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## Upper extremity

Arthroscopy, Volume 35, Issue 4

### **Does The Type of Shoulder Brace Affect Postoperative Pain and Clinical Outcome After Arthroscopic Rotator Cuff Repair?**

Tarek Mohamed Ghandour, Amr Ibrahim, M.D., Amr A. Abdelrahman, M.D., Ahmed Elgammal, M.D., Mohamed Hassan Hammad, M.D.

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#### **Purpose**

To compare postoperative pain and clinical outcome after arthroscopic rotator cuff repair in patients immobilized with an abduction brace versus patients placed in an antirotation brace.

#### **Methods**

One hundred twenty patients (72 women and 48 men) with symptomatic degenerative complete tear of the supraspinatus or infraspinatus tendons were included in the study. Exclusion criteria were history of trauma/traumatic tears, concomitant shoulder pathology, psychological illnesses, and previous shoulder surgery. The Constant-Murley score (CMS) was obtained before surgery and at 3 months, 6 months, and 1 year after surgery. The visual analogue scale (VAS) was done on the day of surgery and at 1 week, 3 weeks, 6 weeks, and 3 months after surgery. Postoperative isokinetic muscle strength evaluation was done for the shoulder external rotator at 1 year.

#### **Results**

Mean age was 50.4 years for the abduction brace group (ABG) and 50.8 years for the open pouch arm sling group (PASG). The mean level of the VAS score ranged from 75.6 for the ABG and 74.9 for the PASG on the day of the operation to 17.7 and 18.5 at 3 months after surgery. In both groups, the repeated measure analysis of variance showed that there were highly significant changes ( $P < .001$ ) in the VAS from the day of operation to 3 months after surgery. A significant improvement was detected in both groups in the mean level of the CMS, from 40.9 for the ABG and 41.2 for the PASG before surgery to 84.7 and 84.5 at 1 year after the operation. There was no statistically significant difference between the 2 groups regarding the isokinetic muscle strength, VAS, or the CMS.

#### **Conclusions**

Our study did not find a significant difference between abduction brace and antirotation sling in patient-oriented outcome measures or postoperative pain after rotator cuff repair.

#### **Level of Evidence**

Level II, prospective comparative study.

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## **Predictive Factors and the Duration to Pre-Injury Work Status Following Biceps Tenodesis**

Avinesh Agarwalla, B.S.a, Anirudh K. Gowd, B.S.a, Joseph N. Liu, M.D.b, Richard N. Puzziello, B.S.a, Brian J. Cole, M.D., M.B.A.a, Anthony A. Romeo, M.D.a, Nikhil N. Verma, M.D.a, Brian Forsythe, M.D

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### **Purpose**

To determine when patients return to work after biceps tenodesis stratified by the preinjury level of work-intensity and to identify predictive measures of return to work.

### **Methods**

Patients undergoing biceps tenodesis between 2014 and 2017 were reviewed. Patients receiving concomitant rotator cuff repair or arthroplasty, revision biceps tenodesis, or unemployment before the procedure were excluded. Patient-acceptable symptom state (PASS), substantial clinical benefit, and minimal clinically important difference were calculated for the American Shoulder Elbow Society (ASES) score, subjective Constant-Murley score (CMS), and Single Assessment Numerical Evaluation (SANE) using the anchor-based and distribution-based approach. Preoperative outcome scores were analyzed to determine their predictive power of return to work using receiver operator curve area under the curve (AUC) analysis. Multivariate logistical analysis assessed predictive variables of return to work.

### **Results**

Seventy-nine percent of patients were able to return to work without permanent restrictions at an average of  $5.4 \pm 2.8$  months after biceps tenodesis. Return to work status for sedentary, light, moderate, and heavy duties were 100%, 85%, 71%, and 69%, respectively. Return to work was associated with achieving PASS for the ASES and SANE questionnaires ( $P = .006$ ,  $.003$ , respectively) but not for the CMS ( $P = .768$ ). On multivariate analysis, there were no preoperative or intraoperative variables that were predictive of return to work in full capacity. The preoperative Short Form-12 mental component score ( $>59.4$ , AUC = 71.2%) was predictive of returning to work.

### **Conclusions**

After biceps tenodesis, most patients were able to return to work at an average of  $5.4 \pm 2.8$  months. Furthermore, there were no demographic or intraoperative variables that were predictive of return to work. Work intensity was not correlated with an increased duration of return to work. Achieving PASS on the ASES and SANE questionnaires was predictive of return to work.

### **Level of Evidence**

Level IV, case series.

## **Biceps Tenodesis Is a Viable Option for Management of Proximal Biceps Injuries in Patients Less Than 25 Years of Age**

Justin W. Griffin, Gregory L. Cvetanovich, M.D., Jae Kim, M.S.a, Timothy S. Leroux, M.D., Jonathan Riboh, M.D.a, Bernard R. Bach, M.D., Brian J. Cole, M.D., Gregory P. Nicholson, M.D., Nikhil N. Verma, M.D., Anthony A. Romeo, M.D.

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### **Purpose**

To evaluate outcomes after biceps tenodesis performed in patients younger than 25 years, to evaluate reoperations and complications in this population, and to critically appraise return to preinjury level of play for this population.

### **Methods**

Forty-five consecutive patients younger than 25 years underwent subpectoral biceps tenodesis for biceps tendinopathy or biceps-labral complex injuries including SLAP tears. Biceps tenodesis was performed using an interference screw technique. Patients with a minimum 2-year follow-up were analyzed. Functional outcomes were assessed with the visual analog scale score, American Shoulder and Elbow Surgeons (ASES) score, ASES functional score, Simple Shoulder Test score, and range of motion. Activity level and return to sport were followed postoperatively.

### **Results**

Of the 45 patients younger than 25 years who underwent biceps tenodesis, 36 (80%) were available for follow-up at a minimum of 2 years, with a mean age of 19.8 years and mean follow-up period of 38.6 months. Of these 36 patients, 34 (94%) were athletes, with 20 patients playing at collegiate level. All clinical outcome scores improved, with the ASES score improving from 54.7 to 81.7, the ASES functional score improving from 17.5 to 25.1, and the Simple Shoulder Test score improving from 7.4 to 10.1 ( $P < .001$ ). At the time of follow-up, 4 patients (11%) had undergone revision surgery for other injuries. Of the 34 athletes, 25 (73%) returned to sports, with 19 returning at the same level and 6 returning at a lower level of play; 77% of overhead athletes returned to sports.

### **Conclusions**

When indicated, biceps tenodesis offers an alternative to SLAP repair in young patients. Biceps tenodesis in patients younger than 25 years yields satisfactory outcomes, with two-thirds of patients returning to sport and a low revision rate.

### **Level of Evidence**

Level IV, therapeutic case series.

## **Open Biceps Tenodesis Associated With Slightly Greater Rate of 30-Day Complications Than Arthroscopic: A Propensity-Matched Analysis**

Anirudh K. Gowd, B.S., Joseph N. Liu, M.D., Grant H. Garcia, M.D., Avinesh Agarwalla, B.S., Brandon C. Cabarcas, B.S.a, Brandon J. Manderle, M.D.a, Nikhil N. Verma, M.D.

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### **Purpose**

To compare the early complication risk associated with open biceps tenodesis (OBT) and arthroscopic biceps tenodesis (ABT) and determine which preoperative factors may influence complication rate.

### **Methods**

The American College of Surgeons National Surgical Quality Improvement Program database was retrospectively queried from 2008 to 2016 for all procedures with CPT codes for ABT (29828) and OBT (23430). Patients were excluded if they received concomitant rotator cuff repair or shoulder arthroplasty. Patients undergoing OBT and ABT were matched by propensity scores based on age, body mass index, operative time, proportion of smokers, and proportion of concomitant subacromial decompression, distal clavicle excision, SLAP, and debridement. The incidence of adverse events in the 30-day postoperative period was compared.

### **Results**

A total of 8,032 patients met the inclusion and exclusion criteria. Prior to propensity match, patients receiving OBT and ABT, respectively, differed with respect to age ( $49.4 \pm 13.8$  vs  $51.4 \pm 13.2$ ;  $P < .001$ ), body mass index ( $29.6 \pm 6.8$  vs  $29.9 \pm 7.0$ ;  $P = .029$ ), and operative time ( $91.2 \pm 51.3$  vs  $85.3 \pm 43.4$ ;  $P < .001$ ). Following propensity match, 6,330 remained in the study (3,165 ABT and 3,165 OBT). OBT had significantly greater incidence of any adverse events (1.58% vs 0.95%;  $P = .032$ ) and anemia requiring transfusion (0.35% vs 0%;  $P = .001$ ). Multivariate analysis suggested that OBT (relative risk [RR] = 1.7, 95% confidence interval [CI], 1.1-2.7;  $P = .020$ ), old age (RR = 1.6, 95% CI, 1.0-2.5), history of dyspnea (RR = 3.8, 95% CI, 1.8-7.7;  $P < .001$ ), and congestive heart failure (RR = 5.5, 95% CI, 1.3-22.7;  $P = .019$ ) were associated with developing a postoperative adverse event within 30 days of surgery.

### **Conclusions**

Both procedures were found to have a low rate of complications, although OBT had a slightly greater (1.58% vs 0.95%) rate of 30-day complications than ABT. Early complication rate should not serve as impetus to direct surgical technique as number needed to treat is high, although ABT may be considered in more high-risk individuals.

### **Level of Evidence**

Level III, retrospective comparative database study.

## **Arthroscopic Latarjet: Suture-Button Fixation Is a Safe and Reliable Alternative to Screw Fixation**

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### **Purpose**

To evaluate mid-term clinical outcomes, complications, bone-block healing, and positioning using suture-button fixation for an arthroscopic Latarjet procedure.

### **Methods**

Patients with traumatic recurrent anterior instability and glenoid bone loss underwent guided arthroscopic Latarjet with suture-button fixation. We included patients with anterior shoulder instability, glenoid bone loss >20%, and radiographic and clinical follow-up minimum of 24 months. Patients with glenoid bone loss <20% or those that refused computed tomography imaging were excluded. Bone-block fixation was accomplished with 2 cortical buttons connected with a looped suture (4 strands). The looped suture was tied posteriorly with a sliding-locking knot. After transfer of the bone block on the anterior neck of the scapula, compression (100 N) was obtained with the help of a tensioning device. Clinical assessment was performed at 2 weeks, 3 months, 6 months, and then yearly with computed tomography completed at 2 weeks and 6 months to confirm bony union.

### **Results**

A consecutive series of 136 patients underwent arthroscopic Latarjet with 121 patients (89%; mean age 27 years) available at final follow-up (mean follow-up, 26 months; range, 24-47 months). No neurologic complications or hardware failures were observed; no patients had secondary surgery for implant removal. The transferred coracoid process healed to the scapular neck in 95% of the cases (115/121). The bone block did not heal in 4 patients; it was fractured in 1 and lysed in another. Smoking was a risk factor associated with nonunion ( $P < .001$ ). The coracoid graft was positioned flush to the glenoid face in 95% (115/121) and below the equator in 92.5% (112/121). At final follow-up, 93% had returned to sports, whereas 4 patients (3%) had a recurrence of shoulder instability. The subjective shoulder value for sports was  $94 \pm 3.7\%$ . Mean Rowe and Walch-Duplay scores were 90 (range, 40-100) and 91 (range, 55-100), respectively.

### **Conclusions**

Suture-button fixation is an alternative to screw fixation for the Latarjet procedure, obtaining predictable healing with excellent graft positioning, and avoiding hardware-related complications. There was no need for hardware removal after suture-button fixation. The systematic identification of the axillary and musculocutaneous nerves reduced risk of neurologic injury. A low instability recurrence rate and excellent return to pre-injury activity level was found. Suture-button fixation is simple, safe, and may be used for both open and arthroscopic Latarjet procedure.

### **Level of Evidence**

Level IV, therapeutic case series.



## **Effect of Recombinant Human Parathyroid Hormone on Rotator Cuff Healing After Arthroscopic Repair**

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### **Purpose**

To assess the effect of teriparatide, a recombinant human parathyroid hormone, on rotator cuff healing after arthroscopic repair compared with patients who were not treated with teriparatide.

### **Methods**

This was a prospective propensity-matched study. Thirty-one patients who underwent arthroscopic rotator cuff repair for tears >2 cm in size between January 2015 and June 2016 were recruited (group I). Daily subcutaneous injections of teriparatide 20 µg were administered for 3 months following surgery. In the same period, propensity score matching (1-to-4) was performed to generate an untreated control group undergoing rotator cuff repair alone (group II) with the same tear size. Magnetic resonance imaging evaluation of tendon healing was performed at least 1 year postoperatively, as well as the range of shoulder motion, American Shoulder and Elbow Surgeons score, Constant score, and simple shoulder test.

### **Results**

There was no significant difference of the retraction size, the anterior to posterior dimension of torn rotator cuff, or the preoperative bone mineral density in groups I and II ( $P = .78$ ,  $.87$ , and  $.96$ , respectively). The rate of retear was significantly lower in group I than in group II (16% vs 33.9%;  $P = .04$ ). Range of motion and functional scores were not significantly different between the 2 groups ( $P > .05$ ).

### **Conclusions**

Teriparatide, a recombinant human parathyroid hormone, can be a systemic treatment option that significantly enhances the tendon-to-bone healing after arthroscopic rotator cuff repair for patients with rotator cuff tears >2 cm.

### **Level of Evidence**

Level III, case-control study.

## **Clinical Outcome of Osteocapsular Arthroplasty for Primary Osteoarthritis of the Elbow: Comparison of Arthroscopic and Open Procedure**

Jae-Man Kwak, M.D.a, Erica Kholinne, M.D.a,b, Yucheng Sun, M.D.a, Sungjoon Lim, M.D.c, Kyoung-Hwan Koh, M.D., Ph.D.a, In-Ho Jeon, M.D., Ph.D

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### **Purpose**

To compare clinical and radiologic outcomes following open (OPEN) and arthroscopic (ARTHRO) osteocapsular arthroplasty for primary elbow osteoarthritis.

### **Methods**

Patients treated with osteocapsular arthroplasty between January 2010 and December 2015 were divided into OPEN and ARTHRO groups. OPEN was performed from January 2010 to October 2012, and ARTHRO from November 2012 to December 2015. OPEN and ARTHRO were performed in 35 and 52 elbows, respectively. Clinical outcome was measured using range of motion (ROM) arc, functional score (Mayo Elbow Performance Score [MEPS]), and pain score (visual analog scale [VAS]). Conventional radiography was used for outcome analysis. Outcomes were analyzed according to ulnohumeral joint (UHJ) narrowing using the computed tomography–based modified Broberg and Morrey classification.

### **Results**

Mean follow-up time was  $36.6 \pm 14.4$  (24-89) and  $35.4 \pm 14.2$  (24-83) months following OPEN and ARTHRO, respectively. Average ages were  $50.0 \pm 7.0$  (40-63) and  $52.4 \pm 10.4$  (41-75) years in OPEN and ARTHRO groups, respectively. Overall scores for ROM (preoperative to final follow-up:  $65.5^\circ \pm 22.8$  to  $112.0^\circ \pm 50.9$ ,  $P < .01$ ), MEPS ( $42.9 \pm 13.7$  to  $73.7 \pm 16.6$ ,  $P < .01$ ), and VAS ( $6.6 \pm 1.3$  to  $4.0 \pm 2.3$ ,  $P < .01$ ) were improved. Preoperative ROM improved from  $64.0^\circ \pm 23.3$  to  $118.0^\circ \pm 17.8$  following OPEN and  $66.5^\circ \pm 22.6$  to  $108.0^\circ \pm 24.0$  following ARTHRO. Preoperative MEPS improved from  $40.7 \pm 15.6$  to  $73.6 \pm 16.7$  following OPEN and  $44.3 \pm 12.2$  to  $73.8 \pm 16.7$  following ARTHRO. Preoperative VAS improved from  $6.9 \pm 1.2$  to  $3.9 \pm 2.6$  following OPEN and  $6.4 \pm 1.3$  to  $4.1 \pm 2.0$  following arthro. In both groups, the last follow-up VAS score and MEPS were worse in the narrowing group (UHJ  $< 2$  mm, grades 2 and 3) than in the intact group (UHJ  $> 2$  mm, grade 1) ( $P < .01$ ).

### **Conclusions**

Arthroscopic osteocapsular arthroplasty is comparable to the OPEN procedure in managing primary osteoarthritis of the elbow; however, the OPEN procedure shows the better outcome in improvement of flexion limitation. Neither procedures can guarantee an excellent outcome in the patients with severe UHJ narrowing.

### **Level of Evidence**

Level III, retrospective comparative trial.

## **Remplissage With Bankart Repair in Anterior Shoulder Instability: A Systematic Review of the Clinical and Cadaveric Literature**

Hassanin Alkaduhimi, M.D, Lukas P.E. Verweij, B.Sc., Nienke W. Willigenburg, Ph.D., Derek F.P. van Deurzen, M.D., Michel P.J. van den Bekerom, M.D.

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### **Purpose**

To compare the clinical and biomechanical results of an arthroscopic Bankart repair alone with an arthroscopic Bankart repair combined with remplissage.

### **Methods**

A literature search was performed on May 1, 2018, in PubMed and Embase for studies comparing an isolated arthroscopic Bankart repair and an arthroscopic Bankart repair with remplissage. The quality of the studies was assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach and the Cochrane Risk of Bias in Non-randomized Studies of Interventions (ROBINS-I) checklist. Results regarding failures, biomechanical properties, and shoulder function were extracted.

### **Results**

We included 13 studies (6 clinical and 7 biomechanical studies), and their overall quality was very low to low. In the biomechanical studies, adding a remplissage to the Bankart repair prevented engagement in all cadavers, resulted in more stiffness, and impaired the range of motion. Among clinical studies, all reported lower recurrence rates and most showed better shoulder function after a Bankart repair with remplissage compared with an isolated Bankart repair. The return-to-sport rates were mostly similar, whereas the loss of range of motion was often higher after a Bankart repair with remplissage.

### **Conclusions**

The addition of a remplissage procedure to a Bankart repair for managing small to medium Hill-Sachs lesions might be beneficial in reducing the risk of recurrent instability and improving shoulder function, without increasing the risk of complications.

### **Level of Evidence**

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

## **Arthroscopic Superior Capsular Reconstruction for Massive, Irreparable Rotator Cuff Tears: A Systematic Review of Modern Literature**

Michael Catapano, M.D., Darren de SA, M.D., F.R.C.S.C.b, Seper Ekhtiari, M.D., Albert Lin, M.D., Asheesh Bedi, M.D., Bryson P. Lesniak, M.D

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### **Purpose**

To systematically review and evaluate the efficacy and complication profile of superior capsular reconstruction (SCR) as a technique to address massive, irreparable rotator cuff tears (MIRCTs).

### **Methods**

Searches of the Cochrane Database of Systematic Reviews, Embase, MEDLINE, PubMed, and conference abstracts of 4 major conferences identified clinical studies addressing SCR for MIRCTs. Two reviewers independently screened the titles, abstracts, and full texts, extracting data from eligible studies. Reported outcome measures and complications were descriptively analyzed.

### **Results**

A total of 10 studies, 7 full texts and 3 conference abstracts, satisfied the inclusion criteria. The included studies examined a total of 350 shoulders with a mean patient age of 60.6 years and mean follow-up period of 20.6 months postoperatively. Only 4 studies had a minimum of 24-month follow-up data. Statistically significant improvements in pain and function were noted in all studies reporting results, with mean improvement ranging from 29.4 to 68.5 and from 2.5 to 5.9 points across the American Shoulder and Elbow Surgeons score and visual analog scale score, respectively. Mean improvement in range of motion ranged from 21.7° to 64.0° in elevation and from 9.0° to 15.0° in external rotation. Statistically significant improvements in the postoperative acromiohumeral distance were noted in 4 of 5 reporting studies, with a mean increase ranging from 2.2 to 5.0 mm. The combined clinical and radiographic failure and/or retear rate ranged from 3.4% to 36.1%. Complications for all studies included deep infection (0%-2%), symptomatic suture anchor loosening (0%-4%), and severe shoulder contracture (0%-2%).

### **Conclusions**

Arthroscopic SCR represents an accepted surgical option for patients with MIRCTs, with short-term improvements shown in pain, range of motion, and function. Although early results are promising, further studies are necessary to determine the long-term success of this technique and to better delineate the clinical indications, survivorship, and risk factors for failure in this population.

### **Level of Evidence**

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

## **Superior Capsular Reconstruction for Massive Rotator Cuff Tear Leads to Significant Improvement in Range of Motion and Clinical Outcomes: A Systematic Review**

Kyle R. Sochacki, M.D., Patrick C. McCulloch, M.D., David M. Lintner, M.D., Joshua D. Harris, M.D.

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### **Purpose**

To determine if arthroscopic superior capsular reconstruction for massive irreparable rotator cuff tears results in statistically significant and clinically significant improvement in patient-reported outcomes and shoulder range of motion with low graft failure, complication, and reoperation rates.

### **Methods**

A systematic review was registered with PROSPERO and performed using PRISMA guidelines. PubMed, SCOPUS, and Cochrane databases were searched. Studies investigating superior capsular reconstruction in adults were included. Animal, cadaveric, and review studies, letters to the editor, and technique papers were excluded. Study methodological quality was analyzed using the Modified Coleman Methodology Score. Shoulder motion and patient-reported outcome scores were analyzed. Statistical significance was defined by  $P < .05$ , and clinical significance was defined by the minimal clinically important difference.

### **Results**

Six articles (286 subjects, 292 shoulders, 67.7% males, mean age  $63.4 \pm 4.1$  years, mean follow-up  $25.7 \pm 14.5$  months) were analyzed. The methodological quality was fair ( $59.7 \pm 13.8$ ). Five studies reported significant improvement in the American Shoulder and Elbow Surgeons (ASES) score (mean range: 30-55,  $P < .001$  for all). Visual analog scale (VAS) scores significantly improved in 3 studies (mean range: 2.5-5.9,  $P < .001$  for 2 and  $P = .005$  for 1). Shoulder forward flexion (mean range:  $28^\circ$ - $56^\circ$ ,  $P < .001$  for 2 and  $P = .04$  for 1) significantly increased in 3 studies. One hundred percent of subjects from 2 studies had clinically significant improvement in ASES and VAS scores and shoulder forward flexion. Thirty-six subjects (14.2% of 254) had graft failure on magnetic resonance imaging (MRI). Eleven subjects (3.8%) had complications, and 34 (11.7%) underwent reoperation.

### **Conclusions**

Arthroscopic superior capsular reconstruction for massive irreparable rotator cuff tears results in statistically significant and clinically significant improvement in patient-reported outcomes and shoulder range of motion with low graft failure, complication, and reoperation rates at short-term follow-up in fair-quality studies.

### **Level of Evidence**

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

## **Long-term results after arthroscopic transosseous rotator cuff repair**

Fabian Plachel, Andreas Traweger, Imre Vasvary, Jakob E. Schanda, Herbert Resch, Philipp Moroder

DOI: <https://doi.org/10.1016/j.jse.2018.09.003>

### **Background**

The purpose of this study was to evaluate the long-term clinical and radiologic results after arthroscopic transosseous rotator cuff repair (TORCR).

### **Methods**

A total of 69 patients with full-thickness supraspinatus tendon tears with or without infraspinatus tendon tears treated with arthroscopic TORCR by a single surgeon between 1998 and 2003 were included. Among them, 56 patients (81%) with a mean age of  $58 \pm 5$  years (range, 42-70 years) were available for final follow-up examination after an average of  $15 \pm 2$  years (range, 12-18 years). The Subjective Shoulder Value, Constant score (CS), University of California at Los Angeles score, and American Shoulder and Elbow Surgeons score were recorded. Magnetic resonance imaging (MRI) was performed to visualize tendon integrity in 66% of patients.

### **Results**

At final follow-up, the mean CS was  $84 \pm 8$  points; mean University of California at Los Angeles score,  $33 \pm 2$  points; mean American Shoulder and Elbow Surgeons score,  $92 \pm 10$  points; and mean Subjective Shoulder Value,  $89\% \pm 17\%$ . MRI revealed asymptomatic repair failure in 9 patients (27%). Moreover, 4 patients (7%) underwent revision surgery because of a symptomatic rerupture, resulting in an overall retear rate of 33%. Patients with intact repairs at final follow-up showed a significantly higher CS ( $P = .019$ ) and abduction strength ( $P = .016$ ) than patients with retears.

### **Conclusion**

Arthroscopic TORCR for the treatment of full-thickness rotator cuff tears provided good clinical results 12 to 18 years after surgery. Cuff integrity on follow-up MRI scans had a positive effect on the clinical outcome.

### **Level of evidence:**

Level IV, Case Series, Treatment Study

## **The Timing of Injections Prior to Arthroscopic Rotator Cuff Repair Impacts the Risk of Surgical Site Infection**

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### **Background**

Corticosteroid injections are a common treatment for rotator cuff tears. Because of concerns of infection, a surgical procedure is often delayed following injections. The purpose of this investigation was to determine if there is a temporal relationship between corticosteroid injections and the risk of surgical site infection after arthroscopic rotator cuff repair. We hypothesized that the incidence of surgical site infection is higher in patients who received a preoperative injection and this relationship exists in a temporal manner as those patients receiving an injection closer to the operative date have a higher risk of infection.

### **Methods**

The PearlDiver database was reviewed for patients undergoing arthroscopic rotator cuff repair from 2007 to 2016. Patients were stratified into 2 cohorts: those undergoing arthroscopic rotator cuff repair within 1 year of injection (n = 12,060), and those undergoing arthroscopic rotator cuff repair without prior injection (n = 48,763). Patients with preoperative injections were further stratified by the duration in months that the injection was performed prior to the surgical procedure. Surgical site infection within 6 months of the surgical procedure was recorded. Statistical analysis included chi-square and multivariate binomial logistic regression analyses to identify risk factors for surgical site infection. Results were considered significant at  $p < 0.05$ .

### **Results**

There was no significant difference in the incidence of surgical site infection in patients receiving a shoulder injection at 0.7% compared with the control cohort at 0.8% (odds ratio [OR], 0.9 [95% confidence interval (CI), 0.7 to 1.1];  $p = 0.2$ ). However, patients receiving an injection within 1 month prior to operative management had a significantly higher rate of surgical site infection overall at 1.3% compared with the control group at 0.8% (OR, 1.7 [95% CI, 1.0 to 2.9];  $p = 0.04$ ). On multivariate analysis, male sex (OR, 1.7 [95% CI, 1.4 to 1.9];  $p = 0.001$ ), obesity (OR, 1.4 [95% CI, 1.2 to 1.6];  $p < 0.001$ ), diabetes (OR, 1.3 [95% CI, 1.1 to 1.5];  $p < 0.001$ ), smoking status (OR, 1.7 [95% CI, 1.4 to 1.9],  $p < 0.001$ ), and preoperative corticosteroid injections within 1 month of the surgical procedure (OR, 2.1 [95% CI, 1.5 to 2.7];  $p < 0.001$ ) were independent risk factors for development of a surgical site infection.

### **Conclusions**

Injections within 1 month of arthroscopic rotator cuff repair significantly increases the risk of surgical site infection. However, there is no increased risk of infection if the surgical procedure is delayed by 1 month following an injection.

**Level of Evidence:** Therapeutic Level III. See Instructions for Authors for a complete description of levels of evidence.

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## Lower Extremity

Arthroscopy, Volume 35, Issue 4

### Assessment of Association Between Spino-Pelvic Parameters and Outcomes Following Gluteus Medius Repair

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#### Purpose

To evaluate postoperative coronal/sagittal spinal plane and spinopelvic parameters in patients undergoing gluteus medius repair and to identify associations between outcomes and the aforementioned spinopelvic variables.

#### Methods

Patients who underwent gluteus medius/minimus repair by a single surgeon between January 20, 2012, and November 25, 2015, were retrospectively identified from a prospectively collected database. Radiographic measurements included Cobb angle, lumbar lordosis, sagittal vertical axis (SVA), pelvic tilt, sacral slope, and pelvic incidence. Patient-reported outcomes (PROs) were obtained at baseline and a minimum of 22 months after surgery. Bivariate correlation determined effects of spinopelvic measurements on PROs. Scoliosis and nonscoliosis groups were compared using independent samples t-test, and multivariate analysis determined whether the preoperative variables affected outcomes.

#### Results

Thirty-eight (80.9%) of 47 consecutive patients were radiographically evaluated with a scoliosis series. All patients demonstrated significant improvements in all PROs and pain ( $P < .001$  for all), as well as at an average  $28.2 \pm 7.8$  (range, 22-51) months after surgery. There were significant negative relationships between SVA and Hip Outcome Score–Activities of Daily Living ( $r = -0.405$ ,  $P = .026$ ) and Hip Outcome Score–Sports Specific ( $r = -0.492$ ,  $P = .011$ ) scores. Patients with a positive SVA ( $>0$  cm) had significantly worse patient-reported outcomes than their counterparts with negative ( $\leq 0$  cm) SVA. Also, patients with positive sagittal plane deformity (SVA  $>5$  cm) had significantly worse HOS-SS than patients without positive sagittal plane deformity (SVA  $<5$  cm) ( $47.0 \pm 35.3$ ,  $73.2 \pm 24.0$ ;  $P = .04$ ). Independent sample t-testing for the patients with scoliosis ( $n = 18$ ) versus no scoliosis ( $n = 20$ ) demonstrates a significantly worse postoperative International Hip Outcome Tool (short version) score in the patients with scoliosis ( $77.4 \pm 15.1$ ,  $53.8 \pm 37.1$ ;  $P = .043$ ).

#### Conclusions

Patients with scoliosis presented with lower rates of symptom improvement and ability to return to an active lifestyle in patients with hip disorders. In addition, patients with positive sagittal plane deformity experienced lower hip-related sport-specific outcome scores. Although the direct relationship between the spine and the hip in patients after gluteus medius/minimus repair remains unclear, this study shows an association between these postoperative outcomes and spinopelvic parameters.

#### Level of Evidence

Level IV, case series.

[BACK](#)



## **Return to Dance and Predictors of Outcome After Hip Arthroscopy for Femoroacetabular Impingement Syndrome**

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### **Purpose**

To investigate the rate of return to dance and factors influencing this primary outcome after hip arthroscopy for the treatment of femoroacetabular impingement syndrome.

### **Methods**

A consecutive series of self-identified dancers with femoroacetabular impingement syndrome was included. To assess for the impact of hypermobility on outcomes, patients were classified as having either generalized joint laxity (GJL) or no GJL based on the Beighton-Horan Joint Mobility Index. A return-to-dance survey, the modified Harris Hip Score, and the Hip Outcome Score (HOS)–Activities of Daily Living and HOS–Sports-Specific subscales were collected preoperatively and postoperatively at 6, 12, 24, and 36 months. The preoperative-to-postoperative outcome score change was compared using the minimal clinically important difference and patient acceptable symptomatic state. Return to dance was evaluated regarding (1) return to any dance activity, (2) return to prior level of dance, and (3) number of hours of dance participation after surgery. Clinical and demographic predictors and return to dance were analyzed using univariate or bivariate analysis where appropriate.

### **Results**

The study included 64 consecutive dancers (62 female and 2 male patients) (mean age,  $22.3 \pm 9.4$  years; body mass index,  $22.8 \pm 4.1$ ) with a mean follow-up period of 23.0 months. Postoperatively, 62 patients (97%) returned to dance at an average of  $6.9 \pm 2.9$  months; 40 patients (62.5%) reported that they returned to a better level of participation, whereas 20 dancers (31%) returned to the same level of participation. Statistically significant increases were observed for the HOS–Activities of Daily Living subscale ( $60.5 \pm 19.5$  vs  $92.4 \pm 11.8$ ,  $P < .001$ ), HOS–Sports-Specific subscale ( $40.3 \pm 20.3$  vs  $83.5 \pm 19.4$ ,  $P < .001$ ), and modified Harris Hip Score ( $57.0 \pm 13.6$  vs  $86.6 \pm 13.9$ ,  $P < .001$ ). There was, however, a significant decrease in the number of hours of dance postoperatively:  $11.5 \pm 8.2$  h/wk preoperatively versus  $9.0 \pm 7.3$  h/wk postoperatively ( $P = .041$ ). All postoperative hip outcome measures showed statistically significant ( $P < .001$ ) and clinically relevant improvements. Patient-reported outcomes and return time showed no significant differences between the patient groups with GJL and without GJL ( $P = .1$  and  $P = .489$ , respectively). For competitive dancers, a correlation was shown with a shorter time to return to dance ( $r^2 = 0.45$ ,  $P = .001$ ), but there were no significant differences by skill level in patient-reported outcomes or dance hours.

### **Conclusions**

After hip arthroscopy, 97% of dancers returned to dance at an average of 6.9 months, with most dancers dancing at a level higher than their preoperative status. Dance experience level was the only significant factor influencing return-to-dance outcomes, with competitive dancers showing a faster return to dancing.conclusion

### **Level of Evidence**

Level IV, therapeutic case series.

[BACK](#)

## **Does Pelvic Rotation Alter Radiologic Measurement of Anterior and Lateral Acetabular Coverage?**

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### **Purpose**

The purpose of this study was to determine the radiologic tolerance of the lateral center edge angle (LCEA) and anterior center edge angle (ACEA) to pelvic rotation.

### **Methods**

Eleven dry cadaveric pelvises from an osteological collection were reconstructed and placed in anatomic position with corresponding bilateral proximal femurs. Conventional anteroposterior (AP) and false-profile (FP) pelvic radiographs were taken at 5° increments with fluoroscopy from 0° to 25° of rotation. LCEA and ACEA were measured for conventional and rotated AP and FP fluoroscopic views, respectively. Statistical analysis was conducted to determine the error in ACEA and LCEA with pelvic rotation.

### **Results**

The mean LCEA was 29.1° (95% confidence interval [CI], 25.5°-32.7°). Mean ACEA was 38.9° (95% CI, 34.1°-43.8°). There was significant change in the LCEA past 10° of rotation ( $P = .041$ ). There was significant change in the ACEA with 50 or more of rotation ( $P < .001$ ). The FP view rotated 40° from an AP view produced 6.8° (95% CI, 4.7-8.9) of error, whereas one rotated 90° from an AP view produced 13.2° (95% CI, 11.2°-15.3°) of error in the ACEA. An AP view rotated 25° toward the x-ray beam produced 2.3° (95% CI, 1.1°-3.4°) error, whereas one rotated 25° away from the beam produced 2.6° (95% CI, 1.5°-3.8°) of error.

### **Conclusions**

Rotation of AP and FP radiographs significantly affects the measured values of the LCEA and ACEA, respectively. The ACEA experiences more dramatic changes with rotation of the FP view compared with the LCEA with the same amount of rotation of an AP view. This study illustrates the importance of verifying the quality of the FP radiograph when using ACEA to guide therapy for hip pathology.

### **Clinical Relevance**

This study emphasizes the importance of evaluating pelvic rotation when using the center edge angle to assess femoral head coverage.

## **Periportal Capsulotomy: Technique and Outcomes for a Limited Capsulotomy During Hip Arthroscopy**

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### **Purpose**

To present the technique and outcomes of a limited periportal capsulotomy without capsular closure for arthroscopic treatment of femoroacetabular impingement (FAI).

### **Methods**

Retrospective review of a prospectively collected database of patients undergoing primary hip arthroscopy for symptomatic FAI was performed to analyze patients who underwent periportal capsulotomy. Periportal capsulotomy was performed through dilation of the midanterior and anterolateral portals without completion of a full interportal capsulotomy, preserving the iliofemoral ligament. Arthroscopic labral treatment and osteochondroplasty were completed as indicated without necessitating capsular closure. Patient demographics, surgical details, and complications were recorded. Pre- and postoperatively, patients completed the modified Harris Hip Score, Hip Disability and Osteoarthritis Outcome Score (HOOS), 12-item Short-Form survey, and visual analog scale. Postoperative outcome data was analyzed at 1- and 2-year follow-up.

### **Results**

One hundred and forty-two patients treated with the periportal capsulotomy technique were included (mean age,  $35.5 \pm 11.7$ ; body mass index,  $25.4 \pm 4.1$ ; 50.7% men). There were no major postoperative complications including hip instability or reoperation. Significant improvements in mean patient-reported outcomes from preoperative scores were seen at the 1- and 2-year follow-ups (modified Harris Hip Score,  $18.4 \pm 19.1$ ,  $21.1 \pm 17.7$ , HOOS symptoms,  $20.1 \pm 21.2$ ,  $22.8 \pm 23.5$ , HOOS pain,  $23.4 \pm 21.2$ ,  $27.6 \pm 19.3$ , HOOS activities of daily life,  $21.2 \pm 20.8$ ,  $24.3 \pm 21.6$ , HOOS sport,  $32.5 \pm 27.0$ ,  $36.5 \pm 26.9$ , HOOS quality of life,  $37.9 \pm 26.7$ ,  $46.0 \pm 22.8$ , and 12-item Short-Form survey physical component score,  $16.4 \pm 15.3$ ,  $20.8 \pm 13.2$ , respectively). Only the HOOS quality of life demonstrated further improvement from 1- to 2 years postoperatively ( $P = .043$ ).

### **Conclusions**

Periportal capsulotomy provides safe and sufficient access to the hip joint for arthroscopic treatment of FAI without necessitating capsular closure. Using this technique, patients showed significant clinical improvement and no postoperative instability at 1 and 2 years after surgery.

### **Level of Evidence**

Level IV, therapeutic case series.

## **No Difference in Outcome Between Femoral Soft-Tissue and Screw Graft Fixation for Reconstruction of the Medial Patellofemoral Ligament: A Randomized Controlled Trial**

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### **Purpose**

The aim of the present randomized controlled trial was to compare 2 different medial patellofemoral ligament reconstruction (MPFL-R) techniques that utilize different femoral fixation principles, which could affect subjective clinical outcomes and surgical morbidity.

### **Methods**

Sixty patients were randomly assigned to 2 MPFL-R techniques: bone or soft-tissue fixation of the graft at the femoral condyle. Patients had operations performed between 2010 and 2015 at a single center. Indication for surgery was 2 or more patellar dislocations. When the bone fixation technique was used, the gracilis tendon was fixed with the use of an interference screw. When the soft-tissue fixation technique was used, the gracilis tendon was looped around the adductor magnus tendon. Both techniques used patella-graft fixation with drill holes in the medial patellar edge. Clinical outcomes were evaluated by means of Kujala, knee injury and osteoarthritis outcome, and pain scores before the operation and at 1- and 2-year follow-up examinations. Surgical morbidity was evaluated by pain on palpation along the reconstruction site.

### **Results**

Kujala scores were 88 and 89 for bone and soft-tissue fixation groups, respectively, with no difference between groups ( $P = .73$ ). No significant differences in knee injury osteoarthritis outcome or pain scores were found. Analysis of surgical morbidity, defined as femoral-based tenderness overlying the fixation site, demonstrated that 13% and 12% of patients had significant tenderness at the reconstruction site after bone and soft-tissue MPFL-R, respectively. No patellar re-dislocations were observed in either group.

### **Conclusions**

MPFL-R with soft-tissue graft fixation at the femoral condyles resulted in findings for subjective clinical outcome, patellar stability, and pain level similar to those associated with MPFL-R with bone fixation. Surgical morbidity was also similar between patients who had soft-tissue and those who had bone fixation MPFL-R. Soft-tissue femoral graft fixation does not result in inferior clinical outcomes compared with screw fixation, and it can be used safely for MPFL-R.

## **Radiographic Landmarks for the Anterior Attachment of the Medial Patellofemoral Complex**

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### **Purpose**

Because fluoroscopy is often used in graft placement during patellar stabilization surgery, the purpose of this study was to describe the radiographic landmarks for the anterior attachment midpoint of the medial patellofemoral complex (MPFC).

### **Methods**

Seventeen fresh-frozen cadaveric knees were dissected, and the MPFC was exposed from the articular side after a lateral parapatellar approach. The midpoint of the anterior attachment of the MPFC was identified using a ruler and marked with a pin. Lateral fluoroscopic images of the patella were then obtained and analyzed using digital analysis software. The distance from the superior articular pole to the pin was divided by the length of the articular surface to describe the location of the pin as a percentage of patellar articular length.

### **Results**

Of the 17 cadaveric knees, 2 were excluded because of lack of MPFC fibers. In the remaining 15 knees, the mean ( $\pm$ standard deviation) proximal-distal width of the attachment to the patella and/or vastus intermedius tendon was  $41 \pm 10$  mm, spanning from  $15 \pm 6$  mm proximal to the superior pole of the patella to  $27 \pm 8$  mm distal to it. When viewed on lateral fluoroscopic images, the MPFC midpoint was  $19\% \pm 14\%$  of the patellar articular length from the superior articular pole.

### **Conclusions**

In this study, the radiographic landmarks that correlate to the anatomic midpoint of the anterior MPFC attachment are  $19\% \pm 14\%$  of the articular surface from the superior pole of the patella.

### **Clinical Relevance**

Recent reports on medial patellofemoral ligament anatomy now include fibers that extend to the quadriceps tendon, summarized as the MPFC. With the inclusion of these fibers, the midpoint of the anterior MPFC attachment is more proximal than that of the medial patellofemoral ligament alone. Because fluoroscopy is often used intraoperatively to guide graft placement, this study correlates radiographic landmarks with anatomic findings of the MPFC midpoint on its attachment to the extensor mechanism.

## **Are Orthopaedic Surgeons Performing Fewer Arthroscopic Partial Meniscectomies in Patients Greater Than 50 Years Old? A National Database Study**

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### **Purpose**

To report the trends in arthroscopic partial meniscectomy (APM) for degenerative meniscal tears in a large private insurance database among patients older than 50 years.

### **Methods**

The Humana database between 2007 and 2015 was queried for this study. Patients meeting the inclusion criteria with degenerative meniscal tears who underwent APMs were identified by International Classification of Diseases, Ninth Revision codes, followed by Current Procedural Terminology codes. A linear regression analysis was performed with a significance level set at  $F < 0.05$ .

### **Results**

A total of 21,759 APMs were performed between 2007 and 2015 in patients older than 50 years. Normalized data for total yearly enrollment showed a significant increase in APMs performed from 2007 to 2010 ( $R^2 = 0.986$ ,  $P = .007$ ). The average percentage increase per year from 2007 to 2010 was 18.59%. However, there was a significant decrease in APMs performed from 2010 to 2015 ( $R^2 = 0.748$ ,  $P = .026$ ). The average percentage decrease per year from 2010 to 2015 was 7.74%. The percentage decrease overall from 2010 to 2015 was 71.68%. No difference in statistical significance was found when age was broken into 5-year age intervals. We found a significant difference in APM based on region ( $P < .001$ ).

### **Conclusions**

The rate of APMs in patients older than 50 years increased from 2007 until 2010. Since 2010, the rate of APMs in patients older than 50 years has significantly decreased. These trends are likely multifactorial. Regardless of cause, it appears that the orthopaedic surgery community is performing fewer APMs in this patient population.

### **Level of Evidence**

Level III, retrospective database epidemiological study.

## **A Biomechanical Comparison of Six Suture Configurations for Soft Tissue–Based Graft Traction and Fixation**

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### **Purpose**

The purpose of this study was to compare 6 different graft fixation techniques to determine the preparation speed, fixation security, biomechanical strength, and resultant tissue trauma.

### **Methods**

Six different techniques (10 samples each): #2 OrthoCord Krackow stitch, #2 FiberWire Krackow stitch, SpeedTrap, WhipKnot, Loop-in-loop stitch were created in the distal 3 cm of 9 cm bovine flexor tendons. The proximal 3 cm tendon segment was clamped in a testing machine and the distal suture ends secured by pneumatic grips. 3 preload cycles (10N-100N) and 50N static load was followed by 500 cycles (50N-200N) and then loaded to failure. Graft preparation times, 100 and 500 cycle displacement, maximum failure load, stiffness, and failure mode were recorded.

### **Results**

Representative graft preparation times were: OrthoCord Krackow (247s), FiberWire Krackow (401s), FiberLoop (177s), SpeedTrap (42s), WhipKnot (39s), Loop-in-loop (45s). No WhipKnots survived cyclic loading. 100 cycle displacements were: OrthoCord Krackow ( $11.5 \pm 3.9$  mm), FiberWire Krackow ( $8.9 \pm 1.2$  mm), FiberLoop ( $14.2 \pm 6.1$  mm), SpeedTrap ( $8.8 \pm 2.5$  mm), Loop-in-loop ( $10.4 \pm 2.9$  mm). FiberLoop displaced significantly more than all others ( $P = .016$ ). Maximum failure loads were: OrthoCord Krackow ( $364 \pm 24$ N), FiberWire Krackow ( $375 \pm 45$ N), FiberLoop ( $413 \pm 95$ N), SpeedTrap ( $437 \pm 65$ N), WhipKnot ( $153 \pm 42$ N), Loop-in-loop ( $329 \pm 112$ N). The most common failure mode was suture breaking. FiberWire containing constructs (Krackow and FiberLoop) shredded or cut through (“cheese wiring”) prior to failure in a majority.

### **Conclusions**

SpeedTrap, WhipKnot and Loop-in-loop were quickest to create (under 1 minute). The Krackow, SpeedTrap, WhipKnot, and Loop-in-Loop did not damage the tendon during cyclic loading. SpeedTrap and Krackow had the least displacement. FiberLoop displaced more than all other groups ( $P = .016$ ). No WhipKnot completed cyclic loading. The SpeedTrap (437N) and FiberLoop (413N) had the highest ultimate strength.

### **Clinical Relevance**

While the SpeedTrap and FiberLoop are the strongest techniques, the FiberLoop shreds the tendon, displaced the most, and took longer to create. Based on these results, the SpeedTrap demonstrates the best overall performance.

## **Patients With Failed Anterior Cruciate Ligament Reconstruction Have an Increased Posterior Lateral Tibial Plateau Slope: A Case-Controlled Study**

Alberto Grassi, M.D., Cecilia Signorelli, Ph.D., Francisco Urrizola, M.D., Luca Macchiarola, M.D., Federico Raggi, M.D., Massimiliano Mosca, M.D., Kristian Samuelsson, M.D., Stefano Zaffagnini, M.D.

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### **Purpose**

To compare knee anatomical parameters of patients with failed anterior cruciate ligament reconstruction (ACL-R) with those of a control group of sex-matched patients with successful ACL-R.

### **Methods**

Forty-three patients (34 male, 9 female) who experienced graft failure after ACL-R were enrolled in the failed group. These patients were matched to a control group of 43 patients who underwent primary ACL-R with a minimum follow-up of 24 months. On magnetic resonance imaging, the following parameters were evaluated: transepicondylar distance, lateral and medial femoral condyle widths, tibial plateau width, notch width index, and the ratio of width and height of the femoral notch, ratio between the height and depth of the lateral and medial femoral condyle, lateral and medial posterior tibial slopes, and anterior subluxation of the lateral and medial tibial plateau. Multivariate regression with backward elimination, including only the previously identified significant variables, defined the independent predictors for revision surgery.

### **Results**

The anatomical variables that were significantly different between the 2 study groups were lateral and medial posterior tibial slopes, anterior subluxation of the lateral and medial tibial plateau, medial tibial plateau width, lateral tibial plateau width, medial femoral condyle width, and transepicondylar distance; however, the multivariate regression analysis identified the lateral posterior tibial slope (LTPs), the anterior subluxation of the medial tibial plateau, and the medial femoral condyle width as significant independent predictors ( $P < .05$ ). The LTPs had the highest coefficient and the highest sensitivity (88%) and specificity (84%) to identify failures when considering the optimal cutoff value of  $7.4^\circ$ .

### **Conclusions**

Several anatomical parameters have been identified that differ significantly between patients with failed ACL-R and those without a documented failure. The most accurate predictor of ACL failure was an LTPs  $>7.4^\circ$ , with a sensitivity of 88% and specificity of 84%. Surgeons should consider measuring LTPs during preoperative assessment of ACL-injured patients, and patients with values  $>7.4^\circ$  should be considered at high risk of ACL-R failure.

### **Level of Evidence**

Level III retrospective prognostic trial.

[BACK](#)



## Variation in Graft Bending Angle During Range of Motion in Single-Bundle Posterior Cruciate Ligament Reconstruction: A 3-Dimensional Computed Tomography Analysis of 2 Techniques

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### Purpose

To compare variations in femoral graft bending angle during range of motion (ROM) of the knee between inside-out (IO) and retro-socket outside-in (OI) techniques in posterior cruciate ligament (PCL) reconstruction using in vivo 3-dimensional (3D) computed tomography analysis.

### Methods

Ten patients underwent PCL reconstruction by the IO technique (5 patients) or the retro-socket OI technique (5 patients) for suspensory femoral fixation. After PCL reconstruction, 3D computed tomography was performed in 0° extension and 90° flexion to reconstruct 3D femur and tibia bone models using Mimics software. Positions of femur and tibia at 30°, 45°, and 60° flexion were reproduced by determining the kinematic factors of anteroposterior translation, mediolateral translation, and internal-external rotation angle of each patient based on previously measured kinematic data. Variation in graft bending angle according to the flexion range of the knee was calculated by the difference in graft angulation measured at each flexion angle. The results were compared between the 2 techniques.

### Results

There was significant difference in variation of femoral graft bending angle between IO and retro-socket OI techniques from 0° to 90° flexion of the knee ( $P = .008$ ). Significant difference was also noticed at 30° to 45° ( $P = .008$ ), 45° to 60° ( $P = .008$ ), and 60° to 90° ( $P = .016$ ) ROM of the knee between the 2 groups.

### Conclusions

The retro-socket OI technique resulted in less variation in femoral graft bending angle compared with the IO technique during knee ROM. We recommend the retro-socket OI technique for femoral tunnel placement to reduce the graft motion at the intra-articular femoral tunnel aperture.

### Clinical Relevance

The retro-socket OI technique produces significantly less variation in femoral graft bending angle when compared with the IO technique. Such reduction in variation of femoral graft bending angle might be related to lower stress at the femoral tunnel aperture.

## **Objectively Assessing Intraoperative Arthroscopic Skills Performance and the Transfer of Simulation Training in Knee Arthroscopy: A Randomized Controlled Trial**

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### **Purpose**

To objectively investigate the transfer validity of simulation training using wireless elbow-worn motion sensors intraoperatively to assess whether surgical simulation leads to improvements in intraoperative arthroscopic performance.

### **Methods**

In this randomized controlled trial, postgraduate year 2 to 3 trainees in nationally approved orthopaedic surgery posts were randomized to standard junior residency training (control group) or standard training plus additional weekly simulation training (intervention group). Both groups performed a supervised real-life diagnostic knee arthroscopy in the operating room at 13 weeks. Performance was measured using wireless elbow-worn motion sensors recording objective surgical performance metrics: number of hand movements, smoothness, and time taken. A participant-supervisor performance ratio was used to adjust for variation in case mix and difficulty. The study took place in a surgical simulation suite and the orthopaedic operating rooms of a university teaching hospital.

### **Results**

The intervention group objectively outperformed the control group in all outcome metrics. Procedures performed by the intervention group required fewer hand movements (544 [interquartile range (IQR), 465-593] vs 893 [IQR, 747-1,242];  $P < .001$ ), had smoother movements ( $25,842 \text{ ms}^{-3}$  [IQR, 20,867-27,468  $\text{ms}^{-3}$ ] vs  $36,846 \text{ ms}^{-3}$  [IQR, 29,840-53,949  $\text{ms}^{-3}$ ];  $P < .001$ ), and took less time (320 seconds [IQR, 294-392 seconds] vs 573 seconds [IQR, 477-860 seconds];  $P < .001$ ) than those performed by the control group. The cases were comparable between the groups. Standardized to the supervisor's performance, the intervention group required fewer hand movements (1.9 [IQR, 1.5-2.1] vs 3.3 [IQR, 2.2-4.8];  $P = .0091$ ), required less time (1.2 [IQR, 1.1-1.7] vs 2.6 [IQR, 1.6-3.0];  $P = .0037$ ), and were smoother (2.1 [IQR, 1.8-2.8] vs 4.3 [IQR, 2.8-5.4];  $P = .0037$ ) than the control group, but they did not perform as well as their supervisors.

### **Conclusions**

This study uses intraoperative motion-analysis technology to objectively show that surgical simulation training improves actual intraoperative technical skills performance.

### **Clinical Relevance**

The described wireless objective assessment method complements the subjective observational performance assessments commonly used. Further studies are required to assess how these measures of intraoperative performance correlate to patient outcomes. Intraoperative motion analysis is translatable across surgical specialties, offering potential for objective assessment of progression through competency-based training, revalidation, and talent selection for specialist training.

## **In Vitro Analysis of Micronized Cartilage Stability in the Knee: Effect of Fibrin Level, Defect Size, and Defect Location**

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### **Purpose**

The purpose of the study is to assess the stability of a dehydrated cartilage allograft combined with platelet-rich plasma sealed with fibrin glue within trochlear and medial femoral condyle (MFC) chondral defects in a cadaver knee model.

### **Methods**

Defects were made in the trochlea (20, 25, and 30 mm) and MFC (15, 20, and 25 mm) of 6 cadaver specimens. Allograft was applied utilizing 2 different techniques: (1) proud in which the fibrin level extends beyond surrounding cartilage and (2) recessed in which the fibrin level is even with or below the surrounding cartilage. The knees were cycled by using a continuous passive motion machine through a range of motion. Defects were assessed for superficial delamination and displacement of the allograft. This was quantified as the percentage of surface delamination and/or exposed bone. Comparisons were made with regard to defect size, location, and fill.

### **Results**

In both the MFC and trochlea, proud application resulted in an increased rate of fibrin delamination. In the trochlea, an average of 38% delamination was detected in the recessed 20-mm defect compared with 70% in the proud 30-mm defect ( $P < .05$ ). This effect was increased with increasing defect size. In the MFC, mean delamination of 43% and 28% exposed bone was noticed in the proud 15-mm defect compared with 95% delamination and 71% exposed bone at 25 mm. In 82% of specimens, displacement and/or delamination occurred within the first 15 minutes of testing.

### **Conclusions**

Increased defect size in both the trochlea and femoral condyle, as well as a proud construct application, were associated with significant delamination and displacement of the allograft/fibrin construct.

### **Clinical Relevance**

Proud application of allograft increases the likelihood of fibrin delamination and graft displacement in both trochlear and MFC defects. This effect is increased with increasing defect size. These data may support limiting range of motion immediately after an allograft procedure.

## **Incidence and Risk Factors for Meniscal Cyst After Meniscal Repair**

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### **Purpose**

To investigate the incidence of magnetic resonance imaging-confirmed cyst formation after meniscal repair and to analyze associated risk factors.

### **Methods**

This retrospective study included cases repaired arthroscopically with the all-inside (AI) technique (using suture anchors) and/or the inside-out (IO) technique between October 2008 and December 2014. A meniscal cyst was detected on T2 fat-suppressed magnetic resonance images. All cases were divided into 3 groups according to the repair method (AI, IO, and combined technique). The incidence of radiographically confirmed meniscal cyst formation in each group and the associated risk factors (age, sex, AI device, medial meniscus, Tegner activity scale preinjury) were analyzed.

### **Results**

A total of 102 menisci in 96 knees were evaluated. The mean follow-up period was 3.8 (range, 2-8) years. The mean patient age was 21.0 (range, 6-53) years. Thirty cases were in the AI group, 60 in the IO group, and 12 in the combined group. Demographically, there were significant differences among groups regarding the number of medial, lateral, and discoid tears; concomitant anterior cruciate ligament tears; Tegner scale; and suture number. Meniscal cysts developed in 14 of 102 cases. Two of the 14 cysts were symptomatic, requiring open cystectomy. The incidence of meniscal cyst was significantly higher in the AI group (12 of 30, 40%) than in the IO group (1 of 60, 1.7%) or the combined-technique group (1 of 12, 8.3%) ( $P < .001$ ). Both symptomatic cysts were in the AI group and were in continuity with the anchors. Medial meniscus tear (odds ratio = 6.92) and the use of AI suture anchors (odds ratio = 15.03) significantly increased the risk of cyst formation.

### **Conclusions**

The incidence of meniscal cysts after arthroscopic meniscal repair was 1.7% to 40.0%, depending on the surgical method. Medial meniscus tears and use of an AI device are suggested as risk factors for cyst formation in this retrospective study.

### **Level of Evidence**

Level III, retrospective comparative study.

## **Loosening of Transtibial Pullout Meniscal Root Repairs due to Simulated Rehabilitation Is Unrecoverable: A Biomechanical Study**

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### **Purpose**

To determine whether meniscal root repairs recover from displacement due to rehabilitative loading.

### **Methods**

Transtibial pullout repairs of the posteromedial meniscal root were performed in 16 cadaveric ovine knees. Single- and double-tunnel repairs using the 2-simple suture technique were cyclically loaded in tension to 10,000 cycles, allowed to rest, and loaded in tension again. Paired differences in displacement with rest were recorded to evaluate recoverability. Displacement of repairs at cycles of interest was recorded, and the response of repairs to 10,000 cycles was assessed.

### **Results**

All outcomes were not significantly different between the single- and double-tunnel techniques; therefore, the results were pooled. The difference in displacement between the first cycle and the first cycle after rest was  $1.59 \pm 0.69$  mm. Repair displacement did not reach an equilibrium within 10,000 cycles and instead resulted in a steady increase in displacement of  $0.05 \pm 0.02$  mm per additional 1,000 cycles. Sutures macroscopically began to cut out of the meniscus in both single- and double-tunnel repairs.

### **Conclusions**

This study showed that significant, unrecoverable loosening from rehabilitative loading occurred in single- and double-tunnel meniscal root repairs. Root repairs also gradually displaced with continued loading instead of reaching an equilibrium displacement after 10,000 cycles. This progressive, unrecoverable loosening needs to be studied further to better understand the resultant impact on knee mechanics. In addition, the quality and quantity of meniscal root repair healing at the time of rehabilitation should be studied to determine how susceptible patients are to repair loosening.

### **Clinical Relevance**

Rehabilitative loading caused unrecoverable and progressive loosening of root repairs, showing the importance of healing before loading. Investigations on the effects of loosening on mechanics and the quality of repair healing at weight bearing are necessary to better understand the clinical implications.

## **What Makes Suture Anchor Use Safe in Hip Arthroscopy? A Systematic Review of Techniques and Safety Profile**

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### **Purpose**

To perform a systematic review that assesses the current literature on suture anchor placement for the purpose of identifying factors that lead to suture anchor perforation and techniques that reduce the likelihood of complications. It was hypothesized that suture anchor placement in hip arthroscopy would generally be safe, with the exception of the complications of articular cartilage violation and psoas tunnel perforation. Perioperative factors, related to patient, surgeon, and technical variables, may influence the safety of suture anchor insertion.

### **Methods**

Three databases (PubMed, Ovid MEDLINE, and Embase) were searched, and 2 reviewers independently screened the resulting literature. The inclusion criteria were clinical and biomechanical studies examining the use of suture anchors in hip arthroscopy. The methodologic quality of all included articles was assessed using the Methodological Index for Non-Randomized Studies criteria and the Cochrane risk-of-bias assessment tool. Results are presented according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines using descriptive statistics.

### **Results**

We included 14 studies in this review, comprising 4 case series (491 patients; 56.6% female patients; mean age, 33.9 years), 9 controlled cadaveric or laboratory studies (111 cadaveric hips and 12 synthetic acetabular bone blocks; 42.2% female hips; mean age, 60.0 years) with a mean Quality Appraisal for Cadaveric Studies score of 11, and 1 randomized controlled trial (37 hips; 55.6% female hips; mean age, 34.2 years). Anterior cortical perforation into the psoas tunnel by suture anchors led to pain and impingement of pelvic neurovascular structures. The anterior acetabular positions (3- to 4-o'clock position) had the thinnest bone, smallest rim angles, and highest incidence of articular perforation. Drilling angles from 10° to 20° measured off the coronal plane were acceptable. The midanterior and distal anterolateral portals were used successfully, with 1 study reporting difficulty placing anchors at anterior locations through the distal anterolateral portal. One study showed that curved suture anchor drill guides allow for a better trajectory away from the articular cartilage. Small-diameter ( $\leq 1.8$ -mm) all-suture anchors had a lower in vivo incidence of articular perforation with similar stability and pullout strength to other anchor types in biomechanical studies.

### **Conclusions**

Suture anchors at anterior acetabular rim positions (3- to 4-o'clock position) should be inserted with caution. Large-diameter ( $\geq 2.3$ -mm) suture anchors increase the likelihood of articular perforation without increasing labral stability. Inserting small-diameter ( $\leq 1.8$ -mm) all-suture anchors from 10° to 20° drilling angles may increase safe insertion angles from all cutaneous portals. Direct arthroscopic visualization, the use of fluoroscopy, distal-proximal insertion, and the use of nitinol wire can help prevent articular violation.

### **Level of Evidence**

Level IV, systematic review of Level I to IV studies.

[BACK](#)

## **Arthroscopic Labral Treatment in Adolescents: Clinical Outcomes With Minimum 5-Year Follow-up**

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**Background** The success of hip arthroscopy has led to increased application in younger populations. However, hip arthroscopy remains a challenging procedure, and its safety and efficacy in the adolescent population have been controversial. Most existing literature on outcomes in such patients contains only short-term follow-up, and a paucity of evidence is available regarding long-term outcomes in adolescents.

**Purpose** To report on clinical outcomes at a minimum 5-year follow-up in patients younger than 18 years who underwent arthroscopic treatment of labral tears.

**Study Design** Case series; Level of evidence, 4.

**Methods** Data were prospectively collected and retrospectively reviewed on all patients younger than 18 years who underwent hip arthroscopy in a tertiary hip preservation setting at a single institution. Patients were excluded if they had previous ipsilateral hip conditions or surgery. All patients underwent either labral repair or debridement for treatment of a labral tear. Patient-reported outcome measures were recorded at 3 months and at 1, 2, or a minimum of 5 years. These included the modified Harris Hip Score (mHHS), Nonarthritic Hip Score, Hip Outcome Score–Sports Specific Subscale (HOS-SSS), visual analog scale, and patient satisfaction. Additionally, the abbreviated International Hip Outcome Tool and Short Form Health Survey were collected at latest follow-up.

**Results** The study included 44 hips in 32 patients that underwent arthroscopic labral repair (86.4%) or labral debridement (13.6%) between April 2008 and April 2011, with latest follow-up at a mean of 69.2 months (range, 60.0–89.9 months) postoperatively. The average age at surgery was 16.3 years (range, 14.2–17.9 years), and 39 hips from female patients. Statistically significant improvements were seen in all patient-reported outcome measures from preoperative to minimum 5-year follow-up. Improvements were noted at 1-year follow-up and maintained at minimum 5-year follow-up. At the latest follow-up, the Patient Acceptable Symptomatic State was achieved in 95.5% of patients for the mHHS and 72.7% for the HOS-SSS. Two patients subsequently underwent secondary arthroscopy on the ipsilateral hip; however, the survivorship of all hips was 100%.

**Conclusion** Hip arthroscopy for the treatment of labral tears in adolescents remains a technically challenging procedure that should be approached with appropriate caution. The results of the present study on a population treated in a specialized hip preservation center demonstrate that hip arthroscopy is a safe procedure with stable improvement in patient-reported outcome measures at 5 years.

## **Prevalence of Generalized Ligamentous Laxity in Patients Undergoing Hip Arthroscopy: A Prospective Study of Patients' Clinical Presentation, Physical Examination, Intraoperative Findings, and Surgical Procedures**

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**Background** Recent studies identified microinstability in the hip as a pathoetiology of painful hip conditions, and it was proposed that generalized ligamentous laxity conditions may predispose patients to such microinstability.

**Purpose** To study the relationship of generalized ligamentous laxity with patient characteristics, clinical presentation, intraoperative findings, and surgical treatments in a cohort of patients undergoing hip arthroscopy.

**Study Design** Cross-sectional study; Level of evidence, 3.

**Methods** Registry data were prospectively collected and retrospectively reviewed between February 2014 and November 2017 for patients who underwent primary hip arthroscopy and had a documented Beighton score to assess generalized ligamentous laxity. Patients with a history of an ipsilateral hip condition or ipsilateral hip surgery, those with Tönnis grade >1, and those who had simultaneous arthroscopic and open procedures were excluded from the study. Two comparisons were made between patients with low and high Beighton scores: Beighton 0 vs  $\geq 1$  (B 0 vs B  $\geq 1$ ) and Beighton 0-3 vs  $\geq 4$  (B 0-3 vs B  $\geq 4$ ). Patient demographics, symptomatology, physical examination, and intraoperative findings were compared between these low and high Beighton groups.

**Results** A total of 1381 patients met our inclusion and exclusion criteria. Within this patient population, there were 882 with B 0, 499 with B  $\geq 1$ , 1120 with B 0-3, and 261 with B  $\geq 4$ . B 0 was 54.1% female, compared with 84.2% of B  $\geq 1$ . Similarly, B 0-3 was 58.5% female, while B  $\geq 4$  was 92.7% female. The difference in sex makeup was significant between both sets of groups ( $P < .0001$ ). The relative risk of having B  $\geq 1$  for women versus men was 2.869, and the relative risk of having B  $\geq 4$  for women versus men was 6.873. The patients with higher Beighton scores in B  $\geq 1$  and B  $\geq 4$  had a younger mean age at onset of symptoms ( $P < .0001$ ) and lower mean body mass index ( $P < .0001$ ) than those in B 0 and B 0-3, respectively. The B  $\geq 1$  group had higher preoperative range of motion with internal rotation ( $P = .05$ ), external rotation ( $P = .017$ ), and flexion ( $P < .0001$ ) than B 0 patients, as well as a lower frequency of Trendelenburg gait pattern ( $P = .0268$ ). Similarly, the B  $\geq 4$  group had higher range of motion than the B 0-3 group with internal rotation ( $P = .030$ ), external rotation ( $P = .003$ ), flexion ( $P < .0001$ ), and abduction ( $P = .002$ ). As compared with the lower-score groups, the higher-score groups also had smaller labral size and tear dimension ( $P < .0001$ ), and a higher proportion of these patients underwent labral repair, capsular repair, and iliopsoas fractional lengthening.

**Conclusion** Patients undergoing hip arthroscopy who have generalized ligamentous laxity are overall younger, have a lower body mass index, and are more often female, as compared with patients who have lesser laxity. Patients with higher preoperative Beighton scores had greater hip range of motion and smaller intraoperative labral size and tear dimensions. Additionally, these patients were more likely to undergo labral repair, capsular plication, and iliopsoas fractional lengthening.

[BACK](#)



## **Influence of Acetabular Labral Tear Length on Outcomes After Hip Arthroscopy for Femoroacetabular Impingement Syndrome With Capsular Plication**

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**Background** The literature on the effects of labral tear on patient-reported outcomes, midterm pain, and overall patient satisfaction is limited.

**Purpose** To determine the effect of labral tear length on postoperative outcomes after hip arthroscopy for femoroacetabular impingement syndrome (FAIS).

**Study Design** Cohort study; Level of evidence, 3.

**Methods** Consecutive patients undergoing primary hip arthroscopy for FAIS from January 2012 to January 2016 were identified in a prospectively collected database. All patients completed the Hip Outcome Score–Activities of Daily Living (HOS-ADL), Hip Outcome Score–Sports Subscale (HOS-SS), modified Harris Hip Score (mHHS), and visual analog scale for pain and satisfaction. Patients were stratified by labral tear length into small (<2.5 cm) or large (≥2.5 cm) based on the receiver operating characteristic curve analysis. Patient characteristics and outcomes were analyzed with multivariate linear regression analyses to identify predictors of labral tear length. Binary logistic regression analysis was performed to determine whether labral tear length predicted the likelihood of achieving the minimal clinically important difference.

**Results** Of the 747 eligible patients, 600 (80.3%) had 2-year reported outcomes and were included in the final analysis. Mean age, body mass index, and tear length were  $33.5 \pm 12.3$  years,  $25.4 \pm 9.2$  kg/m<sup>2</sup>, and  $2.7 \pm 0.7$  cm, respectively. Men had higher frequency of large tears when compared with women (77% vs 43.7%,  $P < .001$ ). Independent t test demonstrated significant differences in 2-year outcomes between patients with tears <2.5 and ≥2.5 cm, respectively: HOS-ADL ( $87.3 \pm 16.3$  vs  $84.3 \pm 18.1$ ,  $P = .033$ ), HOS-SS ( $76.6 \pm 23.5$  vs  $70.5 \pm 27.7$ ,  $P = .005$ ), mHHS ( $82.5 \pm 18.0$  vs  $78.5 \pm 18.2$ ,  $P = .009$ ), and satisfaction ( $83.5 \pm 23.4$  vs  $77.8 \pm 34.9$ ,  $P = .026$ ). Binary logistic regression analysis demonstrated that labral tear length is an independent predictor of visual analog scale for satisfaction, HOS-ADL, HOS-SS, and mHHS. Binary logistic regression analysis demonstrated that patients with small labral tears had a higher likelihood of achieving the minimal clinically important difference for the HOS-SS (odds ratio, 1.61; 95% CI, 1.39-1.92;  $P < .02$ ) and the patient acceptable symptomatic state for the mHHS (odds ratio, 1.56; 95% CI, 1.11-2.2;  $P = .038$ ) than those with larger tears.

**Conclusion** Labral tear length is independently predictive of patient-reported outcomes after hip arthroscopy for FAIS. Furthermore, patients with smaller tears (<2.5 cm) had better outcomes and a higher likelihood of achieving a minimal clinically important difference at 2-year follow-up. However, the mean differences between changes in pre- and postoperative outcomes were relatively small and may not be clinically meaningful.

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## Miscellaneous

Arthroscopy, Volume 35, Issue 4

### **Higher Prevalence of Concomitant Shoulder Labral Tears in Patients With Femoroacetabular Impingement**

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#### **Purpose**

To examine the prevalence of concomitant symptomatic glenoid labral tears in patients with femoroacetabular impingement (FAI) in comparison to a control group of patients undergoing anterior cruciate ligament (ACL) reconstruction.

#### **Methods**

We retrospectively identified 1,644 patients who underwent femoroacetabular osteoplasty (FAO) and labrum repair from January 2007 to September 2016 and 1,055 patients who underwent arthroscopic ACL reconstruction from January 2012 to December 2014, which acted as our control group. An electronic questionnaire, including 8 questions regarding history of shoulder pathology, was sent to all patients in both groups. Symptomatic shoulder labral tears were identified on the basis of a positive magnetic resonance imaging scan or history of labral repair by reviewing patients' medical records and the filled questionnaire. Continuous variables were compared by use of a Mann-Whitney U test, and categorical variables were compared using Fisher's exact test. The Holm-Bonferroni sequential correction method was used to adjust P values for multiple comparisons of the presence of shoulder pathology.

#### **Results**

A total of 443 patients (405 cam lesion) in the FAO group and 307 patients in the ACL reconstruction group completed the prepared questionnaire and were included in the study. Patients in the FAO group were slightly older (36.3 years [range, 15.4-61.7] vs 32.3 years [range, 16.3-75.7]) and more commonly female in the FAO group (58.0%, n = 257) compared with those in the ACL group (48.9%, n = 150). The prevalence of shoulder labral tear was 12.0% (95% confidence interval [CI], 9.3%-15.3%) for the FAO group compared with only 3.3% (95% CI, 1.8%-5.9%) for the ACL group. This represents a 3.7-fold (95% CI, 1.9-7.1) increase in the risk of shoulder labral tear for patients in the FAO group. Furthermore, shoulder labral tears were reported to be traumatic in only 43.4% of patients in the FAO group compared with 80.0% of patients in the ACL group. A similar proportion of patients in both groups (66.0% for FAO vs 60.0% for ACL) underwent a shoulder labral repair procedure.

#### **Conclusion**

There appears to be an association between acetabular labral tear caused by FAI and shoulder labral lesions. Patients in the FAI group had a 3.7-fold increase in the risk of shoulder labral tear compared with the ACL group. Future studies are needed to examine a possible cause behind the current findings.

#### **Level of Evidence**

Level III, comparative trial study.

[BACK](#)