroscopies and conversion to total hip arthroplasty (THA).

### **Results**

During the study period, 1,405 hip arthroscopies were performed with 1,017 eligible for matching. A total of 873 (85.8%) patients had a minimum 2-year follow-up. Fifty-seven patients were matched in each group. Both groups demonstrated significant improvement in patient-reported outcome (PRO) and VAS scores. The LSS group had a lower mean for all preoperative PRO scores. There was no significant difference for the postoperative mean PRO score and change in the PRO score compared with the control group except for NAHS. The mean change in the NAHS demonstrated a greater magnitude of improvement in the LSS group. There was no significant difference between mean VAS scores, patient satisfaction, and rates for revision arthroscopy and conversion to THA between the groups.

### **Conclusions**

Prior LSS does not adversely affect outcomes of hip arthroscopy at a minimum 2-year follow-up. These patients have lower preoperative scores but similar magnitude of improvement and revision/THA rates compared with a matched comparative group of patients without prior LSS.

### **Level of Evidence**

Level II, retrospective analysis of prospectively collected data.

## Prescription Opioid Use Before and After Hip Arthroscopy: A Caution to Prescribers

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Arthroscopy, Volume 35, Issue 2, Received: April 27, 2018; Accepted: August 18, 2018

<https://doi.org/10.1016/j.arthro.2018.08.056>

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### Purpose

To determine pre- and postoperative opioid utilization while identifying risk factors for prolonged postoperative opioid use following hip arthroscopy.

### Methods

All patients undergoing hip arthroscopy between 2007 and the second quarter of 2016 were identified within the Humana Inc. administrative claims database. Chronic preoperative opioid utilization was defined as filling of any opioid prescription 1 to 3 months before surgery, whereas acute preoperative opioid utilization was defined as filling any opioid prescription within 1 month of surgery. Rates of pre- and postoperative opioid utilization were calculated, and patient demographic characteristics and medical conditions associated with pre- and postoperative opioid utilization were identified.

### Results

Of the 1,208 patients undergoing hip arthroscopy, chronic and acute preoperative opioid utilization was observed in 24.9% and 17.3% of patients, respectively. Chronic preoperative opioid utilization was more frequently observed in obese ( $P < .001$ ) patients, those  $\geq 50$  years of age ( $P = .002$ ), and those with preexisting anxiety and/or depression ( $P < .001$ ). In multivariate analysis, chronic preoperative opioid utilization was the strongest predictor of opioid prescription filling at 3, 6, 9, and 12 months postoperatively (odds ratio at 3 months, 18.60, 95% confidence interval, 12.41 to 28.55), whereas preexisting anxiety and/or depression and obesity were additionally identified as predictors of prolonged postoperative opioid utilization.

### Conclusions

Chronic preoperative opioid utilization before hip arthroscopy is common at 24.9%. The high rate of chronic preoperative opioid utilization is particularly important considering that chronic preoperative opioid utilization is the strongest predictor of continued postoperative opioid prescription filling out to 12 months postoperatively.

### Level of Evidence

Level IV, retrospective case series.

## **Hip Arthroscopy for Femoroacetabular Impingement Improves Sleep Quality Postoperatively**

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Arthroscopy, Volume 35, Issue 2, Received: March 23, 2018; Accepted: September 26, 2018

<https://doi.org/10.1016/j.arthro.2018.09.021>

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### **Purpose**

To describe the prevalence of abnormal sleep quality in patients with femoroacetabular impingement syndrome and to determine whether arthroscopic hip preservation surgery with cam/pincer correction, labral preservation, and capsular plication can improve sleep quality postoperatively.

### **Methods**

All patients undergoing primary hip arthroscopy for cam/pincer correction who failed nonoperative management between March 1, 2017, and July 1, 2017, were administered a validated sleep quality questionnaire—the Pittsburgh Sleep Quality Index (PSQI)—preoperatively and at 3, 6, 12, and 24 weeks postoperatively. Exclusion criteria included patients undergoing revision arthroscopy, gluteus medius repair, or a contralateral procedure during the follow-up period and those with known sleep disorders. A global (total) PSQI score >5 indicates poor sleep quality. The Hip Outcome Score—Activities of Daily Living, Hip Outcome Score—Sports Specific Subscale, modified Harris Hip Score, and International Hip Outcome Tool-12 were used to assess functional outcomes. A repeated measures analysis of variance with post hoc Greenhouse-Geisser and Bonferroni corrections was conducted to determine statistically significant changes in sleep patterns.

### **Results**

A total of 52 patients (94.6%) were included in the final analysis. The mean ( $\pm$  standard error) patient age was  $37.8 \pm 1.9$  years, and body mass index was  $27.6 \pm 0.7$ . Preoperatively, 49 (94.2%) of patients experienced poor sleep quality, defined as a global PSQI score >5, with a mean PSQI score of  $9.8 \pm 0.6$ . At 24 weeks postoperatively, 10 (21.7%) of patients experienced poor sleep quality with a mean PSQI score of  $2.2 \pm 0.2$ . All patients had significant improvements in all hip outcome instruments at 24 weeks postoperatively ( $P < .001$ ).

### **Conclusions**

Preoperatively, patients with femoroacetabular impingement syndrome have a high prevalence of sleep disturbance. These patients experience subsequent improvement in sleep disturbance after arthroscopic hip surgery early in the postoperative period.

### **Level of Evidence**

Level IV, case series.

## **Intra-articular Volume Reduction With Arthroscopic Plication for Capsular Laxity of the Hip: A Cadaveric Comparison of Two Surgical Techniques**

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Arthroscopy, Volume 35, Issue 2, Received: April 2, 2018; Accepted: September 26, 2018

<https://doi.org/10.1016/j.arthro.2018.09.023>

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### **Purpose**

To compare intracapsular volume reduction between interportal capsular shift and T-capsulotomy plication in a cadaveric model.

### **Methods**

Twelve pair-matched specimens were randomized into T-capsulotomy plication or interportal capsular shift. T-capsulotomy was performed using a 2-cm interportal and 2-cm bisecting, longitudinal limb to the intertrochanteric line. Plication was performed utilizing 5-mm bites on either side of the capsulotomy with arthroscopic knot tying technique standard alternating half hitches. Pair-matched interportal capsular shift specimens underwent 5-cm interportal capsulotomy, and capsular shift was performed utilizing 5 nonabsorbable sutures placed in 45° orientation at 5 mm from the capsulotomy margin. With each specimen in a position of slight flexion and adduction, a spinal needle was used to inject methylene blue-colored saline solution intra-articularly; the volcano method was used to measure capsular volume before and after each respective plication technique. Mean absolute volumes and relative volumetric reduction for each technique were quantified and compared to determine statistical significance.

### **Results**

At baseline, there were no statistically significant differences in capsular volume between pair-matched specimens (T-capsulotomy plication, 42.5 ± 5.1 mL; interportal capsular shift, 45.0 ± 88.6 mL;  $P = .555$ ). After capsulotomy and secondary plication, both the T-capsulotomy (post: mean = 32.5 ± 8.0 mL;  $P < .001$ ) and interportal capsulotomy groups (post: mean = 29.4 ± 10.0;  $P < .0001$ ) demonstrated significant decreases in capsular volume, with average reductions of 10.0 ± 3.3 mL and 15.6 ± 3.2 mL, respectively. Although the interportal capsular shift (35.9% ± 11.3%) demonstrated greater volumetric reduction relative to baseline when compared with the T-capsular plication (24.5% ± 10.8%), these results were not significant ( $P = .104$ ).

### **Conclusions**

Both T-capsular plication and interportal capsular shift produce statistically significant reductions in overall hip capsular volume. Although the interportal capsular shift may generate modestly higher degrees of capsular reduction, the comparative biomechanical repercussions of each technique are not currently known.

### **Clinical Relevance**

Irrespective of arthroscopic technique, capsular plication with 5-mm bites decreases capsular volume by approximately one-third to one-fourth that of baseline measures.

## **Arthroscopic Reconstruction of the Irreparable Acetabular Labrum: A Match-controlled Study**

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Arthroscopy, Volume 35, Issue 2, Received: August 22, 2017; Accepted: September 27, 2018

<https://doi.org/10.1016/j.arthro.2018.09.024>

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### **Purpose**

To report clinical outcomes of arthroscopic labral reconstruction in the hip at minimum 2-year follow-up in comparison to a pair-matched labral repair group.

### **Methods**

Patients were included in this study if they underwent labral reconstruction during hip arthroscopy and had minimum 2-year follow-up data available. Exclusion criteria were active workers' compensation claims or previous ipsilateral hip surgery or conditions. Reconstruction patients were matched 1:2 to patients that underwent arthroscopic labral repair but otherwise met all inclusion and exclusion criteria. Matching criteria were age within 5 years, sex, body mass index within 5, same capsular treatment, and whether there was chondral damage of Outerbridge grade II or greater. Three patient-reported outcome (PRO) measures and visual analog scale (VAS) for pain were recorded preoperatively and at a minimum of 2 years postoperatively. International Hip Outcome Tool and patient satisfaction were also collected at latest follow-up.

### **Results**

Thirty-four reconstruction patients were matched to 68 repair patients. There were no significant differences in age ( $P = .941$ ), sex ( $P > .999$ ), body mass index ( $P = .935$ ), or any other demographics between groups. A statistically significant increase was seen in PROs for both the reconstruction group (Modified Harris Hip Score,  $P = .002$ ; Hip Outcome Score - Sports Subscale,  $P < .001$ ; Non-arthritic Hip Score,  $P < .001$ ) and the repair group (Modified Harris Hip Score,  $P < .001$ ; Hip Outcome Score - Sports Subscale,  $P < .001$ ; Non-arthritic Hip Score,  $P < .001$ ) at minimum 2-year follow-up. Significant decrease was shown for VAS for both groups (reconstruction VAS,  $P < .001$ ; repair,  $P < .001$ ) at minimum 2-year follow-up. There were no significant differences in rates of postoperative complications ( $P > .999$ ), secondary arthroscopy ( $P > .999$ ), or conversion to total hip arthroplasty ( $P = .728$ ) between groups.

### **Conclusions**

Arthroscopic labral reconstruction is associated with significant improvement in PROs and a low incidence of secondary surgery within 2-year follow-up. Improvements in PROs, VAS, patient satisfaction, and incidence of secondary procedures were comparable to a match control treated with labral repair. Although there were no differences shown in the 2 groups with respect to complication rate, secondary arthroscopy, or conversion to total hip arthroplasty, the study was not powered to compare these outcome parameters. Based on this evidence, either labral repair or reconstruction may be selected depending upon the clinical scenario.

### **Level of Evidence**

Level III; retrospective comparative study.

[BACK](#)

## **Preoperative and Intraoperative Predictors of Long-Term Acceptable Knee Function and Osteoarthritis After Anterior Cruciate Ligament Reconstruction: An Analysis Based on 2 Randomized Controlled Trials**

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Arthroscopy, Volume 35, Issue 2, Received: December 17, 2017; Accepted: July 5, 2018

<https://doi.org/10.1016/j.arthro.2018.07.009>

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### **Purpose**

To determine preoperative predictors of long-term acceptable knee function and the development of osteoarthritis (OA) in long-term follow-up after anterior cruciate ligament (ACL) reconstruction.

### **Methods**

This study is a long-term follow-up of 2 previous randomized controlled trials that included 193 patients who underwent unilateral ACL reconstruction with ipsilateral hamstring tendon or patellar tendon autografts. Patients who suffered multiligament injuries, major meniscal injuries, chondral lesions requiring surgical treatment, or had a previous ACL reconstruction were excluded. Patient demographics, preoperative clinical assessments, and intraoperative findings were used to create stepwise multivariable regression models to determine the patient-acceptable symptom state (PASS) in the International Knee Documentation Committee and the development of OA defined as a Kellgren-Lawrence grade  $\geq 2$ . Knee laxity measurements, hop performance, patient-reported outcome, and concomitant injuries were determined as variables.

### **Results**

A total of 147 patients (63.7% men) were eligible for inclusion, with a mean follow-up of  $16.4 \pm 1.3$  years. The patients were an average age of  $27.9 \pm 8.3$  years at the time of ACL reconstruction. One-half of the cohort reported an International Knee Documentation Committee evaluation system score above the PASS cutoff. The presence of a concomitant injury at operation (odds ratio [OR], 2.61; 95% confidence interval [CI], 1.10-6.21;  $P = .030$ ) and greater preoperative anteroposterior laxity (OR, 1.87; 95% CI, 1.05-3.35;  $P = .034$ ) increased the likelihood of achieving a PASS. A longer period between ACL injury and reconstruction (OR, 2.25; 95% CI, 1.02-5.00;  $P = .046$ ) and older age at reconstruction (OR, 2.28; 95% CI, 1.34-3.86;  $P = .0023$ ) increased the odds of developing OA at follow-up.

### **Conclusions**

Patients who were older at the time of ACL reconstruction and had waited  $>1$  year between the injury and reconstruction ran an increased risk of having OA 16 years after reconstruction. One in 2 patients reported acceptable long-term knee function, but no risk factor for poorer subjective knee function was identified. Patients who had a minor concomitant injury and increased preoperative anteroposterior knee laxity had increased odds of reporting an acceptable long-term knee function.

### **Level of Evidence**

Level II; prospective comparative study.

[BACK](#)

## **The Fate of the Contralateral Knee in Patients With a Lateral Discoid Meniscus**

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Arthroscopy, Volume 35, Issue 2, Received: March 12, 2018; Accepted: July 30, 2018

<https://doi.org/10.1016/j.arthro.2018.07.045>

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### **Purpose**

To analyze the survivorship of the lateral meniscus (LM) in the contralateral knee after surgery for symptomatic torn discoid lateral meniscus (DLM) and to determine its associated factors.

### **Methods**

Two hundred ninety-six patients who underwent arthroscopic meniscectomy for torn symptomatic DLM were reviewed retrospectively. Patients were classified into subgroups based on demographic, clinical, and radiologic variables. The survivorship analysis of the LM on the contralateral knee was calculated using the Kaplan-Meier method, and comparison among the subgroups was conducted using the log-rank test. The predicted prognostic factors associated with survivorship were determined using Cox proportional hazard regression analysis.

### **Results**

Of the 296 patients, 51 (17%) had arthroscopic surgery in the contralateral knee during the study period. The group  $\geq 40$  years old had significantly worse survival than the group  $< 40$  (log-rank test,  $P < .001$ ). In terms of radiologic variables, the group with Kellgren-Lawrence grade 3 or 4 had significantly poorer survivorship than that with grade 1 or 2 (log-rank test,  $P = .045$ ). Age  $\geq 40$  years was associated with poorer survivorship (hazard ratio, 3.235; 95% confidence interval, 1.782-5.875;  $P < .001$ ). Kellgren-Lawrence grades 3 and 4 in the contralateral knee were associated with poorer survival (hazard ratio, 2.071; 95% confidence interval, 1.061-4.043;  $P = .033$ ). The cumulative survival rate at 10 years of the LM in the contralateral knee after surgery for symptomatic torn DLM was 81%.

### **Conclusions**

Patients with a lateral discoid meniscus have a risk of a similar condition in the contralateral knee. Increased risks of symptomatology are associated with age and degenerative changes.

### **Level of Evidence**

Level IV, retrospective uncontrolled case series.

## **Abnormal Biomechanics at 6 Months Are Associated With Cartilage Degeneration at 3 Years After Anterior Cruciate Ligament Reconstruction**

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Arthroscopy, Volume 35, Issue 2, Received: January 31, 2018; Accepted: July 20, 2018

<https://doi.org/10.1016/j.arthro.2018.07.033>

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### **Purpose**

To investigate the changes in landing biomechanics over a 3-year period and their correlation with cartilage degenerative changes in the medial tibiofemoral joint of the knee after anterior cruciate ligament reconstruction (ACLR) using magnetic resonance T1 $\rho$  mapping.

### **Methods**

Thirty-one anterior cruciate ligament–injured patients underwent magnetic resonance imaging of the injured knee before ACLR and 3 years after ACLR, as well as biomechanical analysis of a drop-landing task at 6 months and 3 years after ACLR. Sixteen healthy individuals were recruited and underwent knee magnetic resonance imaging and biomechanical assessment during a drop-landing task. T1 $\rho$  cartilage relaxation times were calculated for the medial femur and tibia.

### **Results**

ACLR patients exhibited increased peak vertical ground reaction force (VGRF), VGRF impulse, peak knee flexion moment (KFM), and KFM impulse from 6 months to 3 years ( $P < .001$  for each). Although the ACLR knees showed significantly lower peak VGRF and KFM at 6 months ( $P < .001$  for both) when compared with the controls, there were no significant differences at 3 years. At 3 years, ACLR patients showed higher T1 $\rho$  values over the medial femur ( $P < .001$ ) and tibia ( $P = .012$ ) when compared with their preoperative values and with healthy control values. Within the ACLR group, side-to-side differences in peak VGRF and sagittal knee biomechanics at 6 months were associated with increased T1 $\rho$  values from baseline to 3 years.

### **Conclusions**

The results of this longitudinal study show that landing biomechanics are altered after ACLR but biomechanical abnormalities tend to recover at 3 years after ACLR. Differences in lower-extremity mechanics during a landing task at 6 months may be associated with cartilage degeneration at 3 years after anterior cruciate ligament injury and reconstruction.

### **Level of Evidence**

Level II, prospective trial.

## **Assessment of Anterolateral Complex Injuries by Magnetic Resonance Imaging in Patients With Acute Rupture of the Anterior Cruciate Ligament**

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Arthroscopy, Volume 35, Issue 2, Received: January 19, 2018; Accepted: August 8, 2018

<https://doi.org/10.1016/j.arthro.2018.08.032>

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### **Purpose**

To assess anterolateral complex (ALC) injuries in patients with acute anterior cruciate ligament (ACL) rupture on magnetic resonance imaging (MRI).

### **Methods**

Patients with acute ACL rupture who underwent ACL surgery between 2015 and 2017 and underwent MRI within 6 weeks of the initial trauma were included. Two radiologists assessed magnetic resonance images retrospectively for the status of the ALC, including the iliotibial band (ITB), Kaplan fibers, and anterolateral ligament (ALL), as follows: grade 0, normal; grade 1, periligamentous edema; grade 2, partial tear; and grade 3, complete tear. The findings were analyzed using the Friedman test and weighted  $\kappa$  values.

### **Results**

Sixty-nine MRI scans were reviewed. Of the 69 patients, 51% had associated injuries to the ITB (grade 1,  $n = 31$ ; grade 2,  $n = 4$ ), 33% had associated injuries to the Kaplan fibers (grade 1,  $n = 21$ ; grade 2,  $n = 2$ ), and 57% had associated injuries to the ALL (grade 1,  $n = 12$ ; grade 2,  $n = 22$ ; grade 3,  $n = 5$ ). We found a significant difference in the frequency and grading between ITB, Kaplan fiber, and ALL injuries ( $P \leq .032$ ). Inter-reader agreement for assessing the ALC on MRI was almost perfect ( $\kappa \geq 0.922$ ).

### **Conclusions**

On the basis of MRI analysis, ALL injuries were found with varying degrees of severity and intensity with noted injuries to associated surrounding fibers in patients with acute ACL rupture.

### **Level of Evidence**

Level IV, case series.

## **Hamstring Autograft Too Small: How Much Allograft Do You Need to Supplement to a Desired Hybrid Graft Size?**

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Arthroscopy, Volume 35, Issue 2, Received: April 27, 2018; Accepted: August 9, 2018

<https://doi.org/10.1016/j.arthro.2018.08.037>

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### **Purpose**

To determine a simple rule for choosing supplemental allograft size for hybrid anterior cruciate ligament reconstruction using mathematical and cadaveric models.

### **Methods**

Mathematical and cadaveric models were used to determine the rule. The mathematical model required application of the geometric Pythagorean theorem to add areas of circles. Cadaveric semitendinosus and gracilis tendons were combined in multiple quadrupled hamstring size combinations and then sized using standard surgical techniques to confirm the mathematical model.

### **Results**

Geometric measurement, not simple addition, of graft diameters was required to determine the final graft size. Direct comparison of cadaveric and mathematical models showed close relations. If a final graft size of 7 mm is desired, an added diameter of all grafts of approximately 9.5 mm is needed. If a final graft size of 8 mm is desired, an added diameter of all grafts of approximately 11 mm is needed. If a final graft size of 9 mm is desired, an added diameter of all grafts of approximately 12.5 mm is needed. If a final graft size of 10 mm is desired, an added graft diameter of approximately 14 mm is needed. Cadaveric hamstring measurements were similar to the mathematical model.

### **Conclusions**

By use of mathematical and cadaveric models, simple rules for determining the additional size of allograft diameter needed to supplement undersized hamstring autograft were created.

### **Clinical Relevance**

With the increasing availability of allograft types and sizes, surgeons currently have no guidelines on the size of allograft that is required to supplement an undersized hamstring autograft. Simple rules were created for determining the amount of allograft supplementation required for undersized hamstrings and are easily applied to clinical situations.

## **The Recurrent Instability of the Patella Score: A Statistically Based Model for Prediction of Long-Term Recurrence Risk After First-Time Dislocation**

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Arthroscopy, Volume 35, Issue 2, Received: May 16, 2018; Accepted: September 14, 2018

<https://doi.org/10.1016/j.arthro.2018.09.017>

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### **Purpose**

To describe the clinical history of a series of primary, lateral patellar dislocations and determine long-term predictors of recurrent instability while accounting for patients undergoing early operative management.

### **Methods**

A large geographic database of more than 500,000 patients was used to identify patients who sustained a first-time lateral patellar dislocation between 1990 and 2010. Charts were individually reviewed to document demographics, radiographic measures including tibial tubercle to trochlear groove distance (TT-TG) and patellar length (PL), recurrent episodes of instability, and patellar stabilization surgery. A risk score that accounted for early surgical management was calculated using Fine and Gray competing risk regression, and its ability to stratify patients was examined using cumulative incidence curves.

### **Results**

Eighty-one patients (mean age  $19.9 \pm 9.4$  years, 38 male, 43 female) were identified and followed for a mean of 10.1 years (range 4.1-20.2). Thirty-eight patients (46.9%) experienced an episode of recurrent instability and 30 (37.0%) underwent patellar stabilization surgery, including 7 who did so before recurrent dislocation. A multivariate, statistically derived scoring system, the Recurrent Instability of the Patella Score (RIP Score), that employed age, skeletal maturity, trochlear dysplasia, and TT-TG/PL ratio to predict recurrent instability while accounting for patients managed surgically, was generated. The resulting RIP score stratified patients into low-, intermediate-, and high-risk categories, with 0.0%, 30.6%, and 79.2% 10-year recurrent instability rates, respectively ( $P = .000004$ ), and an area under the curve of 0.875 ( $P = .00002$ ).

### **Conclusions**

Patients who sustain a first-time, lateral patellar dislocation can be readily classified into low-, intermediate-, and high-risk categories employing the RIP score based on age, skeletal maturity, trochlear dysplasia, and TT-TG/PL ratio. This long-term risk stratification holds significant potential clinical utility for determination of patients who are at high risk for recurrent instability after primary patellar dislocation.

### **Level of Evidence**

Level III, retrospective comparative study.

## **Comparison of Tunnel Enlargement and Clinical Outcome Between Bioabsorbable Interference Screws and Cortical Button-Post Fixation in Arthroscopic Double-Bundle Anterior Cruciate Ligament Reconstruction: A Prospective, Randomized Study With a Minimum Follow-Up of 2 Years**

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Arthroscopy, Volume 35, Issue 2

<https://doi.org/10.1016/j.arthro.2018.08.039>

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### **Purpose**

To investigate the tunnel enlargement rate and clinical function by comparing double-bundle anterior cruciate ligament reconstruction (ACLR) using different fixation devices.

### **Methods**

Patients receiving primary arthroscopic double-bundle ACLR were screened and divided into 2 groups on the basis of the method of graft fixation: bioabsorbable interference screw (BS) group and cortical button (CB) group. Bone tunnel size was assessed digitally using magnetic resonance imaging, which was performed a minimum of 2 years postoperatively. Clinical evaluations were performed using the Knee Injury and Osteoarthritis Outcome Score, International Knee Documentation Committee score, and KT-1000 arthrometer 2 years postoperatively.

### **Results**

Sixty patients receiving primary arthroscopic double-bundle ACLR were included. Overall, the BS group showed greater tunnel enlargement than the CB group, as well as a significantly increased rate of tunnel communication ( $P = .029$ ). The average anteromedial tunnel enlargement rates for the BS and CB groups were 50% and 28%, respectively. The enlargement rate of the posterolateral (PL) femoral tunnel was similar in both groups. In the PL tibial tunnel, the CB group showed a significant increase in enlargement compared with the BS group (64% vs 45%,  $P = .0001$ ). Both groups showed functional improvement in the Knee Injury and Osteoarthritis Outcome Score and International Knee Documentation Committee score. No significant difference in postoperative functional outcomes was found between the 2 groups.

### **Conclusions**

The BS group showed significantly greater tunnel enlargement in anteromedial tunnels and an increased tunnel communication rate compared with the CB group. On the other hand, the CB group showed greater tunnel enlargement in tibial PL tunnels. Tunnel communication was observed mostly on the tibial side in the BS patients. Equivalent clinical function outcomes were noted at 2 years after surgery in both groups of patients.

### **Level of Evidence**

Level II, randomized controlled clinical trial.

[BACK](#)

## **Cost-Effectiveness Analysis of Needle Arthroscopy Versus Magnetic Resonance Imaging in the Diagnosis and Treatment of Meniscal Tears of the Knee**

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Arthroscopy, Volume 35, Issue 2, Received: June 13, 2018; Accepted: September 7, 2018

<https://doi.org/10.1016/j.arthro.2018.09.030>

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### **Purpose**

To determine whether needle arthroscopy (NA) compared with magnetic resonance imaging (MRI) in the diagnosis and treatment of meniscal tears is cost-effective when evaluated over a 2-year period via patient-reported outcomes. The hypothesis is that improved diagnostic accuracy with NA would lead to less costly care and similar outcomes.

### **Methods**

A Markov model/decision tree analysis was performed using TreeAge Pro 2017 software. Patients were evaluated for degenerative and traumatic damage to the lateral/medial meniscus. Assumed sensitivities and specificities were derived from the medical literature. The direct costs for care were derived from the 2017 Medicare fee schedule and from private payer reimbursement rates. Costs for care included procedures performed for false-positive findings and for care for false-negative findings. Effectiveness was examined using the global knee injury and osteoarthritis outcome score (KOOS). Patients were evaluated over 2 years for costs and outcomes, including complications. Dominance and incremental cost-effectiveness were evaluated, and 1- to 2-way sensitivity analysis was performed to determine those variables that had the greatest effect. The consolidated economics evaluation and reporting standards checklist for reporting economic evaluations was used.

### **Results**

NA was less costly and had similar KOOS versus MRI for both the medial/lateral meniscus with private pay. Costs were less for both Medicare and private pay for medial meniscus, \$780 to \$1,862, and lateral meniscus, \$314 to \$1,256, respectively.

### **Conclusions**

Based on the reported MRI incidence of false positives with the medial meniscus and false negatives with the lateral meniscus and based on assumed standards of care, more costly care is provided when using MRI compared with NA. Outcomes were similar with NA compared with MRI.

### **Level of Evidence**

Level II, economic and decision analysis.

## **Anteromedial Tibial Tubercle Osteotomy Improves Results of Medial Patellofemoral Ligament Reconstruction for Recurrent Patellar Instability in Patients With Tibial Tuberosity–Trochlear Groove Distance of 17 to 20 mm**

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Arthroscopy, Volume 35, Issue 2, Received: June 6, 2018; Accepted: October 21, 2018

<https://doi.org/10.1016/j.arthro.2018.10.109>

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### **Purpose**

To compare the midterm clinical outcomes of anteromedialization tibial tubercle osteotomy combined with medial patellofemoral ligament reconstruction (TTO+MPFLR) with MPFLR alone (MPFLRa) for the treatment of recurrent patellar instability (RPI) in patients with a tibial tuberosity–trochlear groove (TT-TG) of 17 to 20 mm.

### **Methods**

From January 2008 to August 2013, patients with RPI and a TT-TG of 17 to 20 mm were divided into 2 groups: TTO+MPFLR or MPFLRa. Subjects were evaluated for J sign classification (1-4+); patellar glide (1-4+); the apprehension test; increased femoral anteversion; the Caton index; trochlear dysplasia; TT-TG; and Kujala, Lysholm, International Knee Documentation Committee (IKDC), and Tegner scores. Kujala improvement was the primary outcome.

### **Results**

Forty-two subjects were evaluated, 18 in the TTO+MPFLR group and 24 in the MPFLRa group. Mean follow-up time was 40.86 months (range, 24–60 months). Demographics between the groups were not different. Preoperatively, there was no statistically significant difference between groups regarding J sign classification; patellar glide; the apprehension test; increased femoral anteversion; the Caton index; trochlear dysplasia; TT-TG; and Kujala, Lysholm, IKDC, and Tegner scores. Postoperative J sign classification mean results comparing TTO+MPFLR and MPFLRa, respectively, were 1 and 1.33 ( $P = .006$ ). Improvement was significantly higher in the TTO+MPFLR group in all scores except for Tegner. Kujala improvement, 30.27 and 23.95, respectively ( $P = .003$ ), was also clinically significant, favoring TTO+MPFLR. Lysholm improvement was 40.5 and 36.2, respectively ( $P = .02$ ), and IKDC improvement was 38.59 and 31.6, respectively ( $P = .002$ ). There were no reported recurrent subluxations or dislocations in either group.

### **Conclusions**

TTO+MPFLR resulted in better functional outcome scores and patellar kinematics compared with MPFLRa in the surgical treatment of RPI in patients with a TT-TG distance of 17 to 20 mm.

### **Level of Evidence**

Level II, prospective comparative study.

## **Risk Factors for Postoperative Opioid Use in Arthroscopic Meniscal Surgery**

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Arthroscopy, Volume 35, Issue 2, Received: June 4, 2018; Accepted: October 24, 2018

<https://doi.org/10.1016/j.arthro.2018.10.122>

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### **Purpose**

(1) To evaluate the influence of preoperative opioid use on postoperative consumption after arthroscopic meniscal surgery and (2) to determine preoperative patient factors associated with increased opioid use after meniscal surgery.

### **Methods**

We performed a retrospective review of all patients with a primary diagnosis of a meniscal tear at a single institution between August 2013 and February 2017. Patients were classified as opioid nonusers if they had not received any opioid medications in the 3 months before meniscal surgery, as acute users if they received at least 1 opioid prescription within 1 month preceding meniscal surgery, or as chronic users if they received at least 1 opioid prescription within 3 months preceding meniscal surgery. Clinical records were reviewed for postoperative opioid use within a year after surgery. We also recorded patient demographic characteristics and the degree of knee osteoarthritis at the time of surgery using the Outerbridge classification.

### **Results**

A total of 735 patients were included. The average age was 46.7 years (range, 12-79 years), and the average body mass index was  $30.2 \pm 6.2$  (range, 13.3-55.4). Patients who were acute or chronic opioid users preoperatively were more likely to continue to use opioids beyond 1 month postoperatively ( $P < .001$ ). A higher percentage of patients with advanced osteoarthritis (Outerbridge grade 3 or 4) were found to continue to use opioids at all time points beyond the first postoperative month ( $P < .05$ ). Pair-wise comparisons showed that the number of total opioid prescriptions filled was significantly higher in the group with Outerbridge grade 1 or 2 and the group with Outerbridge grade 3 or 4 than the group with Outerbridge grade 0 ( $P = .023$  and  $P = .014$ , respectively). No significant difference in postoperative opioid use was noted when we compared meniscal repair versus resection, primary procedure versus revision, different tear types, or concomitant procedures.

### **Conclusions**

In patients undergoing arthroscopic meniscal surgery, the chronicity of preoperative opioid intake and degree of knee osteoarthritis were found to have a significant effect on postoperative opioid use.

### **Level of Study**

Level III, retrospective comparative study.

## **Does Prior Hip Arthroscopy Affect Outcomes of Subsequent Hip Arthroplasty? A Systematic Review**

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Arthroscopy, Volume 35, Issue 2, Received: February 2, 2018; Accepted: August 28, 2018

<https://doi.org/10.1016/j.arthro.2018.08.055>

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### **Purpose**

To compare outcomes of hip arthroplasty in patients with and without a history of hip arthroscopy through a systematic review.

### **Methods**

A comprehensive search of the PubMed (MEDLINE) and Cochrane Central databases was performed using combinations of the keywords “hip,” “arthroscopy,” “arthroscopic,” “arthroplasty,” “replacement,” and “conversion” in December 2017. Level I through III studies directly comparing outcomes of total or resurfacing hip arthroplasty between patients with and without a history of hip arthroscopy were included in this review if they reported at least 1 outcome measure.

### **Results**

Seven retrospective case-control studies collectively evaluating arthroplasty outcomes of 235 patients (104 male and 131 female patients) with a history of hip arthroscopy and 374 matched controls met the inclusion criteria. The mean age in the arthroscopy and control groups was 47.2 years and 49.1 years, respectively. The mean follow-up period after arthroplasty was 3.2 years in the hip arthroscopy group and 3.3 years in the control group. The mean time between arthroscopy and arthroplasty was 1.8 years. A posterior approach was used in 83.6% of arthroplasties. No statistically significant differences were noted in intraoperative measures, postoperative complications, or revision rates, with the exception of 1 study that reported an increased operative time among controls. Most studies reported similar subjective outcomes between groups, with a single study noting worse postoperative findings for the Harris Hip Score, Forgotten Joint Score-12, visual analog scale pain score, and patient satisfaction in the prior hip arthroscopy group.

### **Conclusions**

The current literature suggests that short-term and midterm outcomes of hip arthroplasty are comparable in patients with and without a history of hip arthroscopy. However, the available literature is limited given the small sample sizes and therefore greater potential for  $\beta$  error. Nevertheless, our findings may be useful for surgeons evaluating risks and prognoses in this patient population.

### **Level of Evidence**

Level III, systematic review of Level III studies.

[BACK](#)

## **Systematic Review of Hip Arthroscopy for Femoroacetabular Impingement: The Importance of Labral Repair and Capsular Closure**

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Arthroscopy, Volume 35, Issue 2

<https://doi.org/10.1016/j.arthro.2018.09.005>

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### **Purpose**

To evaluate the safety and efficacy of hip arthroscopy for femoroacetabular impingement syndrome by assessing complications, comprehensive procedure survivorship, and the influence of labral and capsular management on procedure survivorship.

### **Methods**

A systematic review of multiple medical databases was performed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and checklist. All clinical outcome studies that reported on the presence or absence of reoperation after hip arthroscopy for femoroacetabular impingement syndrome were eligible for inclusion. Data pertaining to patient demographic characteristics, surgical technique (specifically labral and capsular management), patient-reported outcomes, complications, reoperation, and conversion to arthroplasty were extracted from each study.

### **Results**

A total of 68 studies (7,241 hips) were included. Most were Level IV studies (63%). Complications occurred in 1.9% of cases. The most common complications were neurologic (53%), heterotopic ossification (24%), infection (15%), and thromboembolic (7%). Conversion to total hip arthroplasty (456 cases) was the most common reason for reoperation, followed by revision hip arthroscopy (226 cases) and periacetabular osteotomy (7 cases). The rate of arthroplasty conversion was lower than 10% in 43 of 59 studies reporting this outcome. The average interval to arthroplasty conversion was 58 months. Between 2009 and 2017, the performance of labral repair increased from 19% to 81% of cases and capsular closure increased from 7% to 58% of cases.

### **Conclusions**

Arthroplasty conversion occurred in fewer than 10% of cases in the clear majority of series. Labral repair (compared with labral debridement) and capsular closure (compared with unrepaired capsulotomy) were associated with a lower risk of conversion to arthroplasty. Throughout the study interval, there were shifts in surgical technique favoring labral repair over debridement and capsular repair over unrepaired capsulotomy. The study is limited by selection bias because cases in which labral and capsular repair was performed may have had superior tissue that was more amenable to repair.

### **Level of Evidence**

Level IV, systematic review.

[BACK](#)

## **Long-Term Survival Analysis and Outcomes of Meniscal Allograft Transplantation With Minimum 10-Year Follow-Up: A Systematic Review**

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Arthroscopy, Volume 35, Issue 2

<https://doi.org/10.1016/j.arthro.2018.08.031>

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### **Purpose**

To investigate the long-term survivorship rates and functional outcomes of meniscal allograft transplantation (MAT) in patients with minimum 10-year postoperative follow-up.

### **Methods**

Two reviewers independently searched EMBASE, MEDLINE, and PubMed from database inception for literature related to MAT according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist. Data are reported in a narrative summary fashion with descriptive statistics.

### **Results**

Eleven studies with a total of 658 patients and 688 MATs were included. Mean age of patients was 33.1 years (range 14-66), of whom 63% were male. Mean survivorship rates were 73.5% at 10-year and 60.3% at 15-year follow-up, with 2 studies reporting 19- and 24-year survivorship of 50% and 15.1%, respectively. Pre- and postoperative Lysholm scores ranged from 36 to 60.5 and 61 to 75, respectively. Pre- and postoperative Tegner scores ranged from 1 to 3 and 2.5 to 4.6, respectively. Postoperative Knee injury and Osteoarthritis Outcome Score subset scores were as follows: Pain: 61.6 to 76.3; Symptoms: 57.9 to 61.8; Function in Daily Living: 68.5 to 79.9; Sport and Recreation: 33.9 to 49.3; Quality of Life: 37.3 to 45.9. Postoperative International Knee Documentation Committee scores ranged from 46 to 77. Regarding surgical technique, 194 MAT bone-fixation technique (53.8%) and 165 MAT suture-only fixation techniques (46.2%) were reported. The most common type of allograft used was cryopreserved (54.5% of the allografts). The most frequent concomitant procedures performed with MAT were to address chondral (20.8% of the cases) and ligament injuries (12.4% of the cases), and realignment procedures (9.4% of the cases). The most common complications observed that were not directly related to concomitant procedures were meniscal allograft partial tears (11.1%), arthrofibrosis (3.6%), and infection (2.0%). Several criteria were used among studies to define failure of MAT, the most common parameters being removal of meniscal allograft (8/11 studies) and conversion to total knee arthroplasty (7/11 studies).

### **Conclusions**

MAT can yield good long-term survivorship rates, with 73.5% and 60.3% of allografts remaining functional after 10 and 15 years, respectively. Functional outcomes 10 years after MAT were fair and improved compared with preoperative scores.

### **Level of Evidence**

Level IV, systematic review of Level III and IV studies.

[BACK](#)

## **Anatomy of the Anterolateral Ligament of the Knee: A Systematic Review**

Diego Ariel de Lima, Camilo Partezani Helito, M.D., Ph.D.b,c, Lana Lacerda de Lima, M.D., M.S.d, Daniel de Castro Silva, M.D.e, Maria Luzete Costa Cavalcante, M.D., Ph.D.e, José Alberto Dias Leite, M.D., Ph.D

Arthroscopy, Volume 35, Issue 2, Received: May 11, 2018; Accepted: September 3, 2018

<https://doi.org/10.1016/j.arthro.2018.09.006>

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### **Purpose**

To conduct a systematic literature review to search for studies on the anatomy of the anterolateral ligament (ALL) of the knee, presenting the most accepted findings, as well as the evolution of anatomic information on this structure.

### **Methods**

We reviewed the PubMed, MEDLINE, and ClinicalKey databases for anatomic studies on the ALL, involving cadaveric, histologic, and biochemical dissection and/or anatomic imaging. The primary data researched were the presence of the ligament; measures of length, width, and thickness; ligament path; insertions; number of bands; histologic assessment; and innervation.

### **Results**

We identified 53 studies. The ALL was found in 82.87% of adult dissections (more easily visualized in fresh cadavers), 74.07% of fetal dissections, and 84.80% of magnetic resonance imaging (MRI) studies. In 29 articles, the ALL was found in 100% of cases. There are 3 ALL insertion points: femoral, tibial, and meniscal. Histologic sections showed dense, well-organized collagen fibers, with an average of 121 fibroblasts/mm<sup>2</sup> in adults, in addition to the presence of vascular and nervous tissue. MRI was shown to be a good examination tool to visualize the ALL, primarily in the coronal plane and with T2-weighted images.

### **Conclusions**

The ALL is a distinct structure in the anterolateral portion of the knee. It exhibits typical ligament characteristics and can be visualized on imaging examinations, especially MRI. It has a femoral attachment near the lateral epicondyle, with a trend in recent years showing it to be located posterior and proximal to it, following an anteroinferior trajectory, with an insertion into the lateral meniscus and proximal tibia at the midpoint between the fibular head and Gerdy tubercle. Among the studies, the length of the ALL varied from 30.41 to 59.0 mm, the width ranged between 4.0 and 7.0 mm, and the thickness ranged between 1.0 and 2.0 mm.

### **Clinical Relevance**

During the past few years, much controversy has been raised about the correct anatomy of the ALL. The main clinical relevance of this study is not only to end the discussion about the ALL's existence but also to clarify and synthesize the main evidence on the ALL's anatomy, mainly the currently most accepted attachments according to the recent literature, to enable more precise development of biomechanical settings and surgical techniques.

**Dynamic intraligamentary stabilization for ACL repair: a systematic review**

Sufian S. Ahmad, Anna J. Schreiner, Michael T. Hirschmann, Steffen Schröter, Stefan Döbele, Marc D. Ahrend, Ulrich Stöckle, Atesch Ateschrang

KSSTA, January 2019, Volume 27, Issue 1, pp 13–20

<https://doi.org/10.1007/s00167-018-5301-z>

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**Purpose**

It was the aim to assess all published original research dealing with dynamic repair of the anterior cruciate ligament (ACL) and to provide a semi-quantitative analysis of clinical outcome reports.

**Methods**

Both OVIS and MEDLINE databases were utilized for allocation of articles. All preclinical and clinical studies related to dynamic intraligamentary stabilization (DIS) were identified. Results were tabulated and semi-quantitative analysis performed.

**Results**

Twenty-three articles related to DIS were identified. The predominant level of evidence ranged between II and IV, with only one level I study. Reported failure rates ranged between 4% and 13.6%. Most clinical studies only reported revision rates without referring to failure of restoring stability. Highest success was achieved with proximal ACL ruptures. Both the level of physical activity and patient age have been found to influence the risk of failure.

**Conclusion**

There is sufficient evidence to support that DIS repair may be an effective modality for the treatment of acute proximal tears of the ACL. However, comparative studies are lacking. Upcoming studies should compare the technique to ACL reconstruction with failure as an endpoint. Comparison to rigid methods of proximal fixation is also necessary to justify the need for dynamic fixation. Overall, there is evidence to suggest the potential space for ACL repair in the decision tree for individualized treatment planning. The best outcome will be in the hands of the best patient selectors.

**Level of evidence**

IV.

## **Arthroscopic primary repair of proximal anterior cruciate ligament tears: outcomes of the first 56 consecutive patients and the role of additional internal bracing**

Anne Jonkergouw, Jelle P. van der List, Gregory S. DiFelice

KSSTA, January 2019, Volume 27, Issue 1, pp 21–28

<https://doi.org/10.1007/s00167-018-5338-z>

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### **Purpose**

Recent outcomes of arthroscopic primary repair of proximal anterior cruciate ligament (ACL) tears have been promising in small cohort studies. The purpose of this study was to assess outcomes of arthroscopic ACL repair in a larger cohort and to assess the role of additional augmentation.

### **Methods**

The first 56 consecutive patients that underwent arthroscopic ACL repair were examined at minimum 2-year follow-up. The latter 27 patients [48.2% (27/56)] received additional internal bracing with ACL repair. All 56 patients were included (100% follow-up). Mean age at surgery was  $33.5 \pm 11.3$  years (59% male) and mean follow-up  $3.2 \pm 1.7$  years. Clinical examination was performed using the objective International Knee Documentation Committee (IKDC) form. Subjective outcomes were obtained using the Lysholm, modified Cincinnati, Single Assessment Numeric Evaluation (SANE), and subjective IKDC scores.

### **Results**

Six repairs (10.7%) failed and four additional patients underwent reoperation (7.1%): two for meniscus tears and two for suture anchor irritation. Objective IKDC scores were A in 38 (73%), B in 8 (15%) and C/D in 6 (12%) patients. Mean Lysholm score was  $94 \pm 7.6$ , modified Cincinnati  $94 \pm 8.9$ , SANE  $90 \pm 12.5$ , pre-injury Tegner  $6.7 \pm 1.5$ , current Tegner  $6.2 \pm 1.5$ , and subjective IKDC  $90 \pm 10.9$ . Failures rates were 7.4% with and 13.8% without internal bracing ( $P = 0.672$ ). There were no statistically significant or clinically relevant differences in subjective outcomes.

### **Conclusion**

Arthroscopic primary repair has resulted in good objective and subjective outcomes at 3.2-year follow-up in a carefully selected population. The role of additional internal bracing is possibly beneficial, but larger groups are needed to assess this.

### **Level of evidence**

III.

## **High complication rate following dynamic intraligamentary stabilization for primary repair of the anterior cruciate ligament**

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KSSTA, January 2019, Volume 27, Issue 1, pp 29–36

<https://doi.org/10.1007/s00167-018-5067-3>

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### **Purpose**

New strategies for dynamic intraligamentary stabilization (DIS) in the primary repair of anterior cruciate ligament (ACL) ruptures are currently under debate. It has been proposed that these might serve as alternative techniques to conventional ACL reconstruction procedures using tendon autografts. The aims of the present investigation were to evaluate the functional results and critically assess the complication rate following primary ACL repair with DIS and to review existing reports of favourable clinical results with the method in relation to knee joint stability and patient satisfaction.

### **Methods**

Fifty-nine patients received dynamic intraligamentary stabilization a mean of 14 days after ACL rupture. Fifty-seven patients (96.6%, male:female = 37:20; mean age 27.6 years) were available for follow-up examinations including the Tegner activity level, anteroposterior stability in comparison with the uninjured knee, subjective satisfaction, and range of knee motion. Complications after 3 and 12 months were also analyzed. Associated lesions requiring surgical measures were found in 30 patients.

### **Results**

A statistically significant decrease in Tegner activity levels was detected between the preoperative status (median 7) and the 12-month follow-up (median 5). The overall complication rate was 57.9%, including rerupture or non-healing (n = 10, 17.5%), repeat arthroscopy (n = 13, 22.8%) as a result of meniscus tears (n = 2, 15.4%), cyclops syndrome (n = 4, 30.8%) or restricted range of motion (n = 7, 53.8%), arthrofibrosis (n = 3, 5.3%), and implant interference (n = 7, 12.3%). Anteroposterior KT-1000 stability of 3 mm or below was achieved in 29 (50.9%) patients.

### **Conclusions**

The DIS procedure does not appear to be appropriate for providing predictable results in a young and active cohort of patients following ACL rupture, as it has an unacceptably high complication rate and leads to residual anteroposterior knee joint laxity of 3 mm or more in 28 (49.1%) of cases.

### **Level of evidence**

IV (prospective case series)

## Improved results of ACL primary repair in one-part tears with intact synovial coverage

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KSSTA, January 2019, Volume 27, Issue 1, pp 37–43

<https://doi.org/10.1007/s00167-018-5199-5>

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### Purpose

It was the aim to assess the influence of synovial sheath disruption on early failure of primary anterior cruciate ligament (ACL) repair. It was hypothesized that more-part ACL tears with disruption of the synovial sheath are associated with a higher risk of failure after primary ACL repair.

### Methods

A cohort study was conducted comprising patients with primal ACL tears undergoing primary ACL repair and dynamic intraligamentary stabilization (DIS). The patients were stratified into three groups: A—one-part rupture with intact synovial membrane (n = 50), B—two-part ruptures resultant to separation of the ACL into two main bundles with synovial membrane tearing (n = 52) and C—more parts involving multilacerated ruptures with membrane disruption (n = 22). Failure was defined as a retear or residual laxity (anterior posterior translation > 5 mm compared to healthy knee). Adjustment for potential risk factors was performed using a multivariate logistic-regression model.

### Results

The overall failure rate was 17.7% throughout the mean follow-up period of  $2.3 \pm 0.8$  years. The failure rate in patients with one-part ACL tears with an intact synovial membrane was 4% (n = 2) (Group A), which was significantly lower than the failure rates in groups B and C, 26.9% (n = 14) ( $p = 0.001$ ) and 27.3% (n = 6) ( $p = 0.003$ ), respectively. Disruption of the synovial sheath in two- or more-part tears was identified as an independent factor influencing treatment failure in primary ACL repair (OR 8.9; 95% CI 2.0–40.0).

### Conclusion

The integrity of the ACL bundles and synovial sheath is a factor that influences the success of ACL repair. This needs to be considered intra-operatively when deciding about repair.

### Level of evidence

IV.

## **Bone bruise in anterior cruciate ligament rupture entails a more severe joint damage affecting joint degenerative progression**

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KSSTA, January 2019, Volume 27, Issue 1, pp 44–59

<https://doi.org/10.1007/s00167-018-4993-4>

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### **Purpose**

During anterior cruciate ligament (ACL) injury, the large external forces responsible for ligament rupture cause a violent impact between tibial and femoral articular cartilage, which is transferred to bone resulting in bone bruise detectable at MRI. Several aspects remain controversial and await evidence on how this MRI finding should be managed while addressing the ligament lesion. Thus, the aim of the present review was to document the evidence of all available literature on the role of bone bruise associated with ACL lesions.

### **Methods**

A systematic review of the literature was performed on bone bruise associated with ACL injury. The search was conducted in September 2017 on three medical electronic databases: PubMed, Web of Science, and the Cochrane Collaboration. Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines were used. Relevant articles were studied to investigate three main aspects: prevalence and progression of bone bruise associated with ACL lesions, its impact on the knee in terms of lesion severity and joint degeneration progression over time and, finally, the influence of bone bruise on patient prognosis in terms of clinical outcome.

### **Results**

The search identified 415 records and, after an initial screening according to the inclusion/exclusion criteria, 83 papers were used for analysis, involving a total of 10,047 patients. Bone bruise has a high prevalence (78% in the most recent papers), with distinct patterns related to the mechanism of injury. This MRI finding is detectable only in a minority of cases the first few months after trauma, but its presence and persistence have been correlated to a more severe joint damage that may affect the degenerative progression of the entire joint, with recent evidence suggesting possible effects on long-term clinical outcome.

### **Conclusion**

This systematic review of the literature documented a growing interest on bone bruise associated with ACL injury, highlighting aspects which could provide to orthopaedic surgeons evidence-based suggestions in terms of clinical relevance when dealing with patients affected by bone bruise following ACL injury. However, prospective long-term studies are needed to better understand the natural history of bone bruise, identifying prognostic factors and targets of specific treatments that should be developed in light of the overall joint derangements accompanying ACL lesions.

### **Levels of evidence**

IV, Systematic review of level I–IV studies.

[BACK](#)

## **Anterior cruciate ligament repair with Independent Suture Tape Reinforcement: a case series with 2-year follow-up**

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KSSTA, January 2019, Volume 27, Issue 1, pp 60–67

<https://doi.org/10.1007/s00167-018-5239-1>

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### **Purpose**

The treatment of acute anterior cruciate ligament (ACL) ruptures with a repair technique has recently regained interest. A novel ACL repair technique was described using Independent Suture Tape Reinforcement with 2-year follow-up results.

### **Methods**

Forty-two consecutive patients with an acute ACL rupture undergoing repair using this technique were followed up for a minimum of 2 years. Patients with mid-substance, distal ACL ruptures, poor ACL tissue quality or retracted ACL remnants as well as patients with multi-ligament injuries were excluded. Knee Injury and Osteoarthritis Outcome Score (KOOS), Visual Analogue Pain Scale (VAS-pain), Veterans RAND 12 Item Health Survey (VR-12) and the Marx Activity scale were collected by online questionnaires. Two-year postoperative patients were asked by telephone if they had experienced a rerupture.

### **Results**

All the KOOS subscales improved significantly in comparison to the preoperative score. The largest improvement of all scores was seen at 3 months postoperatively which is significant in all cases. The KOOS sport and recreation showed a meaningful change and the largest improvement of the KOOS subscales at 3 months postoperatively, as well as the highest total improvement at 1 year postoperatively compared to preoperatively. The VAS-pain and VR-12 physical score improved significantly, however the Marx activity scale decreased significantly in comparison to preoperative scores. Two patients reported a rerupture (4.8%, CI 1.7–11.2%).

### **Conclusions**

This is the first case series that described the 2-year follow-up results of patients with an acute, proximal ACL rupture, treated with the Independent Suture Tape Reinforcement repair technique. A meaningful KOOS sport and recreation change and significant improvements in the KOOS, VAS-pain and VR-12 physical scores as well as a significant decrease of the Marx activity scale in comparison to preoperative scores are demonstrated. Two of the 42 patients (4.8%) reported an ACL rerupture. Repair with this technique could be clinically relevant as a treatment option for patients with an acute, proximal ACL rupture which is not retracted and of good tissue quality.

### **Level of evidence**

IV.

## **Cross-education improves quadriceps strength recovery after ACL reconstruction: a randomized controlled trial**

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KSSTA, January 2019, Volume 27, Issue 1, pp 68–75

<https://doi.org/10.1007/s00167-018-5040-1>

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### **Purpose**

The aim of this study was to investigate the effects of concentric and eccentric cross-education (CE) on quadriceps strength and knee function recoveries after anterior cruciate ligament (ACL) reconstruction.

### **Methods**

Forty-eight patients (age:  $29.5 \pm 6.8$  years, body mass index:  $26.1 \pm 3.2$  kg/m<sup>2</sup>) who had undergone ACL reconstruction with hamstring tendon autograft were included in the study. The patients were randomly divided into three groups when they reached four weeks post surgery: (1) concentric CE (n = 16); (2) eccentric CE (n = 16); and (3) control (n = 16). All groups followed the same post-surgical rehabilitation program for their reconstructed limb. Additionally, the two experimental groups followed eight weeks of isokinetic training for the uninjured knee at 60°/s for 3 days per week. Quadriceps maximum voluntary isometric strength (MVIC) was measured during the 4th week (pre-training), 12th week (post training), and 24th week post surgery. The single-leg hop distance and International Knee Documentary Committee (IKDC) scores were also evaluated during the 24th week post surgery. Analysis of variance was used for statistical analysis.

### **Results**

Group-by-time interaction was significant for quadriceps MVICs for reconstructed and healthy limbs ( $p = 0.02$ ). Quadriceps strength of both knees was greater in concentric and eccentric CE groups compared to control group during the 12th- and 24th weeks post surgery ( $p < 0.05$ ). Strength gain was 28% and 31% in concentric and eccentric CE groups, respectively, when compared with the control group. Concentric and eccentric CE had similar effects on quadriceps strength recovery (n.s.). IKDC score, and single-leg hop distances were not significantly different among groups (n.s.).

### **Conclusions**

Concentric and eccentric quadricep strengthening of healthy limbs in early phases of ACL rehabilitation improved post-surgical quadriceps strength recovery of the reconstructed limb. CE should be integrated into ACL reconstruction rehabilitation, especially in the early rehabilitative phases to restore quadriceps strength.

### **Level of evidence**

Randomized controlled trial, Level I.

## **Bioabsorbable screws, whatever the composition, can result in symptomatic intra-osseous tibial tunnel cysts after ACL reconstruction**

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KSSTA, January 2019, Volume 27, Issue 1, pp 76–85

<https://doi.org/10.1007/s00167-018-5037-9>

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### **Purpose**

To describe the clinical results of patients who underwent surgical treatment for a intra-osseous tibial tunnel cyst on a bioabsorbable interference screw following anterior cruciate ligament reconstruction (ACL).

### **Methods**

This retrospective study included all patients who underwent surgery between 2004 and 2016 for an intra-osseous tibial tunnel cyst on bioabsorbable interference screw following ACL reconstruction. The diagnosis was suggested clinically by pretibial pain at the incision site, sometimes associated with a palpable subcutaneous nodule and then confirmed on MRI. The first stage of surgery included exploratory arthroscopy followed by open excision/curettage of the cyst and then the tunnel was filled. The main criterion for outcome was a clinically normal knee (no pain, 0–120 range of motion, stable, with no effusion) at 6 months of follow-up.

### **Results**

This series included 53 patients, mean age  $35.3 \pm 9.9$  years old with a mean  $4.6 \pm 3.1$  years (between 3.1 months and 19 years) of follow-up after ligament reconstruction. The tibial screw was completely absorbed in 9/53 (17%) of patients, and fragmented in 22/53 (41.5%). At the 6-month follow-up, 42/53 (79.2%) patients had a normal knee, 11/53 (20.8%) persistent pain in the cyst area, 52/53 (98.1%) normal range of motion and 53 (100%) a stable knee. A recurrent cyst developed at 2 years of follow-up in one patient.

### **Conclusion**

Complete absorption of a bioabsorbable interference screw is long, increasing the risk of developing intra-osseous tibial cysts during this period. The development of new materials with improved absorption properties is needed.

### **Level of evidence**

IV—Retrospective study.

## **Femoral tunnel length in anatomical single-bundle ACL reconstruction is correlated with height, weight, and knee bony morphology**

Takanori Iriuchishima, Bunsei Goto, Tatsumasa Okano, Keinosuke Ryu, Freddie H. Fu

KSSTA, January 2019, Volume 27, Issue 1, pp 93–99

<https://doi.org/10.1007/s00167-018-5046-8>

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### **Purpose**

The purpose of this study was to reveal the correlation between femoral tunnel length in anatomical single-bundle anterior cruciate ligament (ACL) reconstruction and body size and/or knee morphology.

### **Methods**

Thirty-one subjects undergoing anatomical single-bundle ACL reconstruction were included in this study (20 female, 11 male; median age 46, 15–63). Pre-operative height, body weight, and body mass index (BMI) were measured. In pre-operative magnetic resonance imaging, the thickness of the quadriceps tendon and the whole anterior–posterior (AP) length of the knee were measured using the sagittal slice. Using post-operative three-dimensional computed tomography, accurate axial and lateral views of the femoral condyle were evaluated. The correlation of femoral tunnel length, which was measured intra-operatively, with the height, weight, BMI, quadriceps tendon thickness, AP length of the knee, trans-epicondylar length, the notch area (axial), length of Blumensaat's line, and the height and area of the lateral wall of the femoral intercondylar notch were statistically analyzed. Tunnel placement was also evaluated using a Quadrant method.

### **Results**

The average femoral tunnel length was  $35.6 \pm 4.4$  mm. The average height, body weight, and BMI were  $162.7 \pm 7.2$  cm,  $61.9 \pm 10$  kg, and  $23.4 \pm 3.5$ , respectively. Femoral tunnel length was significantly correlated with height, body weight and the height and area of lateral wall of the femoral intercondylar notch, and the length of the Blumensaat's line.

### **Conclusion**

For clinical relevance, the risk of creating a femoral tunnel of insufficient length in anatomical single-bundle ACL reconstruction exists in subjects with small body size. Surgeons should pay careful attention to prevent this from occurring.

### **Level of evidence**

Case-controlled study, Level III.

## **No difference between full thickness and partial thickness quadriceps tendon autografts in anterior cruciate ligament reconstruction: a systematic review**

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KSSTA, January 2019, Volume 27, Issue 1, pp 105–116

<https://doi.org/10.1007/s00167-018-5042-z>

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### **Purpose**

The purpose of this review was to compare outcomes and complication profiles of anterior cruciate ligament reconstruction (ACL-R) between full thickness (FT-Q) and partial thickness (PT-Q) quadriceps tendon (QT) autografts.

### **Methods**

As per PRISMA guidelines, PubMed, EMBASE, and MEDLINE were searched in September 2017 for English language, human studies of all levels of evidence on patients undergoing primary ACL-R with FT-Q or PT-Q. This search was repeated in March 2018 to capture additional articles. Data regarding postoperative outcomes and complications were abstracted. Due to heterogeneous reporting, data were not combined in meta-analysis and were summarized descriptively.

### **Results**

Upon screening 3670 titles, 18 studies satisfied inclusion/exclusion criteria. The second search identified an additional two studies for a total of 20 studies (50% case–control, 50% case series). These studies examined 1212 patients (1219 knees) of mean age 29.8 years (range 15–59) followed a mean of 42.2 months (range 12–120). FT-Q and PT-Q autografts were used in eight studies (50.5% of knees), and thirteen studies (49.5% of knees), respectively. Only one study directly compared FT-Q to PT-Q. Instrumented laxity was less than 3 mm in 74.8 and 72.4% of the FT-Q and PT-Q groups, respectively. Postoperative IKDC Subjective Knee Form scores were similar between the FT-Q (82.5) and PT-Q (82.1) groups. Postoperative quadriceps strength, measured as a percentage of the contralateral side, were similar in the FT-Q (89.5%) and PT-Q (85.1%) groups. Graft failure rates for the FT-Q and PT-Q groups were 3.7 and 3.0%, respectively.

### **Conclusion**

Across the 20 studies included in this review, there appeared to be no difference in outcomes or complications between either FT-Q or PT-Q in primary ACL-R. Moreover, primary ACL-R using QT autografts appears to have successful outcomes with a low rate of graft failure, irrespective of tendon thickness. While further comparative studies are needed to better delineate the optimal thickness of quadriceps tendon for primary ACL-R, these data suggest that, in primary ACL-R, either FT-Q or PT-Q is efficacious and, in the clinical setting, surgeons may be justified in using either graft thickness.

### **Level of evidence**

IV, Systematic Review of Level III and IV studies.

[BACK](#)

## **Anterior cruciate ligament reconstruction performed within 12 months of the index injury is associated with a lower rate of medial meniscus tears**

Ying Ren Mok, Keng Lin Wong, Taufiq Panjwani, Chloe Xiaoyun Chan, Shi Jie Toh, Lingaraj Krishna

KSSTA, January 2019, Volume 27, Issue 1, pp 117–123

<https://doi.org/10.1007/s00167-018-5027-y>

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### **Purpose**

To verify the correlation of time to surgery with the prevalence of concomitant intra-articular injuries detected on arthroscopy during anterior cruciate ligament (ACL) reconstruction.

### **Methods**

The medical records of 653 patients who underwent ACL reconstruction surgery were retrospectively analyzed. Univariate and multivariate logistic regression analysis was performed to identify factors that were associated with the presence of at least one intra-articular injury, medial meniscus tears, lateral meniscus tears and chondral injuries at the time of surgery. Further univariate analysis was conducted to determine the earliest time-point for surgery, after which the rate of concomitant injuries was significantly higher.

### **Results**

Longer time to surgery (OR 1.019 95% CI 1.010, 1.028,  $p = 0.000$ ), male sex (OR 1.695 95% CI 1.074, 2.675  $p = 0.023$ ), and higher BMI (OR 1.050 95% CI 1.006, 1.097  $p = 0.025$ ) were correlated with a higher prevalence of medial meniscus tears. There was an increased prevalence of medial meniscus tears when surgery was carried out more than 12 months after the index injury (OR 2.274 95% CI 1.469, 3.522,  $p = 0.000$ ). The correlation between longer time to surgery and chondral injuries approached statistical significance (OR 1.006 95% CI 0.999, 1.012,  $p = 0.073$ ). However, a longer time to surgery was not associated with an increased prevalence of lateral meniscus tears (OR 1.003 95% CI 0.998, 1.009,  $p = n.s.$ ).

### **Conclusions**

Longer time to surgery is associated with an increased prevalence of medial meniscus tears in ACL reconstruction. Surgery performed within 12 months of the index injury reduces the prevalence of medial meniscus tears. Prioritizing males and overweight patients for counselling and early intervention can be considered.

### **Level of evidence**

Therapeutic level III retrospective cohort study.

## **Transportal central femoral tunnel placement has a significantly higher revision rate than transtibial AM femoral tunnel placement in hamstring ACL reconstruction**

Mark Clatworthy, Steffen Sauer, Tim Roberts

KSSTA, January 2019, Volume 27, Issue 1, pp 124-129

<https://doi.org/10.1007/s00167-018-5036-x>

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### **Purpose**

It is proposed that central femoral ACL graft placement better controls rotational stability. This study evaluates the consequence of changing the femoral tunnel position from the AM position drilled transtibially to the central position drilled transportally. The difference in ACL graft failure is reported.

### **Methods**

This prospective consecutive patient single surgeon study compares the revision rates of 1016 transtibial hamstring ACL reconstructions followed for 6–15 years with 464 transportal hamstring ACL reconstructions followed for 2–6 years. Sex, age, graft size, time to surgery, meniscal repair and meniscectomy data were evaluated as contributing factors for ACL graft failure to enable a multivariate analysis. To adjust for the variable follow-up a multivariate hazard ratio, failure per 100 graft years and Kaplan–Meier survivorship was determined.

### **Results**

With transtibial ACLR 52/1016 failed (5.1%). With transportal ACLR 32/464 failed (6.9%). Significant differences between transportal and transtibial ACLR were seen for graft diameter, time to surgery, medial meniscal repair rates and meniscal tissue remaining after meniscectomy. Adjusting for these the multivariate hazard ratio was 2.3 times higher in the transportal group ( $p = 0.001$ ). Central tunnel placement resulted in a significantly 3.5 times higher revision rate compared to an anteromedial tunnel placement per 100 graft years ( $p = 0.001$ ). Five year survival was 980/1016 (96.5%) for transtibial versus 119/131 (90.5%) for transportal. Transportal ACLR also showed a significantly higher earlier failure rate with 20/32 (61%) of the transportal failing in the first year compared with 14/52 (27%) for transtibial. ( $p = 0.001$ .)

### **Conclusion**

Transportal central femoral tunnel ACLR has a higher failure rate and earlier failure than transtibial AM femoral tunnel ACLR.

### **Level of evidence**

Level II—prospective comparative study.

## **Hamstring tendon autografts do not show complete graft maturity 6 months postoperatively after anterior cruciate ligament reconstruction**

Marcus Hofbauer, Francesco Soldati, Pavol Szomolanyi, Siegfried Trattnig, Francesca Bartolucci, Freddie Fu, Matteo Denti

KSSTA, January 2019, Volume 27, Issue 1, pp 130-136

<https://doi.org/10.1007/s00167-018-5033-0>

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### **Purpose**

In this prospective, double-center cohort study, we aim to assess how the anterior cruciate ligament (ACL) signal intensity on magnetic resonance imaging (MRI) potentially varies between a group of patients with anatomic ACL reconstruction using autogenous hamstring grafts 6 months postoperatively and a healthy ACL control group, and how MRI-based graft signal intensity is related to knee laxity.

### **Methods**

Sixty-two consecutive patients who underwent ACL reconstruction using quadrupled hamstring tendon autograft were prospectively invited to participate in this study, and they were evaluated with MRI after 6 months of follow-up. 50 patients with an MRI of their healthy ACL (Clinica Luganese, Lugano, Switzerland) and 12 patients of their contralateral healthy knee (Department of Orthopaedic and Trauma Surgery, Medical University of Vienna, Austria) served as the control group. To evaluate graft maturity, the signal-to-noise quotient (SNQ) was measured in three regions of interest (ROIs) of the proximal, mid-substance and distal ACL graft and the healthy ACL. KT-1000 findings were obtained 6 months postoperatively in the ACL reconstruction group. Statistical analysis was independently performed to outline the differences in the two groups regarding ACL intensity and the correlation between SNQ and KT-1000 values.

### **Results**

There was a significant difference in the mean SNQ between the reconstructed ACL grafts and the healthy ACLs in the proximal and mid-substance regions ( $p = 0.001$  and  $p = 0.004$ ). The distal region of the reconstructed ACL showed a mean SNQ similar to the native ACL (n.s). Patients with a KT-1000 between 0 and 1 mm showed a mean SNQ of 0.1; however, a poor correlation was found between the mean SNQ and KT-1000 findings, probably due to the small sample size of patients with higher laxity.

### **Conclusion**

After 6 months of follow-up, hamstring tendon autografts for anatomic ACL reconstruction do not show equal MRI signal intensity compared to a healthy ACL and should therefore be considered immature or at least not completely healed even if clinical laxity measurement provides good results. However, in the case of a competitive athlete, who is clinically stable and wants to return to sports at 6 months, performing an MRI to confirm the stage of graft healing might be an option.

### **Level of evidence**

Prospective, comparative study II.

## **Revision anterior cruciate ligament reconstruction restores knee laxity but shows inferior functional knee outcome compared with primary reconstruction**

Riccardo Cristiani, Björn Engström, Gunnar Edman, Magnus Forssblad, Anders Stålmán

KSSTA, January 2019, Volume 27, Issue 1, pp 137-145

<https://doi.org/10.1007/s00167-018-5059-3>

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### **Purpose**

To evaluate and compare knee laxity and functional knee outcome between primary and revision anterior cruciate ligament (ACL) reconstruction in the same cohort of patients.

### **Methods**

Patients who underwent primary and revision ACL reconstruction (ACLR) at Capio Arthro Clinic, Stockholm, Sweden, from 2000 to 2015, were identified in our local database. Inclusion criteria were: same patients who underwent primary hamstring tendons (HT) and revision bone–patellar tendon–bone (BPTB) autograft ACLR, no associated ligament injuries and no contralateral ACL injuries/reconstructions. The cause of revision ACLR was graft rupture for all patients. The KT-1000 arthrometer, with an anterior tibial load of 134-N, was used to evaluate knee laxity preoperatively and 6-month postoperatively. The Knee Injury and Osteoarthritis Outcome Score (KOOS) was collected preoperatively and at the 1-year follow-up.

### **Results**

A total of 118 patients with primary and revision ACLR arthrometric laxity measurements were available (51.0% males; mean age at primary ACLR  $21.7 \pm 7.1$  years and revision ACLR  $24.3 \pm 7.5$  years). The mean preoperative and postoperative anterior side-to-side (STS) difference values were not significantly different between primary and revision ACLR. However, primary ACLR showed a significantly higher frequency of postoperative anterior STS difference  $> 5$  mm compared with revision ACLR (8.4 vs 5.0%;  $P = 0.02$ ). The KOOS was available for primary and revision ACLR for 73 patients (55.4% males; mean age at primary ACLR  $21.6 \pm 7$  years and revision ACLR  $24.7 \pm 7.3$  years). Preoperatively, revision ACLR showed significantly higher scores in all KOOS subscales, except for the activity of daily living (ADL) subscale. For the primary ACLR, the improvement from preoperatively to the 1-year follow-up was significantly greater in all KOOS subscales and, the postoperative scores were superior for Pain, ADL and Sports subscales compared with revision ACLR.

### **Conclusions**

The findings of this study showed that anterior knee laxity is restored with revision BPTB autograft ACLR after failed primary HT autograft ACLR, in the same cohort of patients. However, revision ACLR showed a significantly inferior functional knee outcome compared with primary ACLR. It is important for clinicians to inform and set realistic expectations for patients undergoing revision ACLR. Patients must be aware of the fact that having revision ACLR their knee function will not improve as much as with primary ACLR and the final postoperative functional outcome is inferior.

### **Level of evidence**

Retrospective cohort study, Level III.

[BACK](#)

## **No difference in sensory outcome between vertical and oblique incisions for hamstring graft harvest during ACL reconstruction**

Mohamed M. F. Sharaby, Arafat Alfikey, Ismail S. Alhabsi, Suwailim Al-Ghannami

KSSTA, January 2019, Volume 27, Issue 1, pp 146-152

<https://doi.org/10.1007/s00167-018-5057-5>

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### **Purpose**

To compare the incidence, extent of sensory loss, its clinical effect and natural course caused by sensory nerve injury, during two different skin incisions used for autogenous hamstring graft harvest during ACL reconstruction.

### **Methods**

This randomized prospective study was carried out on 84 patients, divided into two groups, all of them underwent arthroscopic ACL reconstruction using hamstring tendon graft with two incisions; a vertical incision used in 43 patients, and an oblique incision in 41 patients. The location and area of sensory loss were evaluated during follow-up as well as the degree of improvement and patient satisfaction.

### **Results**

The average age in this study was  $29.8 \pm 7.2$  in the vertical group and  $29.9 \pm 6.3$  in the oblique group. Both semitendinosus and gracilles were harvested in 34 patients, semitendinosus in 49 patients and gracilles in one patient. In the vertical group, a higher incidence of sensory loss was recorded with 21 patients (51.2%), relative to the oblique group with 18 patients (41.9%). However, there was no statistically significant difference ( $p = n.s$ ). Most of the sensory loss affected the distribution of the IPBSN (infrapatellar branch of saphenous nerve) in 27 patients (69.2%) in both groups, and to a lesser extent in the lower medial area [distribution of SBSN (sartorial branch of saphenous nerve)] in 12 patients (30.8%).

### **Conclusion**

This study clearly revealed the high incidence of nerve injury particularly the IPBSN during hamstring graft harvest, but did not prove a difference between oblique and vertical incisions, with regard to postoperative sensory loss. It was clear that harvesting the semitendinosus alone is not a factor that can diminish nerve injury.

### **Level of evidence**

II.

## **Popliteal neurovascular bundle is safe during inside-out repair of medial meniscus without a safety incision**

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KSSTA, January 2019, Volume 27, Issue 1, pp 153-165

<https://doi.org/10.1007/s00167-018-5060-x>

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### **Purpose**

There is a theoretical risk of injury to neurovascular structures during inside-out meniscal repair without a safety incision, although there are limited studies assessing this risk. This simulation study on archival MRI films was performed to assess the risk for the popliteal neurovascular bundle and the peroneal nerve during passage of needles for inside-out meniscus repair without a “safety incision”, thereby defining a “safe zone” of the menisci that can be safely repaired using this technique.

### **Methods**

Archival MRI scans (n = 50) were retrieved and axial sections through the menisci were used for simulation. The needle passage was simulated for different points on the posterior horn and body of lateral and medial menisci at “half-hour” intervals using clock method (15° intervals) with three different portals and two different needle cannulas, resulting in six different scenarios of needle passage for each point on the meniscus. The distance of the needle in each scenario was measured from popliteal vessels (n = 50) and peroneal nerve (n = 10). The value “mean-3SD” was calculated for positive means and “Mean + 3SD” was calculated if the mean was negative. An additional 2 mm was defined as “safe distance”. Thus, simulation models in which the mean – 3SD was less than 2 mm (or mean + 3SD was greater than – 2 mm for negative means) were labelled as “unsafe”.

### **Results**

Needle passage through medial meniscus at and medial to 1 o'clock position for a right knee (or 11 o'clock position for a left knee) was safe, irrespective of the portal and needle type. For the lateral meniscus, only the equatorial region was found to be safe with this method.

### **Conclusions**

The popliteal neurovascular bundle is safe during the inside-out medial meniscal repair without a safety incision. For the terminal-most part of the posterior horn, the AM portal and the straight cannula should be avoided. However, this method without safety incision cannot be recommended for lateral meniscus because of the risk to the popliteal vessels and the peroneal nerve. Instead, the inside-out method with a safety incision, or an all-inside method should be used for lateral meniscus.

### **Level of evidence**

III.

## **Pullout fixation for medial meniscus posterior root tears: clinical results were not age-dependent, but osteoarthritis progressed**

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KSSTA, January 2019, Volume 27, Issue 1, pp 189-196

<https://doi.org/10.1007/s00167-018-5024-1>

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### **Purpose**

This study investigated the outcomes of pullout fixation for medial meniscus posterior root tears (MMPRTs) in patients  $\leq 60$  years old versus patients  $> 60$  years old. It was hypothesized that older patients would demonstrate results comparable with those of younger patients.

### **Methods**

Patients with pullout fixation who were followed-up for more than 5 years were included. Patients were categorized into two groups based on age (group A,  $\leq 60$  years; group B,  $> 60$  years). The Lysholm score, Kellgren–Lawrence (K–L, 0/1/2/3/4) grade, and medial joint space width were evaluated retrospectively. Preoperative results were compared with the final results in each group, which were compared between groups.

### **Results**

Twenty-five patients in group A (mean age,  $54.7 \pm 3.8$  years) and 22 patients in group B (mean age,  $65.6 \pm 4.4$  years) were recruited. The mean follow-up duration was 70.9 months. The Lysholm score (group A,  $53.0 \pm 9.1$  to  $86.0 \pm 12.1$ ,  $P < 0.001$ ; group B,  $51.1 \pm 7.1$  to  $82.9 \pm 9.7$ ,  $P < 0.001$ ) improved significantly. However, the joint space width (group A,  $4.7 \pm 1.1$  to  $3.9 \pm 1.1$  mm,  $P < 0.001$ ; group B,  $4.7 \pm 0.9$  to  $3.8 \pm 0.9$  mm,  $P < 0.001$ ) and K–L grade (group A, 3/17/5/0/0 to 0/7/11/7/0,  $P < 0.001$ ; group B, 2/14/6/0/0 to 0/3/14/5/0,  $P < 0.001$ ) worsened significantly. No significant differences between groups were observed in final outcomes, including Lysholm score (n.s.), K–L grade (n.s.), and joint space narrowing (n.s.). No case with operation failure that require total knee arthroplasty was not observed.

### **Conclusion**

MMPRT fixation did not prevent the progression of arthrosis completely. However, clinical outcomes were not age-dependent. Thus, age may not be a critical factor to consider when applying fixation.

### **Level of evidence**

Retrospective case–control study; Level of evidence, IV.

## **High short-term return to sports rate despite an ongoing healing process after acute meniscus repair in young athletes**

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KSSTA, January 2019, Volume 27, Issue 1, pp 215-222

<https://doi.org/10.1007/s00167-018-5335-2>

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### **Purpose**

Acute meniscus repair in young athletes is always a challenge due to the long rehabilitation process and time to return to sport (RTS). The purpose was to investigate signal alterations in short-term follow-up after acute meniscus repair on specific magnetic resonance imaging (MRI) scan sequences. It was hypothesized that (1) MRI signal changes over the first postoperative healing phase and represent a continuous healing process and (2) meniscus healing properties correlates with clinical outcomes and RTS.

### **Methods**

Young athletes with traumatic meniscus lesion and arthroscopic meniscus repair within 6 weeks and available preoperative MRI were enrolled. Clinical examination, outcome scores (IKDC, KOOS, Lysholm Score, Tegner activity score) and RTS were surveyed preoperatively and 6 and 12 weeks and 6 months after surgery. Radiological follow-up examinations were performed 2, 4, 6, 12 weeks and 6 months after operation using a 3T-MRI. Evaluation was based on ISAKOS meniscus classification system, meniscus healing were classified according to Henning's criteria.

### **Results**

At final follow-up (FU) 30 patients (28 month, 2 week) with a total of 35 meniscus tears (19 medial, 16 lateral) were included. Clinical scores improved significantly after surgery: IKDC Score (preOP:  $39.4 \pm 18.5$ , final FU:  $78.8 \pm 15.3$ ) KOOS (preOP:  $45.7 \pm 22.1$ , final FU:  $82.7 \pm 12.5$ ) and Lysholm Score (preOP:  $42.8 \pm 23.7$ , final FU:  $84.4 \pm 13.8$ ) ( $p < 0.01$ ). Tegner activity score showed a steadily increase to 4 (range 3–9) at 6 months but did not reached the pre-injury level of 6 (range 3–9). RTS rate was 100% whereof 44.8% reached their pre-injury level. MRI examination revealed a continuous healing process and menisci were classified as 55.9% healed, 35.3% partially healed and 8.8% non-healed at final FU.

### **Conclusion**

This study showed that MRI signal alterations of the meniscus steadily occur within the first 6 months postoperatively. MRI reveals an ongoing healing process at final FU that have to be carefully considered when RTS is discussed with high demanding patients. However, young athletes provide good clinical results and RTS rate even though MRI alterations are still present.

### **Level of evidence**

Therapeutic study, prospective case series, Level IV.

## **Patients older than 50 years had similar results of knee strength and anteroposterior stability after ACL reconstruction compared to younger patients**

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KSSTA, January 2019, Volume 27, Issue 1, pp 230-238

<https://doi.org/10.1007/s00167-018-5342-3>

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### **Purpose**

To evaluate knee strength, ligament stability, and functional outcomes in patients older than 50 years who underwent anterior cruciate ligament (ACL) reconstruction, and to compare these results with those obtained from a younger patient group (< 40 years).

### **Methods**

Forty patients older than 50 years and 50 patients younger than 40 years who underwent ACL reconstruction were retrospectively studied. Isokinetic extensor and flexor muscle strength were evaluated. The peak torque was determined at speeds of 60°/s and 180°/s. The highest peak torque at each velocity was compared with that on the uninjured side. Patients were also evaluated for knee anteroposterior (AP) laxity and functional outcomes, which were measured by the Lysholm and International Knee Documentation Committee (IKDC) scores. All tests were evaluated at baseline and 1 year postoperatively.

### **Results**

The groups were comparable at the baseline. Both groups had significant improvements in all parameters, including isokinetic muscle strength, AP laxity, and functional scores, at 1 year postoperatively (all  $p < 0.05$ ). Compared with younger patients, older patients had similar results for extensor and flexor strength, AP laxity, and Lysholm score (n.s.). However, younger patients had better IKDC scores than did older patients [median 81.1; 95% confidence interval (CI) 95% CI 78.9–88.7 vs. median 75.6; 95% CI 70.1–79.3,  $p = 0.007$ ].

### **Conclusions**

Though with lower IKDC scores, older patients with ACL reconstruction had comparable results of knee strength and ligament laxity to younger patients. ACL reconstruction is recommended for treating patients older than 50 years with ACL insufficiency, especially for those with high functional demand.

### **Level of evidence**

Retrospective cohort study, III.

**Meniscal repair associated with a partial meniscectomy for treating complex horizontal cleavage tears in young patients may lead to excellent long-term outcomes**

Julien Billières, Nicolas Pujo, and the U45 Committee of ESSKA

KSSTA, February 2019, Volume 27, Issue 2, pp 343–348

<https://doi.org/10.1007/s00167-018-5219-5>

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**Introduction**

While open repair of horizontal meniscal tears in young active patients has shown good results at mid- and long-term follow-up, complex horizontal tears (cleavage associated with meniscal flaps) are often treated by arthroscopic subtotal meniscectomy. The aim of this study was to evaluate long-term outcomes after arthroscopic removal of meniscal flaps associated with an open meniscal repair for treating complex lesions in young active patients. The hypothesis was that this salvage procedure would be efficient in such rare cases.

**Methods**

Fourteen patients underwent an arthroscopic partial meniscectomy associated with an open meniscal repair to treat a painful complex horizontal meniscal cleavage between 2005 and 2010. There were two females and 12 males with a median age of 28.4 years (range 15–48 years). Patients were assessed by KOOS and IKDC scores, return to sport and the need for a secondary meniscectomy.

**Results**

Thirty patients were evaluated at a median follow-up of 8.5 years (range 7–12 years). One patient required revision of a partial meniscectomy and one other a meniscal replacement (15% failure rate). All other patients showed improvement with regard to their symptoms and returned to sports, ten (91%) of them at the same level. The mean IKDC subjective score was 86.1 ( $\pm$  10.9). The mean KOOS scores were: pain 91.4 ( $\pm$  7.5), symptoms 91.4 ( $\pm$  10.2), daily activity 97.1 ( $\pm$  4), sports 84.4 ( $\pm$  20.7) and quality of life 84 ( $\pm$  14.2). For six patients, scores at median follow-up of 2.6 years were available and compared to newly obtained data. IKDC score at 8.6 years follow-up was not significantly different. KOOS scores for daily activity and sports were maintained.

**Conclusions**

Even in the presence of a complex lesion, horizontal cleavage can be repaired in young patients with good subjective and objective outcomes and a low rate of long-term failure as with other meniscal lesions in young active patients.

**Level of evidence**

IV.

## **Meniscal fixation is a successful treatment for hypermobile lateral meniscus in soccer players**

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<https://doi.org/10.1007/s00167-018-5080-6>

Received: 7 February 2018 / Accepted: 27 July 2018

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### **Abstract**

**Purpose** To report the outcomes (subjective function, return to play, complications and reoperations) of arthroscopic allinside meniscal fixation in a large sample of soccer players with hypermobile lateral meniscus.

### **Methods**

Between 2010 and 2015, 55 patients undergoing surgical treatment for hypermobile lateral meniscus at Mutuallidat Catalana de Futbolistas (Barcelona, Spain) were identified. Patients with open physes, associated injuries, discoid meniscus, or clinical follow-up less than 6 months were excluded. Once identified, all patients were contacted over the phone to collect cross-sectional data on International Knee Documentation Committee (IKDC) score, postoperative Tegner score, and postoperative visual analogue scale (VAS) for pain. In addition, complications and reoperations were retrospectively collected.

### **Results**

Forty-six cases (in 45 patients) with a mean (SD) age of 26.3 (9.5) years and mean (SD; range) follow-up of 43 (19.5; 8–73) months were included. The pre- and post-operative median (range) Tegner score was 9 (6–9) and 8 (0–9), respectively. Compared to the preoperative period, the postoperative Tegner score was equal in 27/46 (59%) cases and lower in 16/46 (35%) cases (3 missing values). Return to play was possible in 38/46 (82%) cases, from which 27/46 (59%) corresponded to the same pre-injury activity level. Postoperatively, the median (range) VAS for pain was 1 (0–9), and the mean (SD) subjective IKDC was 86.2 (16.7). Three of the 46 cases (6.5%) required a reoperation because of pain in one patient (meniscal suture failure) and meniscal tear in two patients.

### **Conclusions**

All-inside meniscal fixation is a successful treatment for hypermobile lateral meniscus, which allows acceptable return to play and good function in soccer players at a low reoperation rate. However, according to the present cross-sectional case series, players should be advised that return to the same pre-injury activity level is achieved in only 27 of 46 (59%) of the cases. Surgeons facing with the difficult problem of hypermobile lateral meniscus in soccer players should consider meniscus fixation as an easy and successful option.

### **Level of evidenc:**

Level IV—Therapeutic Case Series

## Increased knee laxity with hamstring tendon autograft compared to patellar tendon autograft: a cohort study of 5462 patients with primary anterior cruciate ligament reconstruction

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<https://doi.org/10.1007/s00167-018-5029-9>

Received: 4 May 2018 / Accepted: 21 June 2018

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### Abstract

**Purpose** To compare anterior knee laxity and patient-reported outcome measures (PROMs) between anterior cruciate ligament reconstruction (ACLR) performed with bone–patellar tendon–bone (BPTB) and hamstring tendon (HT) autografts and, moreover, to study any correlation between postoperative anterior knee laxity and PROMs.

### Methods

Patients who underwent primary ACLR at Capio Arthro Clinic, Stockholm, Sweden, from January 2000 to October 2015, were identified in our local database. Instrumented laxity measurements and PROMs were reviewed. The KT-1000 arthrometer, with an anterior tibial load of 134-N, was used to evaluate knee laxity preoperatively and at the 6-month followup. The Lysholm score was collected preoperatively and at 6 months postoperatively. The Knee injury and Osteoarthritis Outcome Score (KOOS) was collected preoperatively and at the 1-year follow-up.

### Results

A total of 5462 primary ACLRs, 692 BPTBs and 4770 HT autografts were included in the study. All the patients showed a significant reduction in knee laxity from preoperatively to postoperatively (BPTB group: from  $3.8 \pm 2.6$  to  $1.2 \pm 2.1$  mm; HT group: from  $3.6 \pm 3.1$  to  $1.8 \pm 2.2$  mm;  $P < 0.001$  for both). The HT group showed a significantly increased postoperative knee laxity compared with the BPTB group ( $1.8 \pm 2.2$  vs  $1.2 \pm 2.1$  mm;  $P < 0.001$ ). The mean anterior tibial translation (ATT) reduction from preoperative to postoperative was significantly larger for the BPTB graft compared with the HT graft ( $2.7 \pm 2.2$  vs  $1.7 \pm 2.6$  mm;  $P < 0.001$ ). A significantly higher rate of “surgical failures”, defined as a postoperative side-to-side (STS) difference  $> 5$  mm, was found in the HT group compared with the BPTB group at follow-up (4.3 vs 2.4%;  $P < 0.001$ ). A significantly larger improvement was found in the HT group compared with the BPTB group for the KOOS Pain (9.5 vs 8.0;  $P = 0.02$ ), Activities of Daily Living (7.2 vs 5.7;  $P = 0.006$ ), Sports (24.2 vs 15.3;  $P < 0.001$ ) and Quality of Life (25.8 vs 22.1;  $P = 0.001$ ) subscales. No significant difference regarding the mean improvement in the Lysholm knee score was found between the two grafts (BPTB group: 14.5, HT group: 14.0; n.s.). No correlation between postoperative anterior knee laxity and PROMs was found in either graft group.

### Conclusion

Primary ACLR performed with HT autograft resulted in greater postoperative anterior knee laxity and significantly more surgical failures (STS  $> 5$  mm) compared with BPTB autograft. The BPTB autograft showed a larger anterior knee laxity reduction (ATT reduction) in conjunction with primary ACLR. The HT autograft led to a significantly larger improvement in four of five KOOS subscales from preoperatively to the 1-year follow-up, compared with BPTB autograft. There was no association between postoperative anterior knee laxity and PROMs for either graft. The findings of the present study provide clinicians with valuable information regarding differences in knee laxity and subjective knee function between BPTB and HT autograft after primary ACLR. The use of BPTB autograft should be considered for patients with high knee stability demands.

[BACK](#)

**Level of evidence**

Retrospective cohort study, Level III.

## **Significant anterior enlargement of femoral tunnel aperture after hamstring ACL reconstruction, compared to bone–patellar tendon–bone graft**

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<https://doi.org/10.1007/s00167-018-5098-9>

Received: 4 October 2017 / Accepted: 6 August 2018

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### **Abstract**

**Purpose** This study aimed to retrospectively compare the enlargement and migration of the femoral tunnel aperture after anatomic rectangular tunnel anterior cruciate ligament (ACL) reconstruction with a bone–patella tendon–bone (BTB) or hamstring tendon (HT) graft using three-dimensional (3-D) computer models.

### **Methods**

Thirty-two patients who underwent ACL reconstruction and postoperative computed tomography (CT) at 3 weeks and 6 months were included in this study. Of these, 20 patients underwent ACL reconstruction with a BTB graft (BTBR group), and the remaining 12 with an HT graft (HTR group). The area of the femoral tunnel aperture was extracted and measured using a 3-D computer model generated from CT images. Changes in the area and migration direction of the femoral tunnel aperture during this period were compared between the two groups.

### **Results**

In the HTR group, the area of the femoral tunnel aperture was significantly increased at 6 months compared to 3 weeks postoperatively ( $P < 0.05$ ). The average area of the femoral tunnel aperture at 6 months postoperatively was larger by  $16.0 \pm 12.4\%$  in the BTBR group and  $41.9 \pm 22.2\%$  in the HTR group, relative to that measured at 3 weeks postoperatively ( $P < 0.05$ ). The femoral tunnel aperture migrated in the anteroinferior direction in the HTR group, and only in the inferior direction in the BTBR group.

### **Conclusions**

The femoral tunnel aperture in the HTR group was significantly more enlarged and more anteriorly located at 6 months after ACL reconstruction, compared to the BTBR group.

### **Level of evidence**

IV

## **Younger patients and smokers report a higher level of pain after knee arthroscopy: a clinical and experimental study including synovial metabolism**

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<https://doi.org/10.1007/s00167-018-5125-x>

Received: 29 November 2017 / Accepted: 28 August 2018

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### **Abstract**

Purpose Factors associated with post-surgical pain are not fully explored. The aim of this study was to identify determinants of postoperative pain after arthroscopic surgery of the knee. Synovial tissue metabolism was analysed by microdialysis and the association with individual and peri-surgical factors to identify determinants important for pain management and thus patient satisfaction.

### **Methods**

Cross-sectional study of 57 patients (22 women) with median age of 39 years. All patients were operated on with arthroscopic surgery of the knee and monitored postoperatively with synovial microdialysis. The cross-sectional cohort was investigated to determine local tissue levels of inflammatory and metabolic compounds along with postoperative pain experience. Measurements: pain was determined by visual analogue scale (VAS). Postoperative synovial tissue levels of prostaglandin E2 (PGE2), glucose, and glycerol were measured by microdialysis in the knee synovium. Patients reporting VAS $\geq$ 4 received rescue pain medication with systemic opioids.

### **Results**

Initial results indicated that patients with pain (interpreted as having VAS $\geq$ 4), i.e. those receiving rescue medication with systemic opioids, were of a younger age ( $p=0.04$ ), lower body weight ( $p=0.02$ ), had a lower BMI ( $p=0.04$ ) and/ or were smokers ( $p=0.02$ ). A closer analysis using multinomial logistic regression showed a significantly higher amount of pain in smokers ( $p=0.01$ ) and patients of a younger age ( $p=0.02$ ). A significant correlation was also found between VAS and duration of surgery ( $p=0.007$ ). No significant correlation could be found between VAS and synovial levels of PGE2, glycerol and glucose, but a statistically significant decline with time of PGE2 in both groups.

### **Conclusions**

The results from this study show a significantly higher frequency of pain, post-surgery among younger patients ( $p=0.02$ ) and smokers ( $p=0.01$ ), as well as an association between pain and length of surgery ( $p=0.007$ ). These findings point out individual factors useful for the prediction of postoperative pain after arthroscopic surgery and are clinically important for personalized pain management.

### **Level of evidence**

II

## **Cross-education does not improve early and late-phase rehabilitation outcomes after ACL reconstruction: a randomized controlled clinical trial**

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<https://doi.org/10.1007/s00167-018-5116-y>

Received: 16 November 2017 / Accepted: 14 August 2018

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### **Abstract**

**Purpose** Limited evidence suggests that cross-education affords clinical benefits in the initial 8 weeks after anterior cruciate ligament (ACL) reconstruction, but it is unknown if such cross-education effects are reproducible and still present in later phases of rehabilitation. We examined whether cross-education, as an adjuvant to standard therapy, would accelerate the rehabilitation up to 26 weeks after ACL reconstruction by attenuating quadriceps weakness.

### **Methods**

ACL-reconstructed patients were randomized into experimental (n=22) and control groups (n=21). Both groups received standard care after ACL reconstruction. In addition, the experimental group strength trained the quadriceps of the non-operated leg during weeks 1–12 after surgery (i.e., cross-education). Self-reported knee function was assessed with the Hughston Clinic Knee score as the primary outcome. Secondary outcomes were maximal quadriceps and hamstring strength and single leg hop distance. All outcomes were measured 29±23 days prior to surgery, as a reference, and at 5-week, 12-week, and 26-week post-surgery.

### **Results**

Both groups scored 12% worse on self-reported knee function 5-week post-surgery (95% CI 7–17) and showed 15% improvement 26-week post-surgery (95% CI –20 to –10). No cross-education effect was found. Interestingly, males scored 8–10% worse than females at each time point post-surgery. None of 33 secondary outcomes showed a cross-education effect. At 26-week post-surgery, both legs improved maximal quadriceps (5–14%) and hamstring strength (7–18%), and the noninjured leg improved 2% in hop distance. The ACL recovery was not affected by limb dominance and age.

### **Conclusion**

26 weeks of standard care improved self-reported knee function and maximal leg strength relative to pre-surgery and adding cross-education did not further accelerate ACL recovery.

### **Level of evidence**

I

### **Clinical Trial Registry name and registration**

This randomized controlled clinical trial is registered at the Dutch trial register (<http://www.trialregister.nl>) under NTR4395.

# **No clinical difference in 10-year outcomes between standard and minimal graft debridement techniques in patients undergoing anterior cruciate ligament reconstruction using autologous hamstrings: a randomized controlled trial**

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<https://doi.org/10.1007/s00167-018-5146-5>

Received: 26 May 2018 / Accepted: 14 September 2018

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## **Abstract**

**Purpose** Delayed ligamentization following anterior cruciate ligament reconstruction (ACLR) may result in reduced graft stiffness and strength, and an increased risk of secondary re-tear. Remnant sparing ACLR may accelerate ligamentization and proprioceptive function, theoretically reducing re-injury risk. This study sought to investigate 10-year graft failure rates and patient perceived knee functioning in those undergoing ACLR with remnant preservation (RP), versus remnant debridement (RD).

## **Methods**

A prospective RCT allocated 49 patients to ACLR with a hamstrings autograft together with a RD (n=25) or RP (n=24) procedure, of which 86% were clinically evaluated at 10 years (22 RD, 22 RP). A detailed chart review and patient phone consultation was undertaken with all patients at 10 years to evaluate the incidence (and timing) of subsequent re-tear and/or contralateral ACL tear, as well as other knee injuries/surgeries, the patient's ability to perform full work/sport duties and their perceived knee function using a numerical rating scale (NRS).

## **Results**

No significant differences existed between groups in descriptive variables. There were 2 graft ruptures (10.0%) in the RP group and 3 (13.6%) in the RD group, with an earlier mean time to graft failure in the RD group (RD 7.7±4.5 months, RP 49.5±17.7 months), albeit the size of this sub-sample was too small for statistical comparison. There was a significantly higher number of patients requiring ≥1 additional ipsilateral knee surgery in the RP group (RP=10, RD=4, p=0.048). At 10 years, there were no significant group differences in the percentage of patients returning to unrestricted activity, with 16 (72.7%) and 15 (75.0%) patients in the RD and RP ACLR groups, respectively, unrestricted in work/sport duties. There were no significant group differences in the functional NRS ratings.

## **Conclusions**

No long term clinical benefit of RP ACLR could be determined by this study with similar re-tear incidence and perceived knee function. A statistically higher number of re-operations were observed in RP ACLR patients and, while re-tears were observed later after RP versus RD ACLR, the study was underpowered to detect statistical significance.

## **Level of evidence**

Level II (prospective randomized controlled trial).

## **Obstructive sleep apnea affects complication rates following knee arthroscopy but use of continuous positive airway pressure is not protective against complications**

James B. Carr II, Jourdan M. Cancienne, Brian C. Werner

<https://doi.org/10.1007/s00167-018-5144-7>

Received: 27 January 2018 / Accepted: 14 September 2018

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### **Abstract**

**Purpose** Obstructive sleep apnea (OSA) has not been studied as a risk factor for complications following knee arthroscopy. The goals of this study were to: (1) compare complication rates after knee arthroscopy between patients with and without OSA and (2) evaluate whether continuous positive airway pressure (CPAP) mitigated complication rates.

### **Methods**

A national private insurance database was queried for patients undergoing simple knee arthroscopy from 2007 to 2016. Patients with a diagnosis of OSA were then identified using ICD-9/10 codes. Patients with OSA were then subdivided into cohorts with and without a billing code for a CPAP device. Adverse events within 30 days postoperatively related to OSA were then assessed in all groups: (1) emergency room (ER) visit, (2) hospital admission, (3) pulmonary embolism (PE), (4) myocardial infarction, (5) respiratory arrest and (6) in-hospital mortality within 6 months postoperatively. Adverse event rates were compared between the control and study groups using a multivariable regression analysis.

### **Results**

97,036 patients underwent simple knee arthroscopy with 8656 patients having a diagnosis of OSA. Of these, 3820 (44%) had orders for CPAP machines. After controlling for confounders, patients with OSA had significantly higher risk of ER visits, PE and respiratory arrest compared to controls ( $p < 0.05$ ). The majority of these significant findings persisted regardless of CPAP use. There were no significant differences in complication rates between OSA patients with and without CPAP orders.

**Conclusions** OSA appears to be independently associated with a higher risk for ER visits, PE and respiratory arrest following knee arthroscopy after controlling for demographic and comorbidity confounders. An order for CPAP was not associated with a significant reduction the risk for these complications. CPAP noncompliance may not be as important a factor when risk stratifying patients undergoing ambulatory knee arthroscopy compared to more significant medical comorbidities.

### **Level of evidence**

III

## **Fatigue affects quality of movement more in ACL-reconstructed soccer players than in healthy soccer players**

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<https://doi.org/10.1007/s00167-018-5149-2>

Received: 25 May 2018 / Accepted: 19 September 2018

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### **Abstract**

**Purpose** Athletes who meet return to play (RTP) criteria after anterior cruciate ligament reconstruction (ACLR) rehabilitation still have a substantially increased risk of second ACL injury. One of the contributing factors to this increased risk could be that the RTP criteria are often not tested in an ecologically valid environment and in a fatigued state. The purpose of this cross-sectional case-control study was to investigate the influence of neuromuscular fatigue on both movement quantity and quality in fully-rehabilitated soccer players after ACLR and to compare them with healthy soccer players.

**Methods** ACL-reconstructed soccer players (n=14) and healthy soccer players (n=19) participated in the study and were matched by playing level and training hours. RTP measurements were performed on the soccer field, in both a non-fatigued and fatigued state. The RTP measurements focussed on both movement quantity (hop tests) and quality [countermovement jump with a Landing Error Scoring System (LESS) score].

**Results** Movement quantity did not differ between ACL-reconstructed and healthy soccer players, both expressed in absolute values and the LSI-D/ND (calculated as dominant/non-dominant\*100%). However, movement quality decreased more in the ACL-reconstructed soccer players in the fatigued state compared to the non-fatigued state.

### **Conclusions**

Ideally, RTP measurements should focus on movement quality and should be conducted on the soccer field in a fatigued state, creating an ecologically valid environment. The LSI-D/ND can be used as an outcome parameter for RTP measurements of movement quantity and should be at least 95%.

### **Level of evidence**

Therapeutic, Level III.

## **Preoperative laxity in ACL-deficient knees increases with posterior tibial slope and medial meniscal tears**

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<https://doi.org/10.1007/s00167-018-5180-3>

Received: 7 June 2018 / Accepted: 20 September 2018

© European Society of Sports Traumatology, Knee Surgery, Arthroscopy (ESSKA) 2019

### **Abstract**

**Purpose** The aim of this study was to determine patient and anatomic factors that influence anteroposterior and rotational laxity in knees with ACL tears. Based on the findings of biomechanical studies, we hypothesized that static and dynamic anterior tibial translation (ATT) as well as positive pivot shift would increase with female gender, tibial slope, and meniscal tears.

### **Methods**

The authors prospectively collected preoperative data and intraoperative findings of 417 patients that underwent ACL reconstruction. The exclusion criteria were: revision ACL procedures (n=53), other surgical antecedents (n=27), prior osteotomies (n=7) or concomitant ligament tears on the ipsilateral knee (n=34), and history of ACL tears in the contralateral knee (n=45), leaving a study cohort of 251 patients. Their preoperative anteroposterior knee laxity was assessed objectively using 'static' monopodal weight-bearing radiographs and 'dynamic' instrumented differential measurements of ATT. Rotational laxity was assessed subjectively using the pivot shift test.

### **Results**

Multivariable regression showed that static ATT increases only with tibial slope ( $\beta=0.30$ ;  $p<0.001$ ), but dynamic ATT increases with tibial slope ( $\beta=0.19$ ;  $p=0.041$ ), medial meniscal tears ( $\beta=1.27$ ;  $p=0.007$ ), complete ACL tears ( $\beta=2.06$ ;  $p<0.001$ ), and to decrease with age ( $\beta=-0.09$ ;  $p<0.001$ ). Multivariable regression also indicated that high-grade pivot shift decreases with age (OR 0.94;  $p<0.001$ ) and for women (OR 0.25;  $p<0.001$ ), and to be higher for knees with complete ACL tears (OR 3.04;  $p=0.002$ ) or medial meniscal tears (OR 2.28;  $p=0.010$ ).

### **Conclusion**

Contrary to expectations based on biomechanical studies, static ATT was only affected by high posterior tibial slope, while dynamic ATT was affected by both high posterior tibial slopes and medial meniscal tears, but not by gender or lateral meniscal tears. Likewise, pivot shift was affected by gender and medial meniscal tears, but not lateral meniscal tears or posterior tibial slope. These findings are relevant to guide surgeons in optimizing their surgical procedures, such as conserving the menisci when possible, and rehabilitation protocols, by delaying full weight-bearing and return to sports in patients with anatomic and lesional risk factors.

### **Level of evidence**

Cohort study, Level IV.

## **Muscle hypotrophy, not inhibition, is responsible for quadriceps weakness during rehabilitation after anterior cruciate ligament reconstruction**

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<https://doi.org/10.1007/s00167-018-5166-1>

Received: 23 March 2018 / Accepted: 25 September 2018

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### **Abstract**

**Purpose** Quadriceps weakness is common after anterior cruciate ligament reconstruction (ACLR). Limited neuromuscular activation may have a role in the weakness. The purpose of this study was to use peripheral magnetic stimulation to measure changes in quadriceps inhibition in patients during rehabilitation from ACLR.

### **Methods**

Ten patients (7M/3F; age 35±8 years; BMI 26.0±4.8 kg/m<sup>2</sup>) who had ACLR with patellar tendon autograft were recruited. At 3 and 6 months postoperatively, patients' knee extension peak torque was measured during maximum voluntary isometric contraction (MVIC), magnetic stimulation-evoked contraction, and MVIC augmented with superimposed burst magnetic stimulation to the femoral nerve. All tests were done bilaterally at 30° and 65° of knee flexion on a dynamometer. Central activation ratio was calculated by dividing the peak torque before stimulation by peak torque after stimulation.

### **Results**

Patients had marked deficits in MVIC, with improvement from 3 to 6 months that was more apparent at 65° versus 30° ( $P < 0.05$ ). There was significant deficit in stimulation-evoked torque on the involved side that diminished over time, and this change occurred differently between the two angles ( $P < 0.05$ ). Central activation ratio was lower on the involved side versus the noninvolved side and this effect was more prominent at 3 versus 6 months: combining the angles, mean central activation ratio on the involved and noninvolved sides, respectively, was 91.4±7.6% and 97.5±5.3% at 3 months, and 93.0±7.8% and 95.8±6.8% at 6 months.

### **Conclusions**

At 3 and 6 months after ACLR, there were significant deficits in quadriceps strength and activation. Quadriceps activation levels were high (>90%) for both sides at both time points. The substantial strength deficits at this postoperative period may be largely due to muscle atrophy with limited contribution from central inhibition. Rehabilitation interventions to normalize quadriceps strength should emphasize hypertrophic stimuli as opposed to neuromuscular activation strategies.

### **Level of evidence**

II prospective cohort study.

## **Abnormal tibial alignment is a risk factor for lateral meniscus posterior root tears in patients with anterior cruciate ligament ruptures**

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<https://doi.org/10.1007/s00167-018-5171-4>

Received: 6 April 2018 / Accepted: 21 September 2018

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### **Purpose**

The purpose of this study was to identify if abnormal tibial alignment was a risk factor for lateral meniscus posterior root tears (LMPRT) in patients with acute anterior cruciate ligament (ACL) ruptures.

### **Methods**

The medical charts of 200 patients treated for ACL ruptures between 2013 and 2016 were retrospectively reviewed and evaluated. MRI images and reports were assessed for concurrent meniscal tears. Radiographs were reviewed for tibia vara and tibial slope angles and MRI reports identifying lateral root tears were compared to intraoperative reports to determine accuracy. Multiple logistic regression models were constructed to identify potential risk factors for LMPRTs.

### **Results**

Of the 200 patients reviewed, a total of 97 individuals with concurrent meniscal injuries were identified. In patients sustaining a concurrent meniscal injury, there was a 4% incidence of medial meniscus posterior root tears and a 10.3% incidence of LMPRTs. Patients sustaining an ACL injury with an LMPRT were found to have greater tibia vara angles ( $4.2 \pm 1.0$  vs.  $2.9 \pm 1.7$ ;  $p=0.024$ ), increased tibial slopes ( $12.6 \pm 1.5$  vs.  $10.7 \pm 2.9$ ;  $p=0.034$ ), and higher BMIs ( $27.3 \pm 2.9$  vs.  $25.3 \pm 5.9$ ;  $p=0.034$ ) when compared to patients without meniscus tears. There was low agreement between MRI and arthroscopic findings (kappa rate=0.54). Multiple logistic regression analysis demonstrated that a tibia vara angle  $>3$  was associated with a 5.2-fold increase (95% CI 0.99–27.01;  $p=0.050$ ), and a tibial slope  $>12$  with a 5.4-fold increase (95% CI 1.03–28.19;  $p=0.046$ ) in LMPRTs.

### **Conclusions**

Patients with greater tibia varus angles, increased tibial slopes, and higher BMIs were found to have an increased risk of LMPRTs when sustaining an ACL rupture. There was a low rate of agreement between MRI and arthroscopy in identifying LMPRTs. In patients with ACL ruptures who have abnormal tibial alignment or increased BMI, physicians should be watchful for lateral meniscus posterior root tears.

### **Level of evidence**

III

## **Greater knee flexion excursion/moment in hopping is associated with better knee function following anterior cruciate ligament reconstruction**

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<https://doi.org/10.1007/s00167-018-5197-7>

Received: 19 March 2018 / Accepted: 2 October 2018

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### **Purpose**

Individuals with impaired knee function after anterior cruciate ligament reconstruction (ACLR) may be at greater risk of developing knee osteoarthritis related to abnormal knee joint movement and loading. The aim of this study was to assess the association between knee biomechanics and knee laxity during hopping and clinically assessed knee function (i.e., patient-reported knee function and hop tests) following ACLR.

### **Methods**

Sixty-six participants (23 women, mean age  $28\pm 6$  years, mean  $18\pm 3$  months following ACLR) completed a standardized single-leg hopping task. Three-dimensional movement analysis was used to assess knee flexion excursion and body weight/height normalized knee flexion moments during landing for the involved limb. Anterior–posterior knee laxity was assessed with a KT-1000 knee arthrometer. Participants then completed a patient-reported knee function questionnaire and three separate hop tests (% of uninvolved limb) and were divided into poor and satisfactory knee function groups (satisfactory:  $\geq 85\%$  patient-reported knee function and  $\geq 85\%$  hop test symmetry). Associations between knee function and hop biomechanics/knee laxity were assessed using logistic regression and interquartile range scaled odds ratios (ORIQR).

### **Results**

Greater knee flexion excursion (ORIQR 2.9, 95%CI 1.1–7.8), greater knee flexion moment (ORIQR 4.9, 95%CI 1.6–14.3) and lesser knee laxity (ORIQR 4.7, 95%CI 1.5–14.9) were significantly associated with greater odds of having satisfactory knee function ( $\geq 85\%$  patient-reported knee function and  $\geq 85\%$  hop test symmetry).

### **Conclusion**

Greater knee flexion excursion/moment during hop-landing and lesser knee laxity is associated with better patient-reported knee function and single-leg hop test performance following ACLR. Patients with lower levels of knee function following ACLR demonstrated hop-landing biomechanics previously associated with early patellofemoral osteoarthritis. Therefore, interventions aimed at improving hop landing biomechanics in people with poor knee function are likely required.

### **Level of evidence**

III, Cross-sectional study.

## Shallow knee flexion angle during femoral tunnel creation using modified transtibial technique can reduce femoral graft bending angle in ACL reconstruction

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<https://doi.org/10.1007/s00167-018-5191-0>

Received: 2 April 2018 / Accepted: 1 October 2018

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### Abstract

#### Purpose

The purpose of this study was to compare femoral graft bending angle between patients with femoral tunnel reamed at less than 80° of knee flexion and those with 80° and above in anatomical anterior cruciate ligament (ACL) reconstruction using modified transtibial technique.

#### Methods

Forty-eight patients who underwent ACL reconstruction using bone–patellar-tendon–bone autograft in modified transtibial technique and CT scan at 1 week postoperatively were included in this study. A femoral guidewire insertion into aimed femoral position at the medial wall of the femoral lateral condyle was started at about 75° of knee flexion. When the tip of the guidewire was blown out into femoral posterior wall, the guidewire was inserted again after increasing knee flexion angle. Distance from femoral tunnel exit on the femoral lateral cortex–femoral posterior cortex (Distance-E) was measured on postoperative lateral radiograph. Femoral and tibial tunnel position was measured on 3-D CT images. In addition, femoral graft bending angle was measured on reconstructed 2-D CT images. Patients were divided into two groups depending on whether femoral tunnel was created at less than 80° of knee flexion (group A) or 80° or more (group B).

#### Results

There were 32 patients in group A and 16 patients in group B, respectively. Average knee flexion angle was 77.2° [standard deviation (SD) 1.6] in group A and 83.6° (SD 2.4) in group B, respectively ( $p < 0.05$ ). Average Distance-E was 5.1 mm (SD 2.6) in group A and 6.6 mm (SD 3.8) in group B, respectively. There was no significant difference in the femoral and tibial tunnel position between group A and B. Femoral graft bending angle was significantly smaller in group A [average angle: 50.9° (SD 6.6)] than in group B [average angle: 55.0° (SD 6.6)] ( $p < 0.05$ ).

#### Conclusions

Anatomical femoral tunnel was able to be created at less than 80° of knee flexion in two-thirds of patients. Shallower flexion angle (less than 80°) provided gentler femoral graft bending angle compared to 80° or more of knee flexion. Therefore, femoral tunnel creation in modified transtibial technique should be started at between 75° and 80° of knee flexion to reduce femoral graft bending angle. Shallow knee flexion angle during femoral tunnel creation using modified transtibial technique can reduce femoral graft bending angle and may lead to better clinical outcomes in ACL reconstruction.

#### Level of evidence

Retrospective comparative study, Level III.

# **Femoral tunnel widening is similar between anteromedial portal and transtibial techniques following single-bundle anterior cruciate ligament reconstruction: a systematic review and meta-analysis**

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<https://doi.org/10.1007/s00167-018-5204-z>

Received: 20 April 2018 / Accepted: 4 October 2018

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## **Abstract**

### **Purpose**

In anterior cruciate ligament (ACL) reconstruction, there is concern regarding the potential risk of femoral tunnel widening in the anteromedial portal (AMP) technique due to the acute graft-bending angle at the aperture and the more elliptical aperture shape of the femoral tunnel compared to the transtibial (TT) techniques. Therefore, the aim of the current systematic review and meta-analysis was to compare the femoral tunnel widening between the AMP and TT techniques in patients who underwent ACL reconstruction.

### **Methods**

It should be included the studies that reported on femoral tunnel widening in patients who underwent single-bundle ACL reconstruction, using soft-tissue tendon graft, with AMP and/or TT techniques. Two reviewers independently recorded data from each study, including the sample size and magnitude of tunnel widening after ACL reconstruction.

### **Results**

Twenty-one studies were finally included in this meta-analysis. The pooled changes of absolute millimeters of tunnel widening from the immediate postoperative status to the last follow-up did not differ significantly between the AMP and TT techniques at both the aperture [3.31 mm, 95% confidence interval (CI) 1.7–5.0. mm versus 2.9 mm, 95% CI 2.4–3.4 mm, P=n.s.] and the midportion (3.5 mm, 95% CI 0.8–6.3 mm versus 3.0 mm, 95% CI 2.2–3.9 mm, P=n.s.) of the femoral tunnel. No significant difference was observed between the two techniques in the relative percentage of femoral tunnel widening (AMP; 28.8%, 95% CI 14.8–42.9% vs. TT; 29.7%, 95% CI 15.6–43.7%, P=n.s.).

### **Conclusion**

No significant difference in femoral tunnel widening was observed between the AMP and TT techniques, both in absolute millimeter and relative percentage, in patients who underwent single-bundle ACL reconstruction. This finding could alleviate the potential concerns associated with femoral tunnels being wider for the AMP than for the TT technique.

### **Level of evidence**

III.

## **Anterior cruciate ligament reconstruction improves subjective ability but not neuromuscular biomechanics during dynamic tasks**

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<https://doi.org/10.1007/s00167-018-5189-7>

Received: 16 November 2017 / Accepted: 1 October 2018

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### **Abstract**

#### **Purpose**

The purpose of this study was to identify high-functioning anterior cruciate ligament-deficient patients and assess the effects of reconstruction on their self-reported functionality, muscle activations and biomechanical properties.

#### **Methods**

Twenty young and active patients participated pre- (11.5±14.3 months post-injury) and again 10.5±1.7 months post-reconstruction and were individually matched to 20 healthy controls. Participants completed hop and side cut movements while patient-related outcome measures, lower limb electromyography, kinetic, and whole body kinematic data were collected. One-dimensional statistical parametric mapping was used to test for group differences (healthy vs deficient; deficient vs reconstructed; reconstructed vs healthy).

#### **Results**

When comparing healthy to anterior cruciate ligament-deficient participants, all questionnaires indicated significant lower subjective function while the only substantial biomechanical difference between these participants was a decreased knee extensor moment in both the hop (peak difference: 0.63 Nm/kg,  $p < 0.001$ ) and side cut (peak difference: 0.76 Nm/kg,  $p < 0.001$ ). When comparing patients' pre- and post-reconstruction, no biomechanical differences were observed whereas only half of the questionnaires (Tegner, Lysholm, KNEES-ADL, KNEES-Slackness, KNEES-Looseness, KNEES-Sport Behaviour, IKDC, and KOOS-QoL) indicated higher function in the reconstructed state. When comparing the reconstructed patients to the healthy participants, all questionnaires were still significantly higher in the healthy controls. The reconstructed group also had a smaller flexion angle (peak difference: 14.5°,  $p = 0.007$ ) and knee extensor moment (peak difference: 0.62 Nm/kg,  $p < 0.001$ ) during the hop and a smaller knee extensor moment (peak difference: 0.90 Nm/kg,  $p < 0.001$ ) during the inside cut-task.

#### **Conclusion**

At 10-months post-reconstruction, the current results indicate that in high-functioning anterior cruciate ligament-deficient patients, reconstruction had little impact on objective measures of functional ability during dynamic tasks although self-reported function was improved.

#### **Level of evidence**

Therapeutic prospective cohort study, Level II.

## **The lateral femoral notch sign: a reliable diagnostic measurement in acute anterior cruciate ligament injury**

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<https://doi.org/10.1007/s00167-018-5214-x>

Received: 26 March 2018 / Accepted: 9 October 2018

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### **Abstract**

#### **Purpose**

To describe the validity and inter- and intra-observer reliability of the lateral femoral notch sign (LFNS) as measured on conventional radiographs for diagnosing acute anterior cruciate ligament (ACL) injury.

#### **Methods**

Patients ( $\leq 45$  years) with a traumatic knee injury who underwent knee arthroscopy and had preoperative radiographs were retrospectively screened for this case-control study. Included patients were assigned to the ACL injury group ( $n=65$ ) or the control group ( $n=53$ ) based on the arthroscopic findings. All radiographs were evaluated for the presence, depth and location of the LFNS by four physicians who were blind to the conditions. To calculate intra-observer reliability, each observer re-assessed 25% of the radiographs at a 4-week interval.

#### **Results**

The depth of the LFNS was significantly greater in ACL-injured patients than in controls [median 0.8 mm (0–3.1 mm) versus 0.0 mm (0–1.4 mm), respectively;  $p=0.008$ ]. The inter- and intra-observer reliabilities of the LFNS depth were 0.93 and 0.96, respectively. Secondary knee pathology (i.e., lateral meniscal injury) in ACL-injured patients was correlated with a deeper LFNS [median 1.1 mm (0–2.6 mm) versus 0.6 mm (0–3.1 mm),  $p=0.012$ ]. Using a cut-off value of 1 mm for the LFNS depth, a positive predictive value of 96% was found.

#### **Conclusion**

This was the first study to investigate the inter- and intra-observer agreement of the depth and location of the LFNS. The depth of the LFNS had a very high predictive value for ACL-injured patients and could be used in the emergency department without any additional cost. A depth of  $>1.0$  mm was a good predictor for ACL injury. Measuring the depth of the LFNS is a simple and clinically relevant tool for diagnosing ACL injury in the acute setting and should be used by clinicians in patients with acute knee trauma.

#### **Level of evidence**

Diagnostic study, level II.

## **Systematic Review and Meta-analysis of Outcomes After Hip Arthroscopy in Femoroacetabular Impingement**

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First Published January 26, 2018; pp. 488–500

<https://doi.org/10.1177/0363546517749475>

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### **Background**

Femoroacetabular impingement (FAI) has become a more commonly recognized cause of limited hip range of motion and hip pain among young adults and athletes. Hip arthroscopy is recommended for the surgical treatment of this disorder, unless specific contraindications exist. Despite the increasing rate of published studies in this area, there remains no aggregate data for outcomes after this approach.

**Purpose** To evaluate risk factors and outcomes after arthroscopic management of FAI, including return to play, revision rate, surgical and nonsurgical complications, change in  $\alpha$ -angle, intraoperative bone resection, and patient-reported outcomes.

### **Study Design**

Meta-analysis and systematic review.

### **Methods**

A review of the current literature was performed with the terms “femoroacetabular impingement,” “hip arthroscopy,” and numerous variations thereof in PubMed, EMBASE, BioMed Central, Cochrane, Science Direct, and Scopus, yielding 1723 abstracts. After screening by eligibility criteria, 31 articles were included. The incidence of bilateral FAI was determined by enrollment data, and pooled estimates were calculated for postoperative patient-reported outcome measures,  $\alpha$ -angles, return to sport, postoperative complications, and reoperation risk.

### **Results**

A total of 1981 hips among 1911 patients were identified, with a mean  $\pm$  SD age of  $29.9 \pm 1.9$  years and  $29.5 \pm 14.0$  months of follow-up. The incidence of bilateral FAI in these studies that required operative intervention was 3.6%. The pooled risk of reoperation after hip arthroscopy, including revision surgery or subsequent total hip arthroplasty, was 5.5% (95% CI, 3.6%-7.5%). The risk of clinical complications was 1.7% (95% CI, 0.9%-2.5%). In total, 87.7% of patients demonstrated return to sport after surgery (95% CI, 82.4%-92.9%,  $P < .001$ ), and all patient-reported outcomes improved postoperatively, with the highest increase observed in the Hip Outcome Score sports scale (41.7 points; 95% CI, 34.1-49.4;  $P < .001$ ). The  $\alpha$ -angle decreased by an average of  $23.6^\circ$  (95% CI,  $18.2^\circ$ - $29.0^\circ$ ;  $P < .001$ ). We identified 11 factors associated with the success of hip arthroscopy in FAI and 16 factors associated with failure or negative outcomes.

### **Conclusion**

A high percentage of patients return to sport activities after hip arthroscopy for FAI, with a low rate of complications and reoperation. All patient-reported outcome measures, except for mental health, significantly improved after surgery.

## **Hip Arthroscopic Management Can Improve Osteitis Pubis and Bone Marrow Edema in Competitive Soccer Players With Femoroacetabular Impingement**

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First Published January 21, 2019; pp. 408–419

<https://doi.org/10.1177/0363546518819099>

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### **Background**

There is a dearth of knowledge regarding the correlation between femoroacetabular impingement (FAI) and osteitis pubis (OP) among symptomatic soccer players.

### **Purpose**

To elucidate whether arthroscopic FAI correction is effective for young competitive soccer players with FAI combined with OP or perisymphyseal pubic bone marrow edema (BME).

### **Study Design**

Case series; Level of evidence, 4.

### **Methods**

A total of 577 consecutive patients who underwent arthroscopic FAI correction were retrospectively reviewed with a minimum 2-year follow-up. Competitive soccer players who were professional, college, and high school athletes were included. The authors assessed the modified Harris Hip Score and Nonarthritic Hip Score preoperatively and at 6 months, 1 year, and 2 years after surgery. In addition, players were divided into groups according to radiographic evidence of OP and BME (2 groups each). Clinical outcomes, return to play, and radiographic assessments were compared between groups.

### **Results**

Twenty-eight hips met the inclusion criteria. The median modified Harris Hip Score significantly improved after hip arthroscopy (81.4, preoperatively; 95.7 at 6 months,  $P = .0065$ ; 100 at 1 year,  $P = .0098$ ; 100 at 2 years,  $P = .013$ ). The median Nonarthritic Hip Score also significantly improved (75.0, preoperatively; 96.3 at 6 months,  $P = .015$ ; 98.8 at 1 year,  $P = .0029$ ; 100 at 2 years,  $P = .015$ ). Furthermore, 92.0% of players returned to play soccer at the same or higher level of competition at a median 5.5 months (range, 4-15 months); 67.8% had radiological confirmation of OP; and 35.7% had pubic BME. The alpha angle was significantly higher in pubic BME group than the no-pubic BME group ( $64.8^\circ$  vs  $59.2^\circ$ ,  $P = .027$ ), although there was no significant difference between the OP and no-OP groups. The prevalence of tenderness of the pubic symphysis significantly decreased preoperatively (32.1%) to postoperatively (3.6%). Magnetic resonance imaging findings confirmed that pubic BME disappeared in all players at a median 11 months (range, 6-36) after initial surgery.

### **Conclusions**

Arthroscopic management for FAI provides favorable clinical outcomes, a high rate of return to sports, and, when present, resolution of pubic BME among competitive soccer players.

[BACK](#)

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## Miscellaneous

Arthroscopy, Volume 35, Issue 2

### **Low-Cost Self-Made Arthroscopic Training Camera Is Equally as Effective as Commercial Camera: A Comparison Study**

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Arthroscopy, Volume 35, Issue 2, Received: April 18, 2018; Accepted: August 14, 2018

<https://doi.org/10.1016/j.arthro.2018.08.038>

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#### **Purpose**

To assess the effectiveness of a low-cost self-made arthroscopic camera (LAC) in basic arthroscopic skills training compared with a commercial arthroscopic camera (CAC).

#### **Methods**

One hundred fifty-three orthopaedic residents were recruited and randomly assigned to either the LAC or CAC. They were allocated 2 practice sessions, with 20 minutes each, to practice 4 given arthroscopic tasks: task 1, transferring objects; task 2, stacking objects; task 3, probing numbers; and task 4, stretching rubber bands. The time taken for participants to complete the given tasks was recorded in 3 separate tests; before practice, immediately after practice, and after a period of 3 months. A comparison of the time taken between both groups to complete the given tasks in each test was measured as the primary outcome.

#### **Results**

Significant improvements in time completion were seen in the post-practice test for both groups in all given arthroscopic tasks, each with  $P < .001$ . However, there was no significant difference between the groups for task 1 ( $P = .743$ ), task 2 ( $P = .940$ ), task 3 ( $P = .932$ ), task 4 ( $P = .929$ ), and total ( $P = .944$ ). The outcomes of the tests (before practice, after practice, and at 3 months) according to repeated measures analysis of variance did not differ significantly between the groups in task 1 ( $P = .475$ ), task 2 ( $P = .558$ ), task 3 ( $P = .850$ ), task 4 ( $P = .965$ ), and total ( $P = .865$ ).

#### **Conclusions**

The LAC is equally as effective as the CAC in basic arthroscopic skills training with the advantage of being cost-effective.

#### **Clinical Relevance**

In view of the scarcity in commercial arthroscopic devices for trainees, this low-cost device, which trainees can personally own and use, may provide a less expensive and easily available way for trainees to improve their arthroscopic skills. This might also cultivate more interest in arthroscopic surgery among junior surgeons.

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