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## Content November 2020

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## Upper extremity

Journal of Shoulder and Elbow Surgery (JSES), Volume 29, issue 11 pages 2248-2256

### **Influence of mental health on postoperative outcomes in patients following biceps tenodesis.**

Agarwalla, A., Lu, Y., Chang, E., et al.

DOI: 10.1016/j.jse.2020.03.020

#### **Purpose**

To evaluate the relationship between preoperative mental health measured by the Short-Form 12 health survey mental component score and outcomes after isolated biceps tenodesis.

#### **Methods**

The American Shoulder and Elbow Surgeons form (ASES), Single Assessment Numeric Evaluation (SANE), Constant-Murley score (CMS), and visual analog scale (VAS) for pain were administered preoperatively and at 6 and 12 months postoperatively to consecutive patients undergoing isolated biceps tenodesis between 2014 and 2018. Minimal clinically important difference, substantial clinical benefit (SCB), patient-acceptable symptom state (PASS), and rates of achievement were calculated. Patients were stratified by mental health status based on preoperative scores on the Short-Form 12 health survey mental component score. Multivariate logistic regression was performed to evaluate preoperative mental health status on achievement of minimal clinically important difference, SCB, and PASS.

#### **Results**

Patients demonstrated significant improvements in all outcome measures ( $P < .001$ ). Patients with depression reported inferior postoperative scores on all patient-reported outcome measures. Low preoperative mental health score significantly predicted reduced likelihood to achieve SCB (odds ratio [OR]: 0.38, 95% confidence interval [CI]: 0.17-0.81,  $P = .01$ ) and PASS (OR: 0.28, 95% CI: 0.12-0.65,  $P = .003$ ) on the ASES form, SANE (OR: 0.24, 95% CI: 0.10-0.61,  $P = .003$ ), CMS (OR: 0.25, 95% CI: 0.08-0.77,  $P = .016$ ), and VAS pain (OR: 0.01, 95% CI: 0.00-0.31,  $P = .008$ ).

#### **Conclusion**

Patients with depression reported inferior scores on all postoperative patient-reported outcome measures and demonstrated lower odds of achieving the SCB and PASS on the ASES form and PASS on the SANE, CMS, and VAS pain, compared with nondepressed patients.

#### **Level of evidence**

Level III

## **A case series of recurrent myotendinous rotator cuff tears repaired and augmented with dermal allograft: clinical outcomes at two years.**

Hall, T., Danielson, K., Brandenburg, S., et al.

DOI: <https://doi.org/10.1016/j.jse.2020.03.021>

### **Introduction**

When rotator cuff tears occur after a primary repair at the footprint, they often fail medially at the myotendinous junction, also called type II tears. These are difficult tears to treat, and little research has been published on how to address tears at the myotendinous junction and the clinical outcomes of the revised repairs. The purpose of this study is to evaluate the outcomes of type II rotator cuff tears repaired with a dermal allograft augmentation.

### **Materials and methods**

We conducted a retrospective chart review of 9 patients with a type II rotator cuff tear medially at the myotendinous junction, arthroscopically repaired and augmented with acellular dermal allograft by a single surgeon. Two-year follow-up was obtained to evaluate pain, function, range of motion, and structural integrity of the repair via ultrasound.

### **Results**

Of all 9 patients, the mean visual analog scale preoperatively was 5.1 (standard error,  $\pm 2.1$ ). With 9 patients having 2-year follow-up, the mean visual analog scale score continued to improve to 1.9 (standard error,  $\pm 2.4$ ). At 2 years, the mean American Shoulder and Elbow Surgeons based on 8 patients was 76.1, and the mean Short Form 36 for all 9 patients was 78.7. All 9 patients with 2-year follow-up had an intact repair on ultrasound read by a musculoskeletal fellowship-trained radiologist.

### **Discussion**

Based on the early outcome data, patient satisfaction scores, and intact repairs visualized on ultrasound at 2 years postoperatively, the use of acellular human dermal matrix augmentation appears to be an efficacious and worthwhile treatment option for patients with recurrent rotator cuff tears at the medial myotendinous junction.

### **Level of evidence**

Level IV

## **Morphologic and radiologic parameters correlating to shoulder function at diagnosis for patients with rotator cuff tear**

Cauchon, A.M., Tétreault, P, Bascans, C., et al.

DOI: <https://doi.org/10.1016/j.jse.2020.03.027>

### **Background**

The magnetic resonance imaging (MRI) parameters used to diagnose rotator cuff tears are weakly correlated to shoulder function. Our hypothesis was that adding 3-dimensional morphologic parameters resulting from biplanar radiographs (3DXR parameters) to the MRI parameters would improve this correlation.

### **Methods**

We assessed 52 patients with rotator cuff tears with an EOS Imaging radiographic examination, MRI study, and clinical evaluation of the shoulder, as well as the Constant score. The bones of the 52 shoulders were reconstructed 3-dimensionally, and eleven 3DXR parameters were automatically extracted. First, the trueness and reliability of these parameters were evaluated. Then, bivariate correlations between each parameter and the Constant score were made. A linear regression model was subsequently built to correlate the 11 parameters and 5 MRI findings with shoulder function at diagnosis, as assessed by the Constant score.

### **Results**

The parameters showed good trueness and reliability of most 3DXR parameters. Supraspinatus tear extension, muscle atrophy, and the distance between the greater and deltoid tuberosities were the only parameters with a statistically significant correlation to a lower Constant score ( $P < .05$ ) in the bivariate study. These correlations were either weak or negligible. A regression model was successfully built with one MRI parameter and four 3DXR parameters. Correlation to function increased from 16.7% to 43.3% with this model.

### **Conclusion**

For patients with rotator cuff tears, the combination of MRI and 3DXR parameters of the shoulder in a linear regression model improves the correlation with the Constant score (shoulder function) at diagnosis.

### **Level of evidence**

Level IV

## **Risk factors for complications and return to the emergency department after interscalene block using liposomal bupivacaine for shoulder surgery.**

Malige, A., Yeazell, S., Ng-Pellegrino, A., et al.

DOI: <https://doi.org/10.1016/j.jse.2020.03.012>

### **Background**

Exparel (liposomal bupivacaine) has recently gained favor for use in interscalene regional blocks for shoulder surgery. While effective for pain relief, this does have adverse effects that can lead to postoperative emergency department (ED) visits. This study aimed to identify any patient risk factors that are associated with complications leading to ED return visits owing to interscalene blocks using Exparel before shoulder surgery.

### **Methods**

A retrospective chart review was performed for all patients undergoing shoulder surgery with an Exparel interscalene block in an 8-month period. For each patient, demographic information, comorbidities, type of block, postoperative complications, ED return visits, and readmissions were recorded. The 5-factor modified Frailty Index score and the Charlson Comorbidity Index score were calculated. Univariate and multivariate logistic regressions were conducted to identify risk factors associated with increased complications and return to the ED.

### **Results**

Overall, 352 patients were included; most patients were men, were aged between 51 and 70 years, and had a body mass index of 25.0-35.0. Postoperative complications related to the Exparel interscalene block occurred in 58 patients (16.5%), including 37 minor complications (10.5%) and 21 major complications (6.0%) that led to return ED visits. Univariate analysis yielded American Society of Anesthesiologists (ASA) score ( $P = .03$ ) as a significant predictor of minor complications. Multivariate logistic regression analysis yielded ASA score ( $P = .096$ ; odds ratio, 1.64) as trending toward being a significant risk factor for minor complications. Univariate analysis yielded age ( $P = .006$ ), ASA score ( $P = .009$ ), and Charlson Comorbidity Index score ( $P = .002$ ) as significant predictors of major complications. Multivariate logistic regression analysis yielded ASA score ( $P = .049$ ; odds ratio, 2.25) as the only significant risk factor for major complications.

### **Conclusion**

Surgeons and anesthesiologists should strongly consider a patient's ASA score, in addition to his or her pulmonary and cardiac history, when deciding whether the patient is an appropriate candidate for an interscalene regional block using Exparel for shoulder surgery.

### **Level of evidence**

Level IV



## **Establishing the learning curve for elbow arthroscopy: surgeon and trainee perspectives on number of cases needed and optimal methods for acquiring skill.**

Key L.K., Jensen, A.R., O'Driscoll, S.W., et al.,

DOI <https://doi.org/10.1016/j.jse.2020.04.022>Get rights and content

### **Background**

Elbow arthroscopy has increased in frequency as its indications have widened. Despite this growth, a learning curve has not yet been defined.

### **Hypothesis**

We hypothesized that there would be significant differences in perspective between trainees and established surgeons for the number of cases needed to reach each skill level and what they felt are the most valuable training tools.

### **Methods**

Orthopedic attending physicians and trainees were asked to complete a questionnaire assessing participant demographics, case volumes required to reach defined skill levels (novice, safe, competent, proficient, and expert), and the efficacy of various learning methodologies for elbow arthroscopy. The value of educational methods was assessed using a 5-point Likert scale (1 = not at all valuable; 5 = extremely valuable).

### **Results**

The study population consisted of 323 total participants, of whom 224 (69.3%) were attending surgeons and 99 (30.7%) were trainees (resident or fellow physicians). According to the attending physicians, the mean numbers of cases needed to reach each skill level were 19 to be safe, 42 to be competent, 93 to be proficient, and 230 to be expert. These case numbers were not significantly different from the perspectives of trainees. Across the respondents, there were no significant differences in the number of cases needed to reach each level of skill based on the respondents' level of training, years of experience, type of fellowship, or self-reported skill level. Although both groups highly valued live surgery (4.7 of 5) and cadaveric practice (4.6 of 5) for acquiring skill, attendings placed higher value on reading (4.0 vs. 3.3,  $P < .001$ ), videos/live demos (4.2 vs. 3.6,  $P < .001$ ), and formal courses (4.5 vs. 4.1,  $P < .001$ ) than trainees. Both groups place relatively low value on surgical simulators (2.8-3.6).

### **Conclusions**

There was considerable agreement among attending surgeons and trainees in terms of the number of cases needed to attain various skill levels of elbow arthroscopy, which was consistent regardless of fellowship background, self-reported skill level, career length, and elbow arthroscopy case volume. However, there was some disagreement between attending surgeons and trainees over the most valuable methods for acquiring surgical skill with trainees placing less value on textbooks, surgical videos, and formal courses compared with attending surgeons. An understanding of the elbow arthroscopy learning curve will help trainees and their training programs establish case volume targets before safe, independent practice. Future studies should aim to clinically validate this learning curve.

### **Level of evidence**

Survey Study, Experts

## **Superior Capsule Reconstruction for Irreparable Massive Rotator Cuff Tears: Does It Make Sense? A Systematic Review of Early Clinical Evidence**

Burak Altintas, MD, Michael Scheidt, BS, Victor Kremser, BS, Robert Boykin, MD, Sanjeev Bhatia, MD, Kaveh R. Sajadi, MD, Scott Mair, MD, Peter J. Millett, MD, MSc\*\*

<https://doi.org/10.1177/0363546520904378>

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**Background:** Treatment of irreparable massive rotator cuff tears (MRCTs) in patients without advanced glenohumeral osteoarthritis remains a challenge. Arthroscopic superior capsule reconstruction (SCR) represents a newer method for treatment with increasing popularity and acceptance.

**Purpose:** To analyze the clinical evidence surrounding SCR and determine the current clinical outcomes postoperatively

**Study Design:** Systematic review.

**Methods:** A systematic review of the literature was performed following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Electronic databases of PubMed, MEDLINE, Cochrane, and Google Scholar were used for the literature search. The study quality was evaluated according to the Modified Coleman Methodology Score. Studies in English evaluating SCR outcomes were included.

**Results:** Seven studies were reviewed, including 352 patients (358 shoulders) treated with arthroscopic SCR with the mean duration of follow-up ranging from 15 to 48 months (range, 12-88 months). Fourteen patients were lost to follow-up, leaving 338 patients (344 shoulders) with clinical outcome data. Graft types included dermal allografts (n = 3 studies), fascia lata autografts (n = 3), or both (n = 1). Most commonly, a double-row technique was utilized for humeral graft fixation. The most common complication included graft tears in 13% of patients, resulting in 15 SCR revisions and 7 reverse shoulder arthroplasties. Postoperatively, improvements in visual analog scale (2.5 to 5.9), American Shoulder and Elbow Surgeons (20 to 56), Japanese Orthopaedic Association (38.0), Subjective Shoulder Value (37.0 to 41.3), and Constant (11.6 to 47.4) scores were observed. Three studies reported respective satisfaction rates of 72.9%, 85.7% and 90%. Increases in external rotation, internal rotation, and abduction with improved strength in external rotation were observed postoperatively. Improvement of pseudoparalysis was also observed in 3 studies. One study reported return to sports in 100% of patients (2 competitively, 24 recreationally) with no adverse outcomes.

**Conclusion:** SCR showed good to excellent short-term clinical outcomes with adequate pain relief and functional improvement. The current evidence suggests that the procedure is an alternative for symptomatic patients with irreparable MRCT; however, the included studies were fair to poor in quality, and there were some notable complications. Long-term follow-up will determine the longevity and ultimate role of this new method in the treatment of irreparable MRCT.

## **Bone Marrow Stimulation in Arthroscopic Repair for Large to Massive Rotator Cuff Tears With Incomplete Footprint Coverage**

Chul Kim, MD, Yun-Jae Lee, MD, Sung-Jae Kim, MD, PhD, Tae-Hwan Yoon, MD, Yong-Min Chun, MD, PhD†

<https://doi.org/10.1177/0363546520959314>

**Background:** There is no research on incomplete footprint coverage with single-row repair related to bone marrow stimulation (BMS) in large to massive rotator cuff tears (RCTs).

**Purpose/Hypothesis:** The purpose was to compare the clinical results and structural integrity between BMS and non-BMS groups that underwent arthroscopic repair of large to massive rotator cuff tears with <50% footprint coverage. It was hypothesized that both groups would exhibit improved clinical outcomes at 2 years after surgery but the BMS group would have significantly better clinical outcomes and structural integrity.

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

**Methods:** This study included 98 patients who underwent arthroscopic repair with <50% footprint coverage for large to massive RCTs with (BMS group; n = 56) or without (non-BMS group; n = 42) BMS. Functional outcomes at the 2-year follow-up were assessed using the visual analog scale for pain score, subjective shoulder value; American Shoulder and Elbow Surgeons score; University of California, Los Angeles, shoulder score; and active range of motion. Structural integrity was evaluated using magnetic resonance arthrography or computed tomography arthrography results at 6 months postoperatively.

**Results:** At the 2-year follow-up, all functional outcomes significantly improved in both groups compared with preoperative values ( $P < .001$ ). However, there were no significant postoperative differences between groups. On follow-up magnetic resonance arthrography or computed tomography arthrography, the overall retear rate was not significantly different between the BMS group (30.3%; 17/56) and the non-BMS group (35.7%; 15/42).

**Conclusion:** While both groups exhibited functional improvement after single-row repair with <50% footprint coverage for large to massive RCTs, BMS did not produce better clinical outcomes or structural integrity.

## Arthroscopic Superior Capsular Reconstruction With Mesh Augmentation for the Treatment of Irreparable Rotator Cuff Tears: A Comparative Study of Surgical Outcomes

Erica Kholinne, MD, PhD, Jae-Man Kwak, MD, Hyojune Kim, MD, Kyoung Hwan Koh, MD, PhD, In-Ho Jeon, MD, PhD†

<https://doi.org/10.1177/0363546520958708>

**Background:** Arthroscopic superior capsular reconstruction (ASCR) is an alternative to open surgery for irreparable chronic rotator cuff tears (RCTs). This approach can provide static restraint while avoiding upward migration of the humeral head. However, graft tears and their effect on clinical outcomes after ASCR remain a debated topic.

**Purpose:** To evaluate the clinical outcomes of ASCR with mesh augmentation for the treatment of irreparable RCTs.

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

**Methods:** The data of 72 patients with irreparable RCTs who underwent ASCR between 2013 and 2018 were retrospectively evaluated. Among them, 64 patients who met the inclusion and exclusion criteria were enrolled in this study. Fascia lata grafts augmented with a polypropylene mesh were used for 30 patients (mesh group), and grafts without mesh augmentation were used for 34 patients (control group). Clinical outcomes were evaluated using range of motion, the American Shoulder and Elbow Surgeons (ASES) questionnaire, and visual analog scale for pain. Radiological outcomes were evaluated according to acromiohumeral distance and stage of rotator cuff arthropathy. The status of fatty infiltration and graft integrity was evaluated using magnetic resonance imaging. Outcomes were assessed preoperatively and at the final follow-up.

**Results:** Both groups showed improvement in clinical and radiological outcomes at the final follow-up. The mesh group demonstrated a larger improvement in ASES score (mean  $\pm$  SD,  $29.1 \pm 15.8$ ) than the control group ( $18.1 \pm 15.9$ ) ( $P = .006$ ). The mean improvement in active forward flexion was significantly higher in mesh group ( $40^\circ \pm 26^\circ$ ) than in control group ( $28^\circ \pm 23^\circ$ ) ( $P = .003$ ). The mean improvement in active external rotation was also significantly higher in the mesh group ( $11^\circ \pm 5^\circ$ ) than in the control group ( $6^\circ \pm 3^\circ$ ) ( $P = .004$ ). Graft healing rate was significantly higher in the mesh group (83.3%) than in the control group (58.8%) ( $P = .039$ ), and acromiohumeral distance was significantly greater in the mesh group ( $9.1 \pm 2.4$  mm) than in the control group ( $6.3 \pm 1.8$  mm) at the final follow-up ( $P = .001$ ). Subgroup analysis revealed that patients with graft failure generally showed progression of fatty infiltration without improvement in the stage of rotator cuff arthropathy. Patients with intact grafts demonstrated a more substantial improvement in functional outcomes (ASES score and forward flexion motion).

**Conclusion:** ASCR with mesh augmentation reduced graft failure rate to restore superior shoulder joint stability.

## Preoperative Opioid Use Is a Risk Factor for Revision Surgery, Complications, and Increased Resource Utilization After Arthroscopic Rotator Cuff Repair

Kevin X. Farley, BS, Jacob M. Wilson, MD, Corey C. Spencer, BS, Spero Karas, MD, John Xerogeanes, MD, Michael B. Gottschalk, MD, Eric R. Wagner, MD, MS†

<https://doi.org/10.1177/0363546520960122>

**Background:** Studies have shown preoperative opioid use to influence outcomes after various surgical procedures. Researchers have not assessed this relationship after rotator cuff repair (RCR).

**Hypothesis/Purpose:** The purpose was to assess the relationship between preoperative opioid use and outcomes after arthroscopic RCR. We hypothesized that patients prescribed higher daily averages of preoperative oral morphine equivalents (OMEs) would show increased rates of 90-day complications and 3-year revision surgery.

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

**Methods:** The MarketScan claims database was utilized to identify patients who underwent arthroscopic RCR between 2009 and 2018. We used preoperative opioid use status to divide patients into groups based on the average daily OMEs consumed in the 6 months before surgery: opioid-naïve, <1, 1-<5, 5-<10, and ≥10 OMEs per day. We retrieved 90-day complication and 3-year revision surgery rates. Opioid use groups were then compared with binomial logistic regression and generalized linear models.

**Results:** We identified 214,283 patients. Of those patients, 50.7% did not receive any preoperative opioids, while 7.7%, 26.8%, 6.3%, and 8.6% received <1, 1-<5, 5-<10, and ≥10 OMEs per day over a 6-month time period, respectively. Complications increased with increasing preoperative OMEs. Multivariate analysis revealed that any patient using ≥1 OME per day had increased rates of 3-year revision surgery, reoperations, and infections. Specifically, patients averaging ≥10 OMEs per day showed a 103% (odds ratio, 2.03 [95% CI, 1.62-2.54];  $P < .001$ ) increase in the odds of revision surgery compared with opioid-naïve patients. Rates of hospital admissions and postoperative emergency department encounters were higher in all opioid use groups. Adjusted differences in 6-month preoperative and 3-month postoperative health care costs were seen in the opioid use groups compared with opioid-naïve patients, ranging from US\$1307 to US\$5820 ( $P < .001$ ).

**Conclusion:** Preoperative opioid use was a risk factor for complications and revision surgery after arthroscopic RCR. We also observed a dose-dependent response between opioid use and postoperative complications.

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## Lower Extremity

Arthroscopy, Volume 36, Issue 11, P 2832-2839.E1

### Outcomes of Preoperative Opioid Usage in Hip Arthroscopy: A Comparison With Opioid-Naïve Patients

Zusmanovich, M., Thompson, K., Campbell, A., & Youm, T.

<https://doi.org/10.1016/j.arthro.2020.06.005>

#### Purpose

To compare postoperative outcomes between opioid-naïve patients and patients with a history of preoperative opioid usage undergoing hip arthroscopy. The secondary purpose is to determine whether preoperative opioid users consumed more oral morphine milligram equivalents than opioid-naïve patients following surgery.

#### Methods

This is a single-center, retrospective analysis comparing outcomes and postoperative opioid usage between patients with and without a history of preoperative opioid use. Inclusion criteria included patients  $\geq 18$  years, Tönnis grade 0 or 1, imaging consistent with FAI or labral pathology, and a diagnosis of symptomatic FAI requiring hip arthroscopy. Patient outcomes were compared throughout a 2-year follow-up using the modified Harris Hip Score, Nonarthritic Hip Score, and visual analog scale (VAS).

#### Results

In total, 17 patients were evaluated in each cohort. The mean age of the study cohort and control cohort were  $52.0 \pm 9.4$  years and  $51.2 \pm 12.2$  years, respectively. Female patients were 58.8% ( $n = 10$ ) of both cohorts. Non-naïve patients had a lower preoperative Nonarthritic Hip Score ( $P = .05$ ) and a greater VAS at their 6-month and 1-year ( $P < .001$ ) postoperative visits. Naïve patients reported greater modified Harris Hip Scores 2 years postoperatively ( $P < .001$ ). The study cohort was prescribed greater levels of oral morphine equivalents at the postoperative 1-year visit ( $P = .05$ ). Opioid-naïve patients were more likely to reach minimally clinically important difference and patient acceptable symptom state of VAS at a faster rate. At the 2-year follow-up, 11.8% of opioid-naïve patients continued to take opioids compared with 58.8% from the non-naïve group for persistent hip pain ( $P < .001$ ).

#### Conclusions

We determined that preoperative opioid usage in patients undergoing hip arthroscopy is associated with inferior outcomes compared with opioid-naïve patients. In addition, preoperative opioid users are likely to continue the use of opioid medications postoperatively and at greater doses than opioid-naïve patients.

#### Level of Evidence

3, retrospective comparative study

## **Clinical Outcomes After Endoscopic Repair of Gluteus Medius Tendon Tear Using a Knotless Technique With a 2-Year Minimum Follow-Up**

Kirby, D., Fried, J. W., Bloom, D. A., Buchalter, D., & Youm, T.

<https://doi.org/10.1016/j.arthro.2020.07.022>

### **Purpose**

To evaluate clinical outcomes in patients who underwent endoscopic gluteus medius repair with at least 2-year follow-up.

### **Methods**

This was a single-center, single-surgeon retrospective study of 19 patients (20 hips) who underwent endoscopic knotless gluteus medius repair between August 2010 and August 2016 with  $\geq 2$  years of follow-up. Preoperative magnetic resonance imaging (MRI) was reviewed and graded according to the Goutallier/Fuchs classification; preoperative X-rays were reviewed and graded according to the Tonnis classification. Baseline and 2-year postoperative modified Harris hip score (mHHS) and nonarthritic hip score (NAHS) were prospectively collected. The numbers of patients reaching the minimal clinically important difference (MCID) and patient acceptable symptomatic rate (PASS) were determined.

### **Results**

Twenty hips from 19 patients met the inclusion criteria and were separated based on tear type. The study population comprised 15 (79%) females and 4 (21%) males presenting with a mean age of  $51.3 \pm 11.9$  years and an average body mass index of  $25.3 \pm 3.9$  kg/m<sup>2</sup>. Patients with partial tears reported average preoperative mHHS and NAHS of  $33.6 \pm 11.3$  and  $40.4 \pm 14.9$ , respectively; at 2-year follow-up, average mHHS and NAHS of  $72.9 \pm 22.9$  and  $77.2 \pm 19.7$  were reported. Patients with full-thickness tears reported average preoperative mHHS and NAHS of  $43.8 \pm 14.7$  and  $46.4 \pm 8.3$ , respectively; at 2-year follow-up, average mHHS and NAHS of  $80.1 \pm 8.5$  and  $79.5 \pm 10.1$  were reported. There was significant clinical improvement at 2-year follow-up, relating to both outcome measures in each subject group ( $P < .001$ ). At 2 years, 90% of hips surpassed MCID, and 63% of hips achieved PASS.

### **Conclusion**

Endoscopic repair for gluteus medius tears results in improved mHHS and NAHS at 2 years of follow-up compared with baseline. Most patients reach critical thresholds of minimal and satisfactory clinical improvement.

### **Level of Evidence**

Level IV, case series with subgroup analysis

## **Mid-Term Outcomes of Endoscopic Gluteus Medius Repair With Concomitant Arthroscopic Labral Treatment: A Propensity-Matched Controlled Study**

Meghpara, M. B., Yelton, M. J., Annin, S., Shapira, J., Rosinsky, P. J., Maldonado, D. R., ... Domb, B. G.

<https://doi.org/10.1016/j.arthro.2020.07.020>

### **Purpose**

To report mid-term outcomes of patients who underwent endoscopic gluteus medius (GM) repair with arthroscopic labral treatment and to compare them with a control cohort of patients who underwent arthroscopic labral treatment without an endoscopic GM repair.

### **Methods**

Data were prospectively collected and retrospectively reviewed for all patients who underwent primary hip arthroscopy between February 2008 and August 2013. Patients were included if they underwent arthroscopic labral treatment, endoscopic GM repair, and had preoperative with minimum 5-year follow-up for the following patient-reported outcomes: modified Harris Hip Score (mHHS), Nonarthritic Hip Score (NAHS), and Hip Outcome Score-Sports Specific Subscale (HOS-SSS). Propensity score matching was used to create a control cohort of patients who underwent primary arthroscopic labral treatment without GM repair.

### **Results**

There were a total of 46 patients with GM repair eligible for the current study, of whom 43 (93.5%) had 5-year follow-up. The average follow-up time was 73.4 months. At minimum 5-year follow-up, all PROs significantly improved ( $P < .001$ ). Among the entire GM repair cohort, rates for achieving the patient acceptable symptomatic state (PASS) for mHHS, HOS-SSS, and international Hip Outcome Tool (iHOT-12) were 74.4%, 51.9%, and 71.8%, respectively. Rates for reaching a minimal clinically important difference for mHHS, NAHS, and HOS-SSS were 79.5%, 89.7%, and 73.1%, respectively. When the GM repair cohort was matched, there were 37 cases in the GM repair cohort and 78 in the control cohort. The GM repair cohort outcomes compared satisfactorily to the control cohort for mHHS (82.3 vs 82.6), NAHS (81.9 vs 82.3), and HOS-SSS (66.3 vs 67.5). Rates of achieving minimal clinically important difference and PASS for mHHS, NAHS, HOS-SSS, and iHOT-12 were also favorable.

### **Conclusions**

Endoscopic GM repair with arthroscopic labral treatment results in safe, durable, and significant improvement in PROs at a minimum 5-year follow-up. The outcomes compared favorably with a control cohort without GM tears.

### **Level of Evidence**

III, retrospective comparative study.



# Examining Techniques for Treatment of Medial Meniscal Ramp Lesions During Anterior Cruciate Ligament Reconstruction: A Systematic Review

Acosta, J., Ravaei, S., Brown, S. M., & Mulcahey, M. K.

<https://doi.org/10.1016/j.arthro.2020.05.041>

## Purpose

The purpose of this study was to systematically review the clinical outcomes and adverse events among different techniques for treatment of medial meniscal ramp lesions performed in conjunction with anterior cruciate ligament (ACL) reconstruction.

## Methods

A systematic review was performed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. PubMed, Cochrane Reviews, Web of Science, and Medline databases were searched for studies examining clinical outcomes after surgical treatment of ramp lesions. Studies were selected if they met the following criteria: (1) evaluation of the outcome of surgical repair of meniscal ramp lesions, (2) injuries associated with ACL tears, (3) minimum 6-month follow up, (4) publication in a peer-reviewed journal, and (5) English language or translation readily available.

## Results

Seven studies met inclusion criteria (485 patients; mean age 27.1 years [range 12 to 59]; mean follow-up 26.9 months [range 8 to 40]). Two all-inside techniques (suture-hook and an all-inside meniscus repair device) in addition to abrasion and trephination alone were analyzed. Each technique demonstrated significant increases in postoperative Lysholm and International Knee Documentation Committee (IKDC) scores, reaching the established minimal clinically important difference (MCID) for each patient reported outcome. Incomplete healing was documented in 12.1% to 12.9% of cases in which the tear was not repaired at the time of ACL reconstruction, 2.3% to 11.7% in cases using the suture-hook for repair, and 10.8% to 15% in the all-inside meniscus repair device group.

## Conclusion

This systematic review demonstrated that several approaches used to treat medial meniscal ramp lesions associated with ACL tears lead to positive clinical outcomes. Small, stable tears <2 cm in size may be managed with debridement alone. For larger, more unstable lesions, an all-inside approach has demonstrated positive clinical outcomes. Prospective trials are needed to determine the best management for meniscal ramp lesions. Additionally, further research is needed to better understand how to minimize the risk of technique-related complications (e.g., improper implant deployment).

## Level of Evidence

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

**Transtibial fixation for medial meniscus posterior root tear reduces posterior extrusion and physiological translation of the medial meniscus in middle-aged and elderly patients.**

Kodama, Y., Furumatsu, T., Masuda, S., et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-019-05810-x>

**Purpose**

To investigate changes in meniscal extrusion during knee flexion before and after pullout fixation for medial meniscus posterior root tear (MMPRT) and determine whether these changes correlate with articular cartilage degeneration and short-term clinical outcomes.

**Methods**

Twenty-two patients (mean age  $58.4 \pm 8.2$  years) diagnosed with type II MMPRT underwent open magnetic resonance imaging preoperatively, 3 months after transtibial fixation and at 12 months after surgery, when second-look arthroscopy was also performed. The medial meniscus medial extrusion (MMME) and the medial meniscus posterior extrusion (MMPE) were measured at knee  $10^\circ$  and  $90^\circ$  flexion at which medial meniscus (MM) posterior translation was also calculated. Articular cartilage degeneration was assessed using International Cartilage Research Society grade at primary surgery and second-look arthroscopy. Clinical evaluations included Knee Injury and Osteoarthritis Outcome Score, International Knee Documentation Committee subjective knee evaluation form, Lysholm score, Tegner activity level scale, and pain visual analogue scale.

**Results**

MMPE at  $10^\circ$  knee flexion was higher 12 months postoperatively than preoperatively ( $4.8 \pm 1.5$  vs.  $3.5 \pm 1.2$ ,  $p = 0.01$ ). MMPE at  $90^\circ$  knee flexion and MM posterior translation were smaller 12 months postoperatively than preoperatively ( $3.5 \pm 1.1$  vs.  $4.6 \pm 1.3$ ,  $7.2 \pm 1.7$  vs.  $8.9 \pm 2.0$ ,  $p < 0.01$ ). Articular cartilage degeneration of medial femoral condyle correlated with MMME in knee extension ( $r = 0.5$ ,  $p = 0.04$ ). All clinical scores significantly improved 12 months postoperatively. However, correlations of all clinical scores against decreased MMPE and increased MMME were not detected.

**Conclusions**

MMPRT transtibial fixation suppressed the progression of MMPE and cartilage degeneration and progressed MMME minimally in knee flexion position at 1 year. However, in the knee extension position, MMME progressed and correlated with cartilage degeneration of medial femoral condyle. MMPRT transtibial fixation contributes to the dynamic stability of the MM in the knee flexion position.

**Level of evidence**

IV.

## **Degenerative medial meniscus posterior root tear and non-root tear do not show differences in joint survival and clinical outcome after partial meniscectomy.**

Kwon, OJ., Bin, SI., Kim, JM. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-019-05771-1>

### **Purpose**

No comparative studies of outcomes between degenerative medial meniscus posterior root tear (MM PRT) and non-root tear (NRT) have been conducted. This study aimed to compare joint survival and clinical outcome between MM PRT and MM NRT after partial meniscectomy with proper control of confounding factors.

### **Methods**

One hundred and ten patients each in MM PRT and MM NRT groups who underwent arthroscopic partial meniscectomy were retrospectively evaluated through propensity score matching. Joint survival was assessed on the basis of surgical and radiographic failures. Clinical outcomes were assessed using the Lysholm score.

### **Results**

The confounding variables were well balanced between the groups, with standardized mean differences of < 0.2 after propensity score matching. Failures occurred in 30 (27.3%) and 35 patients (31.8%) in the MM PRT group and MM NRT group, respectively. The estimated mean survival times were 12.5 years (95% confidence interval [CI] 11.5–13.5) and 11.7 years (10.7–12.7), respectively. There were no significant differences in the overall survival rate and Lysholm score between the two groups (n.s.).

### **Conclusion**

In middle-aged patients with degenerative MM PRT, joint survival and clinical outcome showed comparable results with those with MM NRT after partial meniscectomy. Arthroscopic partial meniscectomy is one of the effective treatments for MM PRT with consideration of various patient factors.

### **Level of evidence**

III.

## **Medial meniscus posterior root repair restores the intra-articular volume of the medial meniscus by decreasing posteromedial extrusion at knee flexion.**

Okazaki, Y., Furumatsu, T., Yamauchi, T. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-020-05953-2>

### **Purpose**

Transtibial repair of a medial meniscus posterior root tear (MMPRT) can improve clinical outcomes, although meniscal extrusion remains. However, few studies have investigated the volume of meniscal extrusion. This study aimed to evaluate the effect of transtibial repair in reducing the volume using three-dimensional (3D) magnetic resonance imaging, at 10° and 90° knee flexion.

### **Methods**

Twenty patients with MMPRTs and 16 volunteers with normal knees participated. The 3D models of meniscus were constructed using SYNAPSE VINCENT®. The meniscal extrusion and its volume were measured at 10° and 90° knee flexion. Differences between the pre- and postoperative examinations were assessed using the Wilcoxon signed-rank test. The postoperative parameters were compared to those in patients with normal knees.

### **Results**

There were no significant pre- and postoperative differences in any parameter at 10° knee flexion. At 90° knee flexion, the posterior extrusion and its meniscal volume were decreased significantly after transtibial repair ( $p < 0.05$ ), even though these parameters were larger than in the normal knees. On the other hand, intra-articular meniscal volume calculated by the extrusion volume was increased to the level of the normal knee.

### **Conclusions**

This study demonstrated that transtibial repairs improved the intra-articular/intra-tibial surface volume of the medial meniscus by reducing the posteromedial extrusion during knee flexion. This 3D analysis is clinically relevant in evaluating that, while transtibial root repair has a limited ability to reduce meniscal extrusion, it can restore the functional volume of the medial meniscus which contributes to the shock absorber postoperatively.

### **Level of evidence**

IV.

## **Progression of radiographic osteoarthritis after partial meniscectomy in degenerative medial meniscal posterior root tears was greater in varus- than in neutral-aligned knees: a minimum 5-year follow-up.**

Kim, C., Bin, S.I., Kim, J.M. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-020-05905-w>

### **Purpose**

To perform a radiographic assessment of osteoarthritis, progression after partial meniscectomy (PM) in degenerative medial meniscus posterior root tears (MMPRTs) in relation to preoperative mechanical axis (MA). The hypothesis is that neutral-aligned knees with degenerative MMPRTs have better radiographic outcomes than those of varus-aligned knees after arthroscopic PM.

### **Methods**

Records of 114 patients with degenerative MMPRTs and Kellgren–Lawrence (KL) grade  $\leq 2$  osteoarthritis, who underwent PM, had preoperative weight-bearing hip-to-ankle radiographs from 2004 to 2014, and were followed-up for at least 5 years were reviewed retrospectively. The mean follow-up period was  $8.3 \pm 2.8$  years. Preoperative MA values were used to classify the patients into either a Neutral (N valgus  $3^\circ$  to varus  $3^\circ$ ;  $n = 60$ ) or Varus-aligned group (V varus  $> 3^\circ$ ;  $n = 54$ ). Joint space width (JSW; mm) and KL grade (0/1/2/3/4) were measured preoperatively and finally on weight-bearing  $45^\circ$  flexion posteroanterior and anteroposterior radiographs, respectively.

### **Results**

Preoperative JSW and KL grade did not differ significantly between the groups (N vs V; JSW  $3.64 \pm 0.83$  vs  $3.44 \pm 0.81$ ,  $P = 0.201$ ; KL grade, 2/31/27/0/0 vs 0/22/32/0/0,  $P = 0.162$ ); however, the final JSW and KL grade differed significantly between the groups (N vs V; JSW  $3.03 \pm 0.78$  vs  $2.07 \pm 0.87$ ; KL grade, 0/21/23/13/3 vs 0/10/26/21/6, both  $P < 0.001$ ). The N group showed significantly less KL progression compared with the V group (N vs V; progression/no progression, 27/33 vs 42/12,  $P = 0.001$ ).

### **Conclusion**

The progression of radiographic osteoarthritis after PM for degenerative MMPRTs was greater in varus-aligned knees than in neutral-aligned knees. PM should be considered cautiously in patients with varus-aligned knees.

### **Level of evidence**

Retrospective comparative study, Level III.

Successful treatment of degenerative medial meniscal tears in well-aligned knees with fibrin clot implantation.

Nakayama, H., Kanto, R., Kambara, S. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-019-05758-y>

### **Purpose**

The purpose of this study was to examine the results of meniscal repair performed for symptomatic degenerative medial meniscal tears.

### **Methods**

Twenty-four knees in 24 patients with symptomatic degenerative medial meniscal tears (mostly complex horizontal tears) who underwent isolated arthroscopic repair combined with autologous fibrin clot implantation were included in this study. The patients were followed up for a minimum of 2 years. The overall clinical outcome was evaluated using the Lysholm score, while the activity level was graded on the Tegner Activity Scale. The assessment of healing status at the repair site was based on clinical signs/symptoms and follow-up MRI examination results. In addition, the effects of the patient's clinical and radiological factors on healing of the repaired menisci were analyzed.

### **Results**

The mean age of the study subjects was  $47.0 \pm 8.1$  years with a mean follow-up period of  $39.3 \pm 11.6$  months. The Lysholm score significantly improved after surgery ( $P < 0.01$ ). During the follow-up period, meniscal repairs were deemed to have failed in 6 of the 24 knees (25%). In the analysis of factors influencing meniscal healing, varus deformity (% of mechanical axis  $< 30\%$ ) was identified in all knees in the repair failure group, and the presence of varus deformity was shown to be a significant risk factor correlated with repair failure, while other factors did not significantly influence the healing status.

### **Conclusions**

The short-term follow-up results showed that arthroscopic repair of degenerative medial meniscal tears combined with fibrin clot implantation attained clinical healing in 18 of 24 knees (75%) of patients, while 6 of the 24 knees (25%) of patients experienced clinical failure. The presence of varus deformity negatively affects the healing rate. In well-aligned knees, degenerative medial meniscal tears are successfully treated by isolated repair with fibrin clot implantation.

### **Level of evidence**

IV.

## **Arthroscopic repair of horizontal cleavage meniscus tears provides good clinical outcomes in spite of poor meniscus healing.**

Ogawa, H., Matsumoto, K., Sengoku, M. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-019-05782-y>

### **Purpose**

The purpose of this study was to evaluate the clinical outcomes and meniscus healing after arthroscopic repair of horizontal-cleavage meniscus tears, compared with vertical-longitudinal meniscus tears.

### **Methods**

This was a retrospective review of a consecutive series of 52 meniscal repairs for horizontal-cleavage tears (n = 27) or vertical-longitudinal tears (n = 25); the groups were compared with respect to clinical symptoms and meniscal healing. Arthroscopic meniscal repair was performed using the inside-out technique with a marrow-stimulating technique. Clinical symptoms were evaluated using the Lysholm score and Knee injury and osteoarthritis outcome score (KOOS). Meniscus healing was evaluated by MRI.

### **Results**

The mean follow-up periods were  $35.4 \pm 8.9$  months in the horizontal-cleavage tear group and  $39.8 \pm 8.3$  months in the vertical-longitudinal tear group. There were no significant differences in Lysholm score and KOOS, including each subscale, between the horizontal-cleavage tear- and vertical-longitudinal tear-groups at the final follow-up. At the final follow-up, MRI meniscus grades 0 and 1 were significantly more frequent in the vertical-longitudinal tear-group than in the horizontal-cleavage tear-group, while grade 3 was significantly more frequent in the horizontal-cleavage tear group than in the vertical-longitudinal tear group ( $p < 0.0001$ ).

### **Conclusions**

Although meniscus healing of horizontal-cleavage tears may be poor, arthroscopic repair should be considered for horizontal-cleavage tears because it does provide good clinical outcomes.

### **Level of evidence**

IV.

## **Chondral lesions at the medial femoral condyle, meniscal degeneration, anterior cruciate ligament insufficiency, and lateral meniscal tears impair the middle-term results after arthroscopic partial meniscectomy.**

Sgroi, M., Gninka, J., Fuchs, M. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-020-05883-z>

### **Purpose**

The aim of the present study was to analyse which clinical, radiological and arthroscopic findings are able to predict the postoperative outcome after arthroscopic partial meniscectomy. Furthermore, the present study aimed to investigate the postoperative outcome after partial meniscectomy in patients with degenerative meniscal lesions.

### **Methods**

A total of 91 patients with a follow-up period of  $34.7 \pm 11.4$  months after arthroscopic partial meniscectomy were included in this retrospective study. Clinical, radiological, and arthroscopic data were analysed at the time of follow-up. The multivariable linear regression analysis for postoperative outcome, based on the Western Ontario Meniscal Evaluation Tool (WOMET), included age, gender, body mass index, physical activity, presence of cartilage lesions, leg alignment, grade of radiographic osteoarthritis, location of meniscal lesions, meniscal extrusion, meniscal degeneration, presence of an anterior cruciate ligament tears as well as bone marrow lesions.

### **Results**

WOMET and WOMAC scores showed a significant improvement of  $45.0 \pm 48.1$  points (CI 34.9–55.1;  $p \leq 0.0001$ ) and  $75.1 \pm 69.3$  points (CI 60.6–89.6;  $p = 0.001$ ) within the follow-up period. Multivariable linear regression analysis showed that poor preoperative WOMET scores ( $p = 0.001$ ), presence of cartilage lesions at the medial femoral condylus ( $p = 0.001$ ), meniscal degeneration ( $p = 0.008$ ), the presence of an anterior cruciate ligament lesion ( $p = 0.005$ ), and lateral meniscal tears ( $p = 0.039$ ) were associated with worse postoperative outcomes. Patients with femoral bone marrow lesions had better outcome ( $p = 0.038$ ).

### **Conclusion**

Poor preoperative WOMET scores, presence of cartilage lesions at the medial femoral condylus, meniscal degeneration, concomitant anterior cruciate ligament lesions as well as lateral meniscal tears are correlated with worse postoperative outcomes after arthroscopic partial meniscectomy. Patients with femoral bone marrow lesions femoral are more likely to gain benefit from arthroscopic partial meniscectomy in the middle term. Despite justified recent restrictions in indication, arthroscopic partial meniscectomy seems to effectively reduce pain and alleviate symptoms in carefully selected patients with degenerative meniscal tears.

### **Level of evidence**

III.



## **Partial meniscectomy provides the favorable outcomes for symptomatic medial meniscus tear with an intact posterior root.**

Kim, JY., Bin, SI., Kim, JM. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-019-05634-9>

### **Purpose**

This study aimed to investigate the long-term outcomes of arthroscopic partial meniscectomy for medial meniscus tear (with intact posterior root) and to analyze the risk factors for treatment failure.

### **Methods**

The records of 165 patients who underwent partial meniscectomy for medial meniscus tear with intact posterior root with a minimum 5-year follow-up were included. Modified Lysholm score and radiologic outcomes were compared between preoperative and latest follow-up periods. The cumulative Outerbridge grade of the medial compartment was defined as follows: 0–4, low chondral wear; 5–6, intermediate wear; or 7–8, high wear. Kaplan–Meier survival and Cox hazard regression analyses were performed to assess the survivorship after partial meniscectomy. Conversion to total knee replacement arthroplasty, high tibial osteotomy or a Lysholm score of < 65 points indicated treatment failure.

### **Results**

Mean Lysholm score improved from  $66.3 \pm 14.2$  preoperatively to  $81.8 \pm 17.9$  at the latest follow-up ( $p = 0.001$ ). The postoperative 10-year survival rate of the low chondral wear group [97% (95% confidence interval (CI) 141.7–152.6 months)] was higher than that of the intermediate [83.1% (95% CI 129.6–147.9 months)] and high wear groups [76.1% (95% CI 115.2–135.0 months)]. A 1 mm joint space width narrowing led to a 37.7% increase in the failure rate [B = - 0.473; hazard ratio, 0.623 (95% CI 0.423–0.917);  $p = 0.016$ ]. The high chondral wear group showed a higher failure rate compared to the low wear group [B = 1.870; hazard ratio, 6.488 (95% CI 0.853–49.333);  $p = 0.041$ ].

### **Conclusion**

Partial meniscectomy offers pain relief and functional improvement for medial meniscus tear with intact posterior root. Preoperative joint space narrowing and higher chondral wear at surgery were significant risk factors of treatment failure. Partial meniscectomy should be considered as an effective treatment for irreparable medial meniscus tear with intact posterior root without joint space narrowing and chondral wear.

### **Level of evidence**

Case series, Level IV.

## **Unrepaired lateral meniscus tears lead to remaining pivot-shift in ACL-reconstructed knees.**

Hoshino, Y., Hiroshima, Y., Miyaji, N. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-020-06007-3>

### **Purpose**

To compare the postoperative rotatory knee laxity between ACL-reconstructed knees with different meniscus treatments using an electromagnetic pivot-shift measurement.

### **Methods**

Forty-six patients with unilateral ACL reconstructions were enrolled (21 males/25 females,  $25 \pm 12$  y.o.). Concomitant meniscus tears, if any, were repaired whenever possible during primary ACL reconstruction. At 1 year postoperatively, pivot-shift test was performed under anaesthesia during screw removal surgery and quantitatively evaluated by tibial acceleration using an electromagnetic system. The acceleration was compared between ACL-reconstructed knees with different meniscal treatments: intact, repaired and unrepaired.

### **Results**

A concomitant meniscus tear was found in 28 knees preoperatively: lateral tears in 11 knees, medial tears in 11 knees and both medial and lateral tears in 6 knees. Postoperatively, 19 ACL-reconstructed knees had a repaired meniscus for either medial, lateral or bilateral menisci tears, and 18 knees had intact menisci pre- and post-operatively. Meanwhile, nine lateral meniscus tears were irreparable and treated by partial meniscectomy or left in situ. ACL-reconstructed knees with unrepaired lateral menisci had significantly larger pivot-shift acceleration ( $0.9 \pm 0.7$  m/s<sup>2</sup>) than those with intact menisci ( $0.5 \pm 0.2$  m/s<sup>2</sup>,  $p < 0.05$ ), whereas rotatory knee laxity was similar between the knees with fully repaired menisci ( $0.6 \pm 0.3$  m/s<sup>2</sup>) and intact menisci (n.s.).

### **Conclusion**

An unrepaired lateral meniscus tear in an ACL-reconstructed knee could lead to remaining pivot-shift postoperatively. A concomitant meniscus tear should be repaired during ACL reconstruction to restore normal rotational laxity.

### **Level of evidence**

Therapeutic Study, Level III.

## **Delayed or neglected meniscus tear repair and meniscectomy in addition to ACL reconstruction have similar clinical outcome.**

Eken, G., Misir, A., Demirag, B. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-020-05931-8>

### **Purpose**

To compare the clinical outcomes of meniscus repair and meniscus resection with concurrent anterior cruciate ligament (ACL) reconstruction in patients with ACL rupture and neglected or delayed medial meniscus tears.

### **Methods**

Thirty patients with ACL ruptures and unstable vertical longitudinal medial meniscus tears were included. Patients were divided into two groups. Group I included 15 patients who underwent meniscal repair and Group II included 15 patients who underwent meniscectomy. The knee range of motion, McMurray test, Lachman test, pivot shift test, Lysholm Knee Scoring Scale, International Knee Documentation Committee (IKDC) Questionnaire, Hospital for Special Surgery (HSS) Knee score, and Tegner activity (TA) scale were used to assess all patients.

### **Results**

The median follow-up time was 3.6 (0.5–6.5) years. Median age was 28 (16–36) years. Fourteen patients (93.3%) in Group I and six patients (40%) in Group II returned to their preinjury sport activity level ( $P = .007$ ). Median maximum knee flexion was  $132^\circ$  ( $121^\circ$ – $140^\circ$ ) in Group I and  $134^\circ$  ( $121^\circ$ – $139^\circ$ ) in Group II (n.s.). All patients had full knee extension and negative McMurray test results. Lachman and pivot shift test results were similar between groups. The median IKDC Questionnaire score was 99 (86–100) in Group I and 93 (70–100) in Group II ( $P = .016$ ). The difference in Lysholm Knee Scoring Scale, HSS knee, and TA scale score between groups were not significant.

### **Conclusion**

Clinical outcomes of patients that underwent meniscus repair were better than those that underwent meniscus resection with concurrent ACL reconstruction. The technically complicated and costly meniscus repair may achieve better clinical outcomes than meniscectomy when treating a neglected or delayed meniscal tear with a concurrent ACL tear.

### **Level of evidence**

III.

## **Partial lateral meniscus anterior root injuries during anatomical single-bundle anterior cruciate ligament reconstruction are likely to occur in women with small skeletons.**

Shimozaki, K., Nakase, J., Oshima, T. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-020-05896-8>

### **Purpose**

This study aimed to investigate the occurrence and characteristics of lateral meniscus anterior root injuries during anatomical single-bundle anterior cruciate ligament (ACL) reconstruction.

### **Methods**

Between 2011 and 2018, 70 women who had ACL injuries without lateral meniscal tears underwent anatomical single-bundle ACL reconstruction. Using computed tomography, the anatomical relationship between the predicted lateral meniscus anterior root insertion and the tibial tunnel was retrospectively assessed, and the patients were divided into partial lateral meniscus anterior root injury and intact groups. The demographic characteristics, the distances between bony landmarks, the tibial tunnel sizes, and lateral meniscal extrusion assessed by magnetic resonance imaging were compared between the two groups.

### **Results**

Thirteen of the 70 patients had suspected partial lateral meniscus anterior root injuries. Patient height was significantly shorter in the injury group than in the intact group ( $157.7 \pm 6.4$  vs.  $161.4 \pm 5.4$  cm;  $p = 0.03$ ); the distance from the apex to the bottom of the slope of the medial intercondylar ridge was significantly shorter in the injury group than in the intact group ( $15.1 \pm 1.9$  vs.  $16.7 \pm 1.4$  mm;  $p = 0.001$ ).

### **Conclusions**

Partial lateral meniscus anterior root injury during anatomical single-bundle ACL reconstruction was suspected in 18% of cases. Patient height and the distance between bony landmarks were significantly shorter in the injury group than in the intact group. Surgeons should understand that even a slight deviation of the tibial tunnel position can lead to partial lateral meniscus anterior root injury in patients with small skeletons.

### **Level of evidence**

IV.

## **Lateral meniscal slope negatively affects post-operative anterior tibial translation at 1 year after primary anterior cruciate ligament reconstruction.**

Tradati, D., Mouton, C., Urhausen, A. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-020-06021-5>

### **Purpose**

The aim of this study was to assess the correlation between posterior tibial slope and meniscal slope over postoperative anterior tibial translation during the first 18 months after primary anterior cruciate ligament (ACL) reconstruction. The main hypothesis was that PTS and MS would be positively correlated with post-operative ATT-SSD after ACL reconstruction.

### **Methods**

Patients (28 males and 15 females) with confirmed ACL tears were selected from an in-house registry and included if they were over 16 years old, had primary ACL-reconstruction and healthy contralateral knee. Patients meeting one of the following criteria were excluded: previous knee surgeries, intraarticular fractures, associated ligamentous lesions, previous or concomitant meniscectomy or extraarticular procedures. Lateral posterior tibial slope, medial posterior tibial slope, lateral meniscal slope and medial meniscal slope were measured using preoperative MRIs. The side-to-side-difference in anterior tibial translation was evaluated 9–18 months postoperatively.

### **Results**

Forty-three patients were included, (28 males/15 females; mean age  $25 \pm 8$  years). Mean postoperative anterior tibial translation was  $1.0 \pm 1.1$  mm at a mean time of  $12 \pm 1$  months. Mean slope values were: lateral posterior tibial slope  $4.7^\circ \pm 2.2^\circ$ , medial posterior tibial slope  $4.0^\circ \pm 2.8^\circ$ , lateral meniscal slope  $3.0^\circ \pm 2.2^\circ$  and medial meniscal slope  $2.0^\circ \pm 2.8^\circ$ . The anterior tibial translation was significantly correlated with lateral meniscal slope ( $r = 0.63$ ;  $p < 0.01$ ). For each  $1^\circ$  increase in lateral meniscal slope, a 0.3 mm 95% CI [0.2, 0.4] ( $p < 0.01$ ) increase in anterior tibial translation was observed. A lateral meniscal slope greater or equal to  $4.0^\circ$  was estimated as optimal threshold for increased risk of abnormal side-to-side difference in postoperative anterior tibial translation ( $\geq 1.2$  mm).

### **Conclusion**

The lateral meniscal slope was positively correlated to side-to-side difference in anterior tibial translation after primary ACL reconstruction. A lateral meniscal slope greater or equal to  $4.0^\circ$  was detected as threshold for an increased risk of abnormal side-to-side difference in postoperative anterior tibial translation in patients who underwent primary ACL reconstruction. This confirms that soft tissue slopes have an impact on the outcomes after reconstructive surgery.

### **Level of evidence**

III.

## **Widening of the popliteal hiatus on magnetic resonance imaging leads to recurrent subluxation of the lateral meniscus.**

Li, Z., Zhao, H., Dai, Z. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-019-05800-z>

### **Purpose**

This study was undertaken to elucidate the clinical significance of widening of the popliteal hiatus on magnetic resonance imaging (MRI), and to document the clinical results and technical aspects of arthroscopic repair of this finding.

### **Methods**

Included are 82 knees after arthroscopic surgery, divided according to arthroscopic diagnosis into group A, hypermobility of lateral meniscus, 8 knees; group B, tear of the anterior horn of the lateral meniscus, 32 knees; and group C, no abnormality of the lateral meniscus, 36 knees with medial meniscal tears and 6 with other conditions. Popliteal hiatus diameter was measured and the popliteal hiatus/lateral tibial plateau (LTP) ratio was calculated on preoperative sagittal and coronal MRI. At arthroscopy, the widened popliteal hiatus in group A was tightened anteriorly by outside-in or all-inside suture and posteriorly with all-inside suture. Outcomes were evaluated with MRI, Lysholm, Tegner and VAS scores.

### **Results**

The preoperative diameter of the popliteal hiatus and the popliteal hiatus/LTP ratio were significantly larger in group A than in groups B and C ( $p < 0.05$ ) on both views. Threshold popliteal hiatus/LTP values of 0.16 and 0.18 on the sagittal and coronal views demonstrated diagnostic discrimination, and these values were significantly reduced after arthroscopy in Group A. Lysholm and Tegner scores were improved after tightening of the popliteal hiatus, while VAS scores reduced (all  $p < 0.05$ ).

### **Conclusion**

Widening of the popliteal hiatus on MRI may lead to recurrent subluxation of the lateral meniscus. Arthroscopic anterior and posterior tightening of the popliteal hiatus was a safe and effective treatment.

### **Level of evidence**

II.

**Meniscal ramp lesions should be considered in anterior cruciate ligament-injured knees, especially with larger instability or longer delay before surgery.**

Tashiro, Y., Mori, T., Kawano, T. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-020-06161-8>

**Purpose**

To determine the incidence of meniscal ramp lesions in an anterior cruciate ligament (ACL) injured knees and to clarify whether ramp lesions are related to chronic ACL deficiency and increased knee instability.

**Methods**

Consecutive ACL injured patients were evaluated arthroscopically for a ramp lesion via a trans-notch view and evidence of menisco-capsular injury was recorded. Other concomitant injuries to the knee were also noted. Incidence of meniscal ramp lesions, delay before surgery, and anterior–posterior stability was analyzed. All patients underwent bilateral KT-2000 evaluation.

**Results**

One hundred and three consecutive ACL injured patients with a mean age of 24 years were included in this study. In total, a ramp lesion was found in 10 knees (9.7%) via a trans-notch view. None of these lesions could be identified by the standard view from the anterolateral portal. Other medial meniscal lesions were found in 26 knees (25.2%) by standard arthroscopic viewing. The ramp lesion group had significantly longer delay before surgery with a median of 191 days ( $p < 0.01$ ) as well as a larger side-to-side difference of KT-2000 measurement ( $7.3 \pm 1.8$  mm;  $p < 0.01$ ), compared with the intact medial meniscus group (53 days and  $5.5 \pm 1.5$  mm, respectively).

**Conclusion**

Ramp lesions that were identified using a trans-notch view were not visualized with standard arthroscopic views. Increased anterior tibial translation and longer delay before surgery were seen in knees with ramp lesions. Careful inspection of the posteromedial menisco-capsular region is required as hidden menisco-capsular lesions may occur which may result in residual knee instability.

**Level of evidence**

Level II.

## **Non-treatment of stable ramp lesions does not degrade clinical outcomes in the setting of primary ACL reconstruction.**

Balazs, G.C., Greditzer, H.G., Wang, D. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-020-06017-1>

### **Purpose**

The purpose of this study was to evaluate the clinical outcomes of various methods of treatment of stable and unstable ramp lesions compared to patients with no meniscal pathology at the time of primary ACL reconstruction.

### **Methods**

All patients with a preoperative MRI performed at our facility who were enrolled in an institutional ACL registry and 1-year clinical follow-up were identified. A musculoskeletal radiologist reviewed preoperative MRI scans for evidence of a ramp lesion. Ramp lesions were classified as stable if a peripheral tear of the posterior horn of the medial meniscus was identified by MRI, but did not displace into the medial compartment with anteriorly directed probing at the time of surgery. Ramp lesions were classified as unstable if a tear was identified by preoperative MRI at the meniscocapsular junction and the meniscus was displaceable into the medial compartment with probing. Reoperation rates for ACL graft failure or recurrent medial meniscus pathology were collected. Patient-reported outcome scores (IKDC, SF12 PCS, SF12 MCS, and Marx Activity scale) were recorded at baseline and final follow-up.

### **Results**

A total of 162 patients were included in the analysis with median 2-year (range 1–5 years) clinical follow-up. Patients with a repaired unstable ramp lesion had a significantly higher likelihood of reoperation for recurrent medial meniscus pathology than patients without meniscal pathology at the time of index surgery. Patients with an untreated stable ramp lesion had a similar rate of reoperation when compared to patients without meniscal pathology. At final follow-up, there was no difference between groups in IKDC score, SF12 PCS/MCS, or Marx activity score or change in any score.

### **Conclusions**

Patients with untreated stable ramp lesions have similar clinical outcomes at median 2-year (range 1–5 years) follow-up when compared to patients without a ramp lesion. Treatment of stable ramp lesions at the time of ACL reconstruction does not have clinical benefit.

### **Level of evidence**

III.



## **Meniscus repairs in the adolescent population—safe and reliable outcomes: a systematic review.**

Tagliero, A.J., Kennedy, N.I., Leland, D.P. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-020-06287-9>

### **Purpose**

The purpose of this study was to determine the outcomes of meniscus repair in the adolescent population, including: (1) failure and reoperation rates, (2) clinical and functional results, and (3) activity-related outcomes including return to sport.

### **Methods**

Two authors independently searched MEDLINE, Cochrane Central Register of Controlled Trials & Cochrane Library, and CINHALL databases for literature related to meniscus repair in an adolescent population according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. No meta-analysis was performed in this qualitative systematic review.

### **Results**

Thirteen studies, including no Level I, one Level II, one Level III, and eleven Level IV studies yielded 466 patients with 503 meniscus repairs. All defined meniscal re-tear as a primary endpoint, with a reported failure rate ranging from 0 to 42% at a follow-up ranging from 22 to 211 months. There were a total of 93 failed repairs. IKDC scores were reported in four studies with a mean improvement ranging from 24 to 42 ( $P < 0.001$ ). Mean post-operative Lysholm scores were reported in seven studies, ranging from 85 to 96. Additionally, four of those studies provided mean pre-operative Lysholm scores, ranging from 56 to 79, with statistically significant mean score improvements ranging from 17 to 31. Mean post-operative Tegner Activity scores were reported in nine studies, with mean values ranging from 6.2 to 8.

### **Conclusion**

This systematic review demonstrates that both subjective and clinical outcomes, including failure rate, Lysholm, IKDC, and Tegner activity scale scores, are good to excellent following meniscal repair in the adolescent population. Further investigations should aim to isolate tear type, location, surgical technique, concomitant procedures, and rehabilitation protocols to overall rate of failure and clinical and functional outcomes.

### **Level of evidence**

IV.

## **The occurrence of ACL injury influenced by the variance in width between the tibial spine and the femoral intercondylar notch.**

Iriuchishima, T., Goto, B. & Fu, F.H.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-020-05965-y>

### **Purpose**

The purpose of this study was to reveal the influence of the variance in width between the tibial spine and the femoral intercondylar notch on the occurrence of ACL injury.

### **Methods**

Thirty-nine subjects undergoing anatomical ACL reconstruction (30 female, 9 male; average age  $29 \pm 15.2$ ) and 37 subjects with intact ACL (21 female, 16 male; average age  $29 \pm 12.5$ ) were included in this study. In the anterior–posterior knee radiograph, tibial spine height, and the length between the top of the medial and lateral tibial spine (tibial spine width) were measured. In axial knee MRI exhibiting the longest femoral epicondylar length, intercondylar notch outlet length was measured and notch width index was calculated. Tibial spine width/notch outlet length, and tibial spine width/notch width index were compared between the ACL tear and intact groups.

### **Results**

Tibial spine width/notch outlet length of the ACL tear and intact groups was  $0.6 \pm 0.1$  and  $0.7 \pm 0.1$ , respectively. Tibial spine width/notch width index of the ACL tear and intact groups was  $0.4 \pm 0.1$ , and  $0.6 \pm 0.1$ , respectively. Both parameters were significantly larger in the ACL intact group.

### **Conclusion**

Both tibial spine width/notch outlet length and tibial spine width/notch width index were significantly smaller in the ACL tear group when compared with the ACL intact group. The occurrence of ACL injury influenced by the variance in width between the tibial spine and the femoral intercondylar notch.

### **Level of evidence**

III.

## **No difference in revision rates between anteromedial portal and transtibial drilling of the femoral graft tunnel in primary anterior cruciate ligament reconstruction: early results from the New Zealand ACL Registry.**

Rahardja, R., Zhu, M., Love, H. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-020-05959-w>

### **Purpose**

The use of an accessory anteromedial portal to drill the femoral graft tunnel in primary anterior cruciate ligament (ACL) reconstruction was introduced in the 2000s in an effort to achieve a more anatomic femoral tunnel position. However, some early studies reported an increase in revision ACL reconstruction compared to the traditional transtibial technique. The aim of this study was to analyse recent data recorded by the New Zealand ACL Registry to compare outcomes of ACL reconstruction performed using the anteromedial portal and transtibial techniques.

### **Methods**

Analysis was performed on primary isolated single-bundle ACL reconstructions recorded between 2014 and 2018 by the New Zealand ACL Registry. Patients were categorised into two groups according to whether an anteromedial portal or transtibial technique was used to drill the femoral graft tunnel. The primary outcome was revision ACL reconstruction and was compared between both groups through univariate and multivariate survival analyses. The secondary outcomes that were analysed included subscales of the Knee Injury and Osteoarthritis Outcome Score (KOOS) and Marx activity score.

### **Results**

Six thousand one hundred and eighty-eight primary single-bundle ACL reconstructions were performed using either the anteromedial portal or transtibial drilling techniques. The mean time of follow-up was 23.3 (SD  $\pm$  14.0) months. Similar patient characteristics such as mean age (29 years, SD  $\pm$  11), sex (males = 58% versus 57%) and time to surgery (median 4 months, IQR 5) were observed between both groups. The rate of revision ACL reconstruction was 2.6% in the anteromedial portal group and 2.2% in the transtibial group (n.s.). The adjusted risk of revision ACL reconstruction was 1.07 (95% CI 0.62–1.84, n.s.). Patients in the anteromedial portal group reported improved scores for subscales of the KOOS and higher Marx activity scores at 1-year post-reconstruction.

### **Conclusion**

There was no difference in the risk of revision ACL reconstruction between the two femoral tunnel drilling techniques at short-term follow-up. We observed minor differences in patient-reported outcomes at 1-year follow-up favouring the anteromedial portal technique, which may not be clinically relevant. Surgeons can achieve good clinical outcomes with either drilling technique.

### **Level of evidence**

III.

## **Anterior cruciate ligament reconstruction with bone–patellar tendon–bone graft is associated with higher and earlier return to sports as compared to hamstring tendon graft.**

Gupta, R., Kapoor, A., soni, A. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-020-06074-6>

### **Purpose**

To study the effect of age, duration of injury, type of graft and concomitant knee injuries on return to sports after anterior cruciate ligament (ACL) reconstruction.

### **Method**

One-hundred and sixteen athletes underwent ACL reconstruction using either bone–patellar tendon–bone graft (BPTB; n = 58) or semitendinosus-gracilis graft (n = 58), depending upon their random number sequences. Five variables were analyzed in terms of their effect on return to sports—age, type of graft, time interval between injury and surgery, chondral damage and meniscal tears.

### **Results**

Fifty-three out of 73 (72.6%) athletes aged between 16 and 25 years and 21/43 (49%) athletes aged between 25 and 40 years returned to sports ( $p = 0.02$ ). The mean time to return to sports was  $9.7 \pm 2.1$  months and  $10.8 \pm 1.7$  months in athletes aged  $< 25$  years and 25–40 years, respectively ( $p = 0.04$ ). ACL reconstruction with BPTB graft (43/58) was associated with higher rate of return to sports as compared to hamstring tendon graft (31/58;  $p = 0.02$ ). The mean duration of return to sports with BPTB and STGPI graft was  $9.7 \pm 2.0$  months and  $10.7 \pm 2.0$  months, respectively ( $p = 0.02$ ). 29/36 (80.5%) patients operated between 2 and 6 months, 18/29 (62%) operated in  $< 2$  months, and 27/51 (53%) operated after 6 months of injury had returned to sports ( $p = 0.03$ ). Athletes who were operated within 2 months of the injury were the earliest to return to sports ( $9.4 \pm 2.1$  months), followed by those operated within 2–6 months ( $9.9 \pm 1.9$  months) and lastly by the ones operated after 6 months of the injury ( $10.9 \pm 2.1$  months;  $p = 0.04$ ).

### **Conclusions**

The rate of return to sports was observed to be higher in athletes younger than 25 years as compared to older athletes ( $> 25$  years). ACL reconstruction with BPTB graft was associated with higher and earlier returns to sports as compared to hamstring graft. The rate of return to sports was highest if surgery was performed between 2 and 6 months after the injury.

### **Level of evidence**

III.

## **Trauma and femoral tunnel position are the most common failure modes of anterior cruciate ligament reconstruction: a systematic review.**

Vermeijden, H.D., Yang, X.A., van der List, J.P. et al.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-020-06160-9>

### **Purpose**

To improve outcomes of anterior cruciate ligament reconstruction (ACLR), it is important to understand the reasons for failure of this procedure. This systematic review was performed to identify current failure modes of ACLR.

### **Methods**

A systematic search was performed using PubMed, EMBASE, Cochrane, and annual registries for ACLR failures. Studies were included when failure modes were reported (I) of  $\geq 10$  patients and (II) at a minimum of two-year follow-up. Modes of failure were also compared between different graft types and in femoral tunnel positions.

### **Results**

This review included 24 cohort studies and 4 registry-based studies (1 level I, 1 level II, 10 level III, and 16 level IV studies). Overall, a total of 3657 failures were identified. The most common single failure mode of ACLR was new trauma (38%), followed by technical errors (22%), combined causes (i.e. multiple failure mechanisms; 19%), and biological failures (i.e. failure due to infection or laxity without traumatic or technical considerations; 8%). Technical causes also played a contributing role in 17% of all failures. Femoral tunnel malposition was the most common cause of technical failure (63%). When specifically looking at the bone–patellar tendon–bone (BPTB) or hamstring (HT) autografts, trauma was the most common failure mode in both, whereas biological failure was more pronounced in the HT group (4% vs. 22%, respectively). Technical errors were more common following transtibial as compared to anteromedial portal techniques (49% vs. 26%).

### **Conclusion**

Trauma is the single leading cause of ACLR failure, followed by technical errors, and combined causes. Technical errors seemed to play a major or contributing role in large part of reported failures, with femoral tunnel malposition being the leading cause of failure. Trauma was also the most common failure mode in both BPTB and HT grafts. Technical errors were a more common failure mode following transtibial than anteromedial portal technique.

### **Level of evidence**

IV.

## **Arthroscopic anterior cruciate ligament reconstruction is a reliable option to treat knee instability in patients over 50 years old.**

Ovigue, J., Bouguennec, N. & Gravelleau, N.

DOI: <https://doi-org.eur.idm.oclc.org/10.1007/s00167-020-06254-4>

### **Purpose**

To evaluate return to sport and clinical outcomes with at least 2 years followup after arthroscopic reconstruction ACL in population over 50 years-old. Methods: eighty-one patients aged 50 years or older underwent isolated, primary ACL reconstruction with hamstring autograft between 2014 and 2016. In all patients, a period of conservative treatment had failed (minimum 6 months), and they complained of functional instability and/or limitation during daily activity. Patients were assessed preoperatively and at the latest follow-up with a physical examination, return to sports activity, the Lysholm score, the International Knee Documentation Committee scoring system, the Knee injury and Osteoarthritis Outcome Score, and the Tegner activity scale. Data regarding complications and revision surgeries were collected at 2-year follow-up.

### **Results**

At the last follow-up, significant improvement in outcome scores from pre- to postoperative assessments was found. The mean overall IKDC score increased from a preoperative mean of 54.4–82.9 ( $p < 0.001$ ). Mean preoperative Lysholm score increased from a preoperative mean of 67.4–90.4 ( $p < 0.001$ ). The mean overall KOOS score increased from a preoperative mean ( $p < 0.001$ ). Median preoperative Tegner score was 5 (range 2–8) and median postoperative score was 5 (range 1–7). 86% of patients returned to the sport, 51% to their preinjury sports level. Tegner score, before accident, was the only positive influencing factor a return to pre-injury level of the sport.

### **Conclusion**

Arthroscopic reconstruction ACL in patients over 50 years-old resulted in excellent functional outcomes, with most patients returning to sport and at the same level they had before the injury.

### **Level of evidence**

Level IV.

## **A Hybrid Transtibial Technique Combines the Advantages of Anteromedial Portal and Transtibial Approaches: A Prospective Randomized Controlled Trial**

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**Background:** The anteromedial (AM) portal and transtibial (TT) approaches are 2 common anterior cruciate ligament (ACL) femoral tunnel drilling techniques, each with unique benefits and disadvantages. A hybrid TT (HTT) technique using medial portal guidance of a flexible TT guide wire has recently been described that may combine the strengths of both the AM portal and the TT approaches.

**Hypothesis:** The HTT technique will achieve anatomic femoral tunnel apertures similar to the AM portal technique, with improved femoral tunnel length and orientation.

**Study Design:** Randomized controlled trial; Level of evidence, 2.

**Methods:** A total of 30 consecutive patients with primary ACL tears were randomized to undergo the TT, AM portal, or HTT technique for femoral tunnel positioning at the time of reconstruction. All patients underwent 3-dimensional computed tomography of the operative knee at 6 weeks postoperatively. Femoral and tibial tunnel aperture positions and tunnel lengths, as well as graft bending angles in the sagittal and coronal planes, were measured.

**Results:** Tibial tunnel lengths and aperture positions were identical between the 3 groups. The AM portal and HTT techniques achieved identical femoral aperture positions in regard to both height ( $P = .629$ ) and depth ( $P = .582$ ). By contrast, compared with the AM portal and HTT techniques, femoral apertures created with the TT technique were significantly higher ( $P < .001$  and  $P < .001$ , respectively) and shallower ( $P = .014$  and  $P = .022$ , respectively) in the notch. The mean femoral tunnel length varied significantly between the groups, measuring 35.2, 41.6, and 54.1 mm for the AM portal, HTT, and TT groups, respectively ( $P < .001$ ). Last, there was no difference between the mean coronal ( $P = .190$ ) and sagittal ( $P = .358$ ) graft bending angles between the TT and HTT groups. By contrast, compared with the TT and HTT techniques, femoral tunnels created with the AM portal technique were significantly more angulated in the coronal plane ( $17.7^\circ$  [ $P < .001$ ] and  $12.5^\circ$  [ $P = .006$ ], respectively) and sagittal plane ( $13.5^\circ$  [ $P < .001$ ] and  $10.5^\circ$  [ $P = .013$ ], respectively).

**Conclusion:** This prospective randomized controlled trial found that the HTT technique achieved femoral aperture positions equally as anatomic as the AM portal technique but produced longer, less angulated femoral tunnels, which may help reduce graft strain and mismatch. As such, this hybrid approach may represent a beneficial combination of both the TT and the AM portal techniques.

## **Rate of Force Development Remains Reduced in the Knee Flexors 3 to 9 Months After Anterior Cruciate Ligament Reconstruction Using Medial Hamstring Autografts: A Cross-Sectional Study**

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**Background:** Anterior cruciate ligament (ACL) rupture is a serious injury with a high prevalence worldwide, and subsequent ACL reconstructions (ACLR) appear to be most commonly performed using hamstring-derived (semitendinosus tendon) autografts. Recovery of maximal muscle strength to  $\geq 90\%$  of the healthy contralateral limb is considered an important criterion for safe return to sports. However, the speed of developing muscular force (ie, the rate of force development [RFD]) is also important for the performance of many types of activities in sports and daily living, yet RFD of the knee extensor and flexor muscles has apparently never been examined in patients who undergo ACLR with hamstring autograft (HA).

**Purpose:** To examine potential deficits in RFD, maximal muscle strength (ie, maximal voluntary isometric contraction [MVIC]), and functional capacity of ACLR-HA limbs in comparison with the healthy contralateral leg and matched healthy controls 3 to 9 months after surgery.

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

**Methods:** A total of 23 young patients who had undergone ACLR-HA 3 to 9 months earlier were matched by age to 14 healthy controls; both groups underwent neuromuscular screening. Knee extensor and flexor MVIC and RFD, as well as functional capacity (single-leg hop for distance [SLHD] test, timed single-leg sit-to-stand [STS] test), were assessed on both limbs. Furthermore, patient-reported knee function (Knee injury and Osteoarthritis Outcome Score) was assessed.

**Results:** Knee extensor and flexor MVIC and RFD were markedly compromised in ACLR-HA limbs compared with healthy contralateral limbs (MVIC for extensor and flexor, 13% and 26%, respectively; RFD, 14%-17% and 32%-39%) and controls (MVIC, 16% and 31%; RFD, 14%-19% and 30%-41%) ( $P < .05-.001$ ). Further, ACLR-HA limbs showed reduced functional capacity (reduced SLHD and STS performance) compared with contralateral limbs (SLHD, 11%; STS, 14%) and controls (SLHD, 20%; STS, 31%) ( $P < .01-.001$ ). Strength (MVIC) and functional (SLHD) parameters were positively related to the duration of time after surgery ( $P < .05$ ), although this relationship was not observed for RFD and STS.

**Conclusion:** Knee extensor and flexor RFD and maximal strength, as well as functional single-leg performance, remained substantially reduced in ACLR-HA limbs compared with uninjured contralateral limbs and healthy controls 3 to 9 months after reconstructive surgery.



## All-Inside Repair of Bucket-Handle Meniscal Tears: Clinical Outcomes and Prognostic Factors

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**Background:** There is no consensus on technique of choice for repair of bucket-handle meniscal tears (BHMTs).

**Purpose:** To determine factors that affect patient outcomes and failure rates in patients undergoing all-inside repairs of BHMTs.

**Study Design:** Systematic review.

**Methods:** A systematic review of 3 databases using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines was performed. All English-language literature from 1993 to 2019 describing clinical outcomes for patients undergoing all-inside BHMT repair with ≥12-month follow-up was reviewed by 2 independent reviewers. Patient characteristics (patient sex, age), intraoperative factors (laterality, concomitant procedures, surgical technique, implants utilized), and postoperative outcomes (failure rates) were analyzed. Study quality was evaluated with the Modified Coleman Methodology Score (MCMS).

**Results:** Fifteen studies (1 level 1, 4 level 3, 10 level 4) with 763 total patients (64% male; average age, 26.4 years [range, 9-58 years]; average follow-up, 39.8 months [range, 12-120 months]) including 396 all-inside BHMT repairs were included. Six devices were used for repair including the Meniscal Repair System, FasT-Fix, Meniscus Arrow, Biofix Arrow, RapidLoc device, and PDS II suture, with failure rates of 13.5%, 22.4%, 27.1%, 42.9%, 45.2%, and 0%, respectively. The overall repair failure rate was 29.3% at an average of 13.0 months (range, 5.0-32.4 months), but 19.0% for devices still in use. The RapidLoc and Biofix Arrow had higher failure rates than other devices ( $P = .0003$ ). Women (31%) were less likely to experience a failure than were men (69%) ( $P = .03$ ). Longer follow-up duration resulted in higher failure rates (>30 months, 34.4%; <30 months, 23.4%;  $P = .016$ ). In 4 studies reporting on both all-inside and inside-out repairs, no significant differences in failure rates were observed. No significant differences in failure rates were found between medial and lateral repairs nor repair with and without concurrent anterior cruciate ligament reconstruction ( $P > .05$  for all). The overall average MCMS was  $54.4 \pm 12$ .

**Conclusion:** The overall failure rate after all-inside repair of BHMTs is 29.3% at an average of 13.0 months, with no difference in failure rates between medial and lateral meniscal repairs. The variables shown to negatively affect the failure rates were the RapidLoc and Biofix Arrow, male sex, and longer follow-up duration.

## Two-Year Outcomes After Meniscopeasty by Capsular Advancement With the Application of Arthroscopic Centralization Technique for Lateral Compartment Knee Osteoarthritis

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**Background:** A high prevalence of osteoarthritis (OA) progression in patients with lateral meniscal defects has been reported. However, optimal management techniques for active patients remain ill-defined.

**Hypothesis:** Meniscopeasty by capsular advancement with the application of the centralization technique would improve clinical and radiological outcomes in patients with lateral compartment OA attributed to lateral meniscal defects.

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

**Methods:** A total of 27 patients were enrolled who had undergone meniscopeasty by capsular advancement for lateral compartment OA attributed to lateral meniscal defects. In these patients, the meniscotibial capsule was released from the tibia and advanced with the remaining meniscus onto the rim of the tibial plateau to reform a meniscus-like configuration. Measures of clinical outcomes included clinical examination, Lysholm score, International Knee Documentation Committee (IKDC) subjective score, Knee injury and Osteoarthritis Outcome Score (KOOS), subjective rating scales regarding recovery of the operated knee, and sports performance level. Measures of radiographic outcomes included meniscal extrusion width or regeneration of the meniscus-like tissue on magnetic resonance imaging and lateral joint space width on standing extension anteroposterior and Rosenberg views. All clinical and radiographic outcomes were reported preoperatively and 2 years postoperatively, except magnetic resonance imaging findings, which were reported preoperatively and 1 year postoperatively.

**Results:** The clinical outcomes were significantly improved 2 years postoperatively as compared with baseline: Lysholm score, IKDC subjective score, and KOOS subscores (all  $P < .0001$ ). The patients' subjective recovery ( $P < .0001$ ) and sports performance level ( $P < .0001$ ) were also improved. One year postoperatively, 10 of 11 patients who had no meniscus remaining at the middle segment showed more than one-third the volume of meniscal tissue-like regeneration, and meniscal extrusion width was significantly reduced as compared with baseline in the remaining 16 patients ( $P = .0006$ ). Joint space width increased at 2 years on the standing anteroposterior view ( $P < .0001$ ) and the Rosenberg view ( $P = .0001$ ).

**Conclusion:** Meniscopeasty of the lateral meniscus by capsular advancement improved clinical and radiographic outcomes at 2-year follow-up in patients with lateral compartment OA attributed to lateral meniscal defects.

## Age-Associated Pathology and Functional Outcomes After Hip Arthroscopy in Female Patients: Analysis With 2-Year Follow-up

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**Background:** Previous research has demonstrated a statistically significant relationship between hip arthroscopy outcomes and age.

**Purpose:** To investigate the link, if any, between hip arthroscopy outcomes and intraoperative pathology as well as with patient age and sex.

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

**Methods:** Of 272 female patients aged  $\geq 14$  years undergoing primary hip arthroscopy for femoroacetabular impingement between August 2010 and September 2017, and with 2-year patient-reported outcome scores, a total of 194 (71.3%) were included for final analysis. These patients were separated into 3 age-based cohorts:  $<30$  years ( $n = 44$ ), 30 to 45 years ( $n = 74$ ), and  $>45$  years ( $n = 76$ ). Their data were then analyzed and compared with respect to patient characteristic information, intraoperative pathology, and functional outcome scores for statistical significance, which was set at  $P < .05$ .

**Results:** When an analysis of variance was conducted for the 3 age groups at 2-year follow-up, there was a statistically significant difference for modified Hip Harris Score ( $P = .0003$ ;  $<30$  years,  $88.26 \pm 13.1$  [mean  $\pm$  SD]; 30-45 years,  $82.68 \pm 18.0$ ;  $>45$  years,  $75.03 \pm 19.5$ ). The results of an analysis of variance comparing 2-year Non-arthritic Hip Score were also statistically significant ( $P = .0002$ ;  $<30$  years,  $89.9 \pm 13.7$ ; 30-45 years,  $85.8 \pm 15.8$ ;  $>45$  years,  $78.1 \pm 17.2$ ). Results of logistic regression demonstrated that the odds of a cam-type lesion decreased by 0.971 for every additional year in age among female patients. The odds of achieving the patient-acceptable symptomatic state decreased by a factor of 0.96 for each additional year in age ( $P < .0004$ ).

**Conclusion:** Surgical treatment of femoroacetabular impingement in females led to improved functional outcomes at 2 years of follow-up, although older female patients did worse after hip arthroscopy as compared with their younger counterparts. There may be an age-dependent decrease in incidence of cam-type lesions in female patients.

## **Lumbosacral Transitional Vertebrae Predict Inferior Patient-Reported Outcomes After Hip Arthroscopy**

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**Background:** While the association between spinal disease and hip arthroplasty outcomes has been well studied, there is less known about the effect of spinal pathology in hip arthroscopy (HA) outcomes. Lumbosacral transitional vertebrae (LSTV) are anatomic variations where caudal vertebrae articulate or fuse with the sacrum or ilium.

**Hypothesis:** LSTV can lead to inferior outcomes after HA for treatment of femoroacetabular impingement.

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

**Methods:** We retrospectively reviewed the prospectively collected Hip Arthroscopy Database at our institution for patients with LSTV who underwent HA between 2010 and 2017. A total of 62 patients with LSTV were identified and then matched to controls. Patient-reported outcome measures (PROMs) were collected, including the modified Harris Hip Score, Hip Outcome Score–Activities of Daily Living, Hip Outcome Score–Sports, and the 33-item International Hip Outcome Tool. They were collected at 4 time points: preoperatively and 5 to 11 months, 12 to 23 months, and 24 to 35 months postoperatively. Longitudinal analysis of the PROMs was done using generalized estimating equation modeling. Additionally, alpha angles were measured from preoperative radiographic data.

**Results:** Preoperatively, there was no significant difference between patients with and without LSTV on 3 of the 4 PROMs; however, patients with LSTV did have significantly lower preoperative scores than controls for the Hip Outcome Score–Activities of Daily Living ( $P = .029$ ). Patients with LSTV reported significantly lower scores on all 4 PROMs at each postoperative time point. Radiographic data showed no significant difference in alpha angles across cohorts. When LSTV were compared by Castellvi type, types 3 and 4 tended to have lower scores than types 1 and 2; however, these comparisons were not significant.

**Conclusion:** The data support our hypothesis that HA has less benefit in patients with LSTV as compared with patients without LSTV. In patients with LSTV, careful evaluation of the anomaly is recommended to help guide surgical counseling and manage expectations.

## Threshold Values for Success After Hip Arthroscopy Using the Patient-Reported Outcomes Measurement Information System Assessment: Determining the Minimum Clinically Important Difference and Patient Acceptable Symptomatic State

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**Background:** Threshold values for patient-reported outcome measures, such as the minimum clinically important difference (MCID) and patient acceptable symptomatic state (PASS), are important for relating postoperative outcomes to meaningful functional improvement.

**Purpose:** To determine the PASS and MCID after hip arthroscopy for femoroacetabular impingement using the Patient-Reported Outcomes Measurement Information System (PROMIS) questionnaire.

**Study Design:** Cohort study (diagnosis); Level of evidence, 3.

**Methods:** A consecutive series of patients undergoing primary hip arthroscopy for femoroacetabular impingement were administered preoperative and minimum 1-year postoperative PROMIS surveys focusing on physical function (PF) and pain interference (PI). External anchor questions for the MCID and PASS were given with the postoperative PROMIS survey. Receiver operator curves were constructed to determine the threshold values for the MCID and PASS. Curves were generated for the study population as well as separate cohorts segregated by median baseline PF or PI scores and preoperative athletic participation. A multivariate post hoc analysis was then constructed to evaluate factors associated with achieving the PASS or MCID.

**Results:** There were 113 patients (35% male; mean  $\pm$  SD age,  $32.8 \pm 12.5$  years; body mass index,  $25.8 \pm 4.8$  kg/m<sup>2</sup>), with 60 (53%) reporting preoperative athletic participation. Survey time averaged  $77.5 \pm 49.2$  seconds. Anchor-based MCID values were 5.1 and 10.9 for the PF and PI domains, respectively. PASS thresholds were 51.8 and 51.9 for the PF and PI, respectively. PASS values were not affected by baseline scores, but athletic patients had a higher PASS threshold than did those not participating in a sport (53.1 vs 44.7). MCID values were affected by preoperative baseline scores but were largely independent of sports participation. A post hoc analysis found that 94 (83%) patients attained the MCID PF while 66 (58%) attained the PASS PF. A multivariate nominal logistic regression found that younger patients ( $P = .01$ ) and athletic patients ( $P = .003$ ) were more likely to attain the PASS.

**Conclusion:** The PROMIS survey is an efficient metric to evaluate preoperative disability and postoperative function after primary hip arthroscopy for femoroacetabular impingement. The MCID and PASS provide surgeons with threshold values to help determine PROMIS scores that are clinically meaningful to patients, and they can assist with therapeutic decision making as well as expectation setting.

## **Arthroscopic Anatomic Glenoid Reconstruction Using Distal Tibial Allograft for Recurrent Anterior Shoulder Instability: Clinical and Radiographic Outcomes**

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**Background:** The all-arthroscopic anatomic glenoid reconstruction technique using a distal tibial allograft avoids damage to the subscapularis muscle and allows repair of the capsulolabral tissue.

**Purpose:** To analyze the clinicoradiologic outcomes of patients who underwent this procedure to treat anterior shoulder instability with glenoid bone loss with a minimum 2-year follow-up.

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

**Methods:** Over 6 years, 73 patients (52 male and 21 female; mean age, 28.8 years) under the care of the same surgeon underwent arthroscopic stabilization with capsulolabral Bankart repair and bony allograft augmentation of the glenoid for recurrent shoulder instability with significant bone loss. Pre- and postoperative patient-reported functional assessment was performed using 2 questionnaires, the Western Ontario Shoulder Instability Index (WOSI) and the Disabilities of the Arm, Shoulder and Hand, and radiological assessment was performed using radiographs and computed tomography scans obtained preoperatively and approximately 1 year later (mean  $\pm$  SD,  $0.9 \pm 1.1$  years).

**Results:** The mean follow-up was  $4.7 \pm 1.1$  years. The mean pre- and postoperative WOSI scores were  $71.1 \pm 17.5$  and  $25.6 \pm 21.9$ , respectively ( $P < .001$ ). There were no recurrences of dislocation, although 1 patient had symptoms of subluxation; however, 5 patients had hardware complications that required screw removal. There were no cases of nerve injury. Postoperative computed tomography scans were available for 66 patients. Seven patients were lost to follow-up. The graft union rate was 100%. Overall, graft resorption was  $<50\%$  in 86% of patients (57/66). Eighteen patients (27%) had no resorption (grade 0), 39 (59%) had  $<50\%$  (grades 1 and 2), and 9 (14%) had  $\geq 50\%$  (grade 3); however, none had symptoms of instability. The mean alpha angle of the screw between the screw shaft axis and the native glenoid axis was  $18.3^\circ \pm 5.7^\circ$ . Graft positioning was flush with the glenoid in 61 of 66 patients (92.4%), and vertical positioning was excellent in 64 of 66 patients (97.0%) (3- to 5-o'clock position).

**Conclusion:** Arthroscopic stabilization using distal tibial allograft augmentation resulted in excellent clinicoradiologic outcomes at a 2-year follow-up. This procedure has the advantages of being an anatomic reconstruction that addresses bony and soft tissue instability. However, long-term follow-up studies are necessary for better assessment of outcomes.

## **Bone Marrow Stimulation in Arthroscopic Repair for Large to Massive Rotator Cuff Tears With Incomplete Footprint Coverage**

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**Background:** There is no research on incomplete footprint coverage with single-row repair related to bone marrow stimulation (BMS) in large to massive rotator cuff tears (RCTs).

**Purpose/Hypothesis:** The purpose was to compare the clinical results and structural integrity between BMS and non-BMS groups that underwent arthroscopic repair of large to massive rotator cuff tears with <50% footprint coverage. It was hypothesized that both groups would exhibit improved clinical outcomes at 2 years after surgery but the BMS group would have significantly better clinical outcomes and structural integrity.

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

**Methods:** This study included 98 patients who underwent arthroscopic repair with <50% footprint coverage for large to massive RCTs with (BMS group; n = 56) or without (non-BMS group; n = 42) BMS. Functional outcomes at the 2-year follow-up were assessed using the visual analog scale for pain score, subjective shoulder value; American Shoulder and Elbow Surgeons score; University of California, Los Angeles, shoulder score; and active range of motion. Structural integrity was evaluated using magnetic resonance arthrography or computed tomography arthrography results at 6 months postoperatively.

**Results:** At the 2-year follow-up, all functional outcomes significantly improved in both groups compared with preoperative values ( $P < .001$ ). However, there were no significant postoperative differences between groups. On follow-up magnetic resonance arthrography or computed tomography arthrography, the overall retear rate was not significantly different between the BMS group (30.3%; 17/56) and the non-BMS group (35.7%; 15/42).

**Conclusion:** While both groups exhibited functional improvement after single-row repair with <50% footprint coverage for large to massive RCTs, BMS did not produce better clinical outcomes or structural integrity.

## **Arthroscopic Superior Capsular Reconstruction With Mesh Augmentation for the Treatment of Irreparable Rotator Cuff Tears: A Comparative Study of Surgical Outcomes**

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**Background:** Arthroscopic superior capsular reconstruction (ASCR) is an alternative to open surgery for irreparable chronic rotator cuff tears (RCTs). This approach can provide static restraint while avoiding upward migration of the humeral head. However, graft tears and their effect on clinical outcomes after ASCR remain a debated topic.

**Purpose:** To evaluate the clinical outcomes of ASCR with mesh augmentation for the treatment of irreparable RCTs.

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

**Methods:** The data of 72 patients with irreparable RCTs who underwent ASCR between 2013 and 2018 were retrospectively evaluated. Among them, 64 patients who met the inclusion and exclusion criteria were enrolled in this study. Fascia lata grafts augmented with a polypropylene mesh were used for 30 patients (mesh group), and grafts without mesh augmentation were used for 34 patients (control group). Clinical outcomes were evaluated using range of motion, the American Shoulder and Elbow Surgeons (ASES) questionnaire, and visual analog scale for pain. Radiological outcomes were evaluated according to acromiohumeral distance and stage of rotator cuff arthropathy. The status of fatty infiltration and graft integrity was evaluated using magnetic resonance imaging. Outcomes were assessed preoperatively and at the final follow-up.

**Results:** Both groups showed improvement in clinical and radiological outcomes at the final follow-up. The mesh group demonstrated a larger improvement in ASES score (mean  $\pm$  SD,  $29.1 \pm 15.8$ ) than the control group ( $18.1 \pm 15.9$ ) ( $P = .006$ ). The mean improvement in active forward flexion was significantly higher in mesh group ( $40^\circ \pm 26^\circ$ ) than in control group ( $28^\circ \pm 23^\circ$ ) ( $P = .003$ ). The mean improvement in active external rotation was also significantly higher in the mesh group ( $11^\circ \pm 5^\circ$ ) than in the control group ( $6^\circ \pm 3^\circ$ ) ( $P = .004$ ). Graft healing rate was significantly higher in the mesh group (83.3%) than in the control group (58.8%) ( $P = .039$ ), and acromiohumeral distance was significantly greater in the mesh group ( $9.1 \pm 2.4$  mm) than in the control group ( $6.3 \pm 1.8$  mm) at the final follow-up ( $P = .001$ ). Subgroup analysis revealed that patients with graft failure generally showed progression of fatty infiltration without improvement in the stage of rotator cuff arthropathy. Patients with intact grafts demonstrated a more substantial improvement in functional outcomes (ASES score and forward flexion motion).

**Conclusion:** ASCR with mesh augmentation reduced graft failure rate to restore superior shoulder joint stability.



## **Preoperative Opioid Use Is a Risk Factor for Revision Surgery, Complications, and Increased Resource Utilization After Arthroscopic Rotator Cuff Repair**

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**Background:** Studies have shown preoperative opioid use to influence outcomes after various surgical procedures. Researchers have not assessed this relationship after rotator cuff repair (RCR).

**Hypothesis/Purpose:** The purpose was to assess the relationship between preoperative opioid use and outcomes after arthroscopic RCR. We hypothesized that patients prescribed higher daily averages of preoperative oral morphine equivalents (OMEs) would show increased rates of 90-day complications and 3-year revision surgery.

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

**Methods:** The MarketScan claims database was utilized to identify patients who underwent arthroscopic RCR between 2009 and 2018. We used preoperative opioid use status to divide patients into groups based on the average daily OMEs consumed in the 6 months before surgery: opioid-naïve, <1, 1-<5, 5-<10, and ≥10 OMEs per day. We retrieved 90-day complication and 3-year revision surgery rates. Opioid use groups were then compared with binomial logistic regression and generalized linear models.

**Results:** We identified 214,283 patients. Of those patients, 50.7% did not receive any preoperative opioids, while 7.7%, 26.8%, 6.3%, and 8.6% received <1, 1-<5, 5-<10, and ≥10 OMEs per day over a 6-month time period, respectively. Complications increased with increasing preoperative OMEs. Multivariate analysis revealed that any patient using ≥1 OME per day had increased rates of 3-year revision surgery, reoperations, and infections. Specifically, patients averaging ≥10 OMEs per day showed a 103% (odds ratio, 2.03 [95% CI, 1.62-2.54];  $P < .001$ ) increase in the odds of revision surgery compared with opioid-naïve patients. Rates of hospital admissions and postoperative emergency department encounters were higher in all opioid use groups. Adjusted differences in 6-month preoperative and 3-month postoperative health care costs were seen in the opioid use groups compared with opioid-naïve patients, ranging from US\$1307 to US\$5820 ( $P < .001$ ).

**Conclusion:** Preoperative opioid use was a risk factor for complications and revision surgery after arthroscopic RCR. We also observed a dose-dependent response between opioid use and postoperative complications.

## **Characteristics of Soccer Players Undergoing Primary Hip Arthroscopy for Femoroacetabular Impingement: A Sex- and Competitive Level–Specific Analysis**

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**Background:** Radiographic features of femoroacetabular impingement (FAI) are prevalent in kicking athletes, especially soccer players. However, there remains a paucity of data on the characteristics of symptomatic soccer players with an established diagnosis of FAI.

**Purpose:** To report on patient demographics, injury, and clinical and radiographic characteristics in a large cohort of soccer players who underwent primary hip arthroscopy for FAI and to perform a sex- and competition level–specific analysis of these data.

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

**Methods:** An institutional hip preservation registry containing 3318 consecutive primary hip arthroscopies for FAI performed between March 2010 and January 2016 was retrospectively reviewed for patients identified as soccer players. Patient demographics, injury characteristics, and clinical and radiographic findings were recorded, and sex- and competition level–specific differences were analyzed.

**Results:** A total of 421 hips (336 soccer players) were identified, including 257 (61.0%) men and 164 (39.0%) women. Of these, 105 (24.9%) were reported as highly competitive, 194 (46.1%) as competitive, 75 (17.8%) as recreational, and 47 (11.2%) did not report a level. The majority of the 336 soccer players (231 hips; 55%) reported chronic hip pain lasting >6 months with no acute injury at the initial visit. Alpha angle, coronal center-edge angle, and femoral version on computed tomography scan measured  $64.5^\circ \pm 12^\circ$ ,  $32.3^\circ \pm 9^\circ$ , and  $13.7^\circ \pm 10^\circ$  (mean  $\pm$  SD), respectively. There were 230 (55%) hips with a type 2 anterior inferior iliac spine (AIIS), 78 (18.5%) with a type 1 AIIS, and 19 (4.5%) with a type 3 AIIS. When compared with male athletes, female athletes had more hip internal rotation on physical examination ( $14.9^\circ$  vs  $8^\circ$ ;  $P < .001$ ), lower alpha angles ( $57.5^\circ$  vs  $68.5^\circ$ ;  $P < .001$ ), and lower-grade AIIS morphology ( $P = .003$ ). Acute injury as the reason for hip symptoms was most likely in the highly competitive group ( $P < .001$ ).

**Conclusion:** Female soccer players were more likely to have less severe clinical and radiographic findings than were male soccer players. Acute injury as the cause of hip symptoms was more common in highly competitive players.

**Clinical Relevance:** Focusing on soccer players with an established FAI diagnosis, the findings of this study suggest that there are sex- and competition level–based differences in the presentation, physical examination, and imaging characteristics among the players. These findings can better guide clinicians in the diagnostic evaluation of symptomatic soccer players with FAI and in tailoring treatment recommendations to specific cohorts.