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## Upper extremity

Arthroscopy, Volume 34, Issue 9

### **Risk Factors for Recurrence of Anterior-Inferior Instability of the Shoulder After Arthroscopic Bankart Repair in Patients Younger Than 30 Years**

Sung Hyun Lee, M.D., Kyeong Hoon Lim, M.D., Jeong Woo Kim, M.D. M.D. Jeong Woo M.D.  
Jeong Woo Kim

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#### **Purpose**

To identify the risk factors for recurrent instability after arthroscopic Bankart repair and evaluate the recurrence rate and functional outcomes.

#### **Methods**

A retrospective review was performed of patients with anterior-inferior shoulder instability who underwent arthroscopic Bankart repair between 2008 and 2014. Patients below 30 years of age who were available for follow-up at least for 2 years were sorted into 2 groups according to the presence of recurrent instability. Furthermore, statistical analysis by binary logistic regression analysis included the significance of various risk factors including gender, demographic factors, number of preoperative dislocations, time interval between the first dislocation and the surgery (shorter than 6 months or not), generalized hyperlaxity, concomitant injury, bony Bankart, and off-track lesion. The functional outcomes were assessed with the Rowe and Walch-Duplay scores.

#### **Results**

A total of 170 shoulders were included (without-recurrence group: 138, recurrent group: 32). The overall postoperative recurrent instability rate was 18.8%. SLAP repair, interval closure, and capsular plication were performed when necessary. However, these additional procedures were not influenced by recurrence ( $P = .37$ ). The 2 groups showed significant differences in the number of preoperative dislocations ( $P = .048$ ; adjusted odds ratio [OR] 2-5 times, 6.41; more than 5 times, 8.77), time interval between the first dislocation and surgery ( $P = .003$ , adjusted OR 5.62), and off-track Hill-Sachs lesion ( $P = .04$ , adjusted OR 4.31). There was significant improvement in the mean Rowe and Walch-Duplay scores at 2 years postoperatively ( $P < .001$  in both cases), but the mean scores were lower in the group with recurrence than in the group without ( $P = .021$  and  $.014$ , respectively).

#### **Conclusions**

The overall results suggest that surgery within 6 months of the first dislocation should be considered, with meticulous attention in patients with a high number of preoperative dislocations or off-track Hill-Sachs lesions.

#### **Level of evidence**

Level III, retrospective case-control study.

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## **Repair Integrity and Functional Outcomes After Arthroscopic Suture Bridge Subscapularis Tendon Repair**

Kazuhiro Shibayama, M.D., Hiroyuki Sugaya, M.D. M.D. Hiroyuki Sugaya M.D. Hiroyuki Sugaya, Keisuke Matsuki, M.D., Norimasa Takahashi, M.D., Morihito Tokai, M.D., Kazutomo Onishi, M.D., Sakae Tanaka, M.D., Ph.D.

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### **Purpose**

This retrospective study aimed to report repair integrity and clinical outcomes after arthroscopic suture bridge subscapularis (SSC) tendon repair.

### **Methods**

The subjects included 101 shoulders subjected to arthroscopic suture bridge repair for full-thickness SSC tear with a minimum of a 2-year follow-up. There were 57 men and 44 women with a mean age of 66 years (range, 32-85 years). The mean follow-up was 30 months (range, 24-71 months). Tenotomy or tenodesis was performed for the long head of the biceps in all cases. All patients were assessed for active range of motion; belly-press and bear-hug tests; University of California, Los Angeles score; and American Shoulder and Elbow Surgeons score preoperatively and at the final follow-up. Repair integrity and fatty degeneration of the SSC muscle were evaluated with magnetic resonance imaging at a mean 14 months (range, 12-58 months) after surgery.

### **Results**

Flexion, internal rotation, and both functional scores significantly improved after surgery. Retears were found in 5 shoulders (5%). The shoulders with a re-tear showed significantly inferior functional scores compared with the intact shoulders. Fatty degeneration was significantly improved in the intact group, whereas there was no significant improvement in the re-tear group. Both belly-press and bear-hug test scores significantly improved after surgery; however, weakness persisted in shoulders with higher grade preoperative fatty degeneration even after successful repair.

### **Conclusions**

Arthroscopic suture bridge repair for SSC tears yielded good clinical outcomes and a very low re-tear rate, even for larger tears or shoulders with higher grade fatty degeneration. Fatty degeneration of the SSC muscle improved after successful repair, although internal rotation weakness persisted in shoulders with higher grade preoperative fatty degeneration. Arthroscopic suture bridge repair is a promising procedure for treating SSC tears.

### **Level of Evidence**

Level IV, case series study.

## **Shoulder Arthroscopy With Versus Without Suprascapular Nerve Release: Clinical Outcomes and Return to Sport Rate in Elite Overhead Athletes**

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### **Purpose**

To compare the clinical outcomes and return to sport rate between elite overhead athletes who underwent shoulder arthroscopy and decompression of the suprascapular nerve (SSN) versus overhead athletes who underwent shoulder arthroscopy without SSN release.

### **Methods**

From 2007 to 2014, high-level overhead athletes diagnosed with a rotator cuff tear and/or a glenoid labral lesion and SSN entrapment were included in the study if their symptoms did not improve with nonoperative treatment and if they agreed to undergo surgery and participate. Their preoperative University of California at Los Angeles (UCLA) shoulder score, bilateral postoperative Constant scores, postoperative UCLA score, and return to sport rate were evaluated and compared with those of a group of elite athletes who had a similar diagnosis but refused to undergo SSN decompression during shoulder arthroscopy.

### **Results**

Thirty-five athletes (25 male, 10 female) were included in the SSN decompression group (group 1), and 21 athletes were included in the non-SSN decompression group (group 2). The mean age was 27 years (range: 19-34) and 24 years (range: 21-32) in group 1 and group 2, respectively ( $P = .56$ ). The mean follow-up time was 38.4 months (24-50 months) in group 1 and 42.2 months (26-53 months) in group 2 ( $P = .09$ ). Both groups had significantly improved UCLA scores after surgery ( $P < .05$ ). The postoperative UCLA ( $P = .01$ ) and Constant scores ( $P < .001$ ) were significantly higher in the SSN decompression group. The mean difference in Constant score between the affected and the unaffected side was 4 points (range: 2-12) in the SSN decompression group and 8 points (range: 4-14) in the non-SSN decompression group postoperatively ( $P = .0002$ ). In both groups, 100% of patients reached the patient acceptable symptom state value for Constant score at follow-up. For the UCLA score, patients who underwent SSN decompression had significantly higher pre- to postoperative improvement than the nondecompression group ( $P = .016$ ). The return to sport rate was 97% in group 1 and 84% in group 2. The mean length of career was 2.1 years (range: 1.5-2.4 years) and 2.3 years (range: 1.2-3.2 years) in group 1 and group 2, respectively.

### **Conclusions**

In elite overhead athletes with shoulder pathology and SSN entrapment, combined shoulder arthroscopy and SSN release yield superior clinical outcomes, greater improvement in UCLA score, and a higher return to sport rate than shoulder arthroscopy without SSN decompression. Regardless of SSN treatment, both groups achieved the patient acceptable symptom state after shoulder arthroscopy.

### **Level of Evidence**

Level III, comparative case series.

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## **Variability in the Contour of Cadaveric Anterior and Posterior Glenoids Based on Ipsilateral 3-Dimensional Computed Tomography Reconstructions: Implications for Clinical Estimation of Bone Loss**

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### **Purpose**

To compare differences in the contour of the anterior and posterior glenoid in 3-dimensional computed tomography reconstructions as a reason for variability in estimating glenoid bone loss.

### **Methods**

Three reviewers digitally placed 11 points (1 at 6 o'clock, 5 from 3 to 6 o'clock, and 5 from 6 to 9 o'clock) along the inferior half of glenoid 3-dimensional computed tomography reconstructions of 32 cadaveric specimens. A best-fit circle for the whole glenoid was determined from all 11 points. The anterior 6 points determined an anterior-based circle, as for estimation of posterior bone loss. The posterior 6 points determined a posterior-based circle, as for estimation of anterior bone loss. The area and radii were determined for all circles. Individual intraclass correlations were used to evaluate reliability. Paired t-tests and Wilcoxon signed rank tests were used to compare areas and radii of the anterior and posterior circles relative to the best-fit glenoid circle. Significance was defined as  $P < .05$ .

### **Results**

There was good-to-excellent inter-rater reliability for the overall best-fit circle (intraclass correlation coefficient [ICC] = 0.97 [95% confidence interval (CI), 0.95-0.99]), anterior circle (ICC = 0.82 [95% CI, 0.71-0.90]), and posterior circle (ICC = 0.78 [95% CI, 0.65-0.88]). The average area of the posterior-based circle was significantly greater than the area of the best-fit circle for the intact glenoid (111% [95% CI, 104.3%-117.7%];  $P = .0016$ ). The average radius of the posterior-based circle was significantly larger than the radius of the intact glenoid (105% [95% CI, 101.7%-108.3%];  $P = .0042$ ). There were no significant differences between the average area (96% [95% CI, 89.0%-103.0%];  $P = .16$ ) and average radius (97% [95% CI, 93.5%-100.5%];  $P = .19$ ) for the anterior-based circle relative to the actual whole glenoid.

### **Conclusions**

Estimation of anterior glenoid bone loss based on the normal posterior glenoid rim may overestimate glenoid bone loss because of differences in the contour of the anterior and posterior glenoid, whereas estimations of posterior glenoid bone loss based on the anterior rim did not differ significantly from the intact glenoid.

### **Clinical Relevance**

A circle based on the remaining intact portion of the injured glenoid may lead to an inaccurate estimate of glenoid bone loss.

## **Bridging Repair of Large Rotator Cuff Tears Using a Multilayer Decellularized Tendon Slices Graft in a Rabbit Model**

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### **Purpose**

The purpose of this study was to evaluate the efficacy of an extracellular matrix scaffold with multilayer decellularized tendon slices (MDTSs) for reconstructing large rotator cuff tears in a rabbit model.

### **Methods**

Large defects in the infraspinatus tendons were created bilaterally in 36 rabbits. The graft group underwent bridging repair of the defects with the MDTs grafts from Achilles tendons of adult beagle dogs, and the control group underwent repair with the autologous excised tendon. Specimens underwent histologic observation, biomechanical testing, and microcomputed tomography analysis at 2, 4, and 8 weeks after surgery.

### **Results**

Histologic analysis confirmed that the MDTs graft promoted cell ingrowth and tissue integration, and fibrocartilage and Sharpey fibers formed at the enthesis at 8 weeks. Accordingly, the MDTs graft generated a histologic appearance similar to that of the autogenous tendon graft. Mechanical testing revealed a significant increase of the regenerated tendons in ultimate load and stiffness from 4 to 8 weeks postoperatively, which was similar to autologous tendon repair. Microcomputed tomography analysis demonstrated that the MDTs graft promoted bone formation at the tendon-bone insertion, thus improving the mechanical properties of the repair tendon.

### **Conclusions**

The MDTs graft used to bridge large rotator cuff defects in a rabbit model promoted host cell ingrowth, enhanced the remodeling of regenerated tendon, and promoted fibrocartilage formation, thus improving the biomechanical properties of the repaired tendon. This study thereby provides fundamental information for rotator cuff regeneration with the MDTs graft.

### **Clinical Relevance**

Rotator cuff regeneration using MDTs grafts is a promising procedure for large rotator cuff tears.

## **Kartogenin Enhances Collagen Organization and Mechanical Strength of the Repaired Enthesis in a Murine Model of Rotator Cuff Repair**

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### **Purpose**

To investigate the use of kartogenin (KGN) in augmenting healing of the repaired entheses after rotator cuff repair in a murine model.

### **Methods**

Seventy-two C57BL/6 wild-type mice underwent unilateral detachment and transosseous repair of the supraspinatus tendon augmented with either fibrin sealant (control group; n = 36) or fibrin sealant containing 100  $\mu\text{mol/L}$  of KGN (experimental group; n = 36) applied at the repair site. Postoperatively, mice were allowed free cage activity without immobilization. Mice were humanely killed at 2 and 4 weeks postoperatively. Repair site integrity was evaluated histologically through fibrocartilage formation and collagen fiber organization and biomechanically through load-to-failure testing of the supraspinatus tendon–bone construct.

### **Results**

At 2 weeks, no differences were noted in percent area of fibrocartilage, collagen organization, or ultimate strength between groups. At 4 weeks, superior collagen fiber organization (based on collagen birefringence [ $17.3 \pm 2.0$  vs  $7.0 \pm 6.5$  integrated density/ $\mu\text{m}^2$ ;  $P < .01$ ]) and higher ultimate failure loads ( $3.5 \pm 0.6$  N vs  $2.3 \pm 1.1$  N;  $P = .04$ ) were seen in the KGN group. The percent area of fibrocartilage ( $13.2 \pm 8.4\%$  vs  $4.4 \pm 5.4\%$ ;  $P = .04$ ) was higher in the control group compared with the KGN group.

### **Conclusions**

Rotator cuff repair augmentation with KGN improved the collagen fiber organization and biomechanical strength of the tendon–bone interface at 4 weeks in a murine model.

### **Clinical Relevance**

These findings have implications for improving the structural integrity of the repaired entheses and potentially reducing the retear rate after rotator cuff repair, which can ultimately lead to improvements in clinical outcomes.

## **Anterior Cable Reconstruction Using the Proximal Biceps Tendon for Large Rotator Cuff Defects Limits Superior Migration and Subacromial Contact Without Inhibiting Range of Motion: A Biomechanical Analysis**

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### **Purpose**

To assess an anterior cable reconstruction (ACR) using autologous proximal biceps tendon for large to massive rotator cuff tears.

### **Methods**

Nine cadaveric shoulders (mean age, 58 years) were tested with a custom testing system. Range of motion, superior translation of the humeral head, and subacromial contact pressure were measured at 0°, 30°, 60°, and 90° of external rotation (ER) with 0°, 20°, and 40° of glenohumeral abduction. Five conditions were tested: intact, stage II tear (supraspinatus), stage II tear + ACR, stage III tear (supraspinatus + anterior half of infraspinatus), and stage III tear + ACR. ACR involved a biceps tendon tenotomy at the transverse humeral ligament, preserving its labral attachment. ACR included nonpenetrating suture-loop fixation using 2 side-to-side sutures and an anchor at the articular margin to restore anatomy and secure the tendon along the anterior edge of the cuff defect. ACR was performed in 20° glenohumeral abduction and 60° ER.

### **Results**

ACR for both stage II and stage III showed significantly higher total range of motion compared with intact at all angles ( $P \leq .001$ ). ACR significantly decreased superior translation for stage II tears at 0°, 30°, and 60° ER for both 0° and 20° abduction ( $P \leq .01$ ) and for stage III tears at 0° and 30° ER for both 0° and 20° abduction ( $P \leq .004$ ). ACR for stage III tear significantly reduced peak subacromial contact pressure at 30° and 60° ER with 0° and 40° abduction and at 30° ER with 20° abduction ( $P \leq .041$ ).

### **Conclusions**

ACR using autologous biceps tendon biomechanically normalized superior migration and subacromial contact pressure, without limiting range of motion.

### **Clinical Relevance**

ACR may improve rotator cuff tendon repair longevity by providing basic static ligamentous support to the dynamic tendon while helping to limit superior migration without restricting glenohumeral kinematics.

## **Labral Preservation: Outcomes Following Labrum Augmentation Versus Labrum Reconstruction**

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### **Purpose**

The purpose of this study was to compare the clinical outcomes and patient satisfaction between patients with previous surgeries who underwent hip labral augmentation versus labral reconstruction surgery.

### **Methods**

From 2006 to 2014, all patients with previous labral procedures who underwent subsequent labral augmentation by the senior surgeon were included. Patients with joint space  $\leq 2$  mm and lateral center edge angle  $< 20^\circ$  and who refused to participate in follow-up were excluded. Patients who underwent labral augmentation, preserving macroscopically healthy native labral tissue and adding iliotibial band graft to increase labral volume, were compared with a matching group (1:2) of patients who underwent labral reconstruction where damaged or absent native labral tissue was replaced by the graft. Hip Outcome Score-Activity of Daily Living (HOS-ADL) was the primary outcome measure. Secondary outcomes included the modified Harris Hip Score (mHHS), HOS for Sports (HOS-Sport), Short Form-12, Western Ontario and McMaster Universities Osteoarthritis Index, and patient satisfaction with outcome. Nonparametric statistics were used to compare groups.

### **Results**

Thirty-three patients (12 males, 21 females) who underwent labral augmentation (LA group) were compared with 66 (24 males, 42 females) labral reconstruction patients (LR group). The average age was  $29 \pm 10$  years in both groups. Six patients (18%) required revision arthroscopy in the LA group, and 9 patients (14%) in the LR group ( $P = .563$ ). One patient (3%) in the LA group required a total hip arthroplasty, and 3 patients in the LR group (4.5%) had a total hip arthroplasty ( $P = .99$ ). Of the remaining 26 patients in the LA group and 53 patients in the LR group, minimum 2-year follow-up was available for 21 (81%) and 51 (96%), respectively. Postoperatively the HOS-ADL, HOS-Sport, mHHS, and Western Ontario and McMaster Universities Osteoarthritis Index were significantly higher in the LA group ( $P < .05$ ). The percentage of patients who reached minimum clinically important difference was significantly higher in the LA group for HOS-ADL ( $P = .002$ ) and HOS-Sport ( $P = .008$ ); however, there was no difference for the mHHS ( $P = .795$ ). Patient satisfaction was 10 and 8 in the LA group and LR group, respectively ( $P = .585$ ).

### **Conclusions**

In patients with previous procedures, the labral augmentation technique with preservation of macroscopically healthy native labral fibers resulted in significantly better outcomes compared with the segmental labral reconstruction procedure where damaged or previously removed labrum was replaced by a graft.

### **Level of Evidence**

Level III, comparative case series.

[BACK](#)

**Neer Award 2018: Benzoyl peroxide effectively decreases preoperative Cutibacterium acnes shoulder burden: a prospective randomized controlled trial**

Logan Kolakowski, MD, Jim K. Lai, MD, Grant T. Duvall, BS, Julio J. Jauregui, MD, Andrew G. Dubina, MD, Derek L. Jones, BS, Katrina M. Williams, PhD, S. Ashfaq Hasan, MD, R. Frank Henn III, MD, Mohit N. Gilotra

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**Background**

Benzoyl peroxide (BPO) solutions effectively reduce Cutibacterium acnes (formerly Propionibacterium acnes) on the face, neck, and back in nonoperative settings. This study compared preoperative application of BPO vs. chlorhexidine gluconate (CHG) in decreasing shoulder C acnes skin burden in surgical patients.

**Methods**

Eighty patients undergoing shoulder surgery were prospectively enrolled in a randomized double-blind trial at 1 institution from August 2015 to April 2017. Participants were randomized to 5% BPO or 4% CHG for 3 consecutive days. The nonoperative shoulder had no intervention and served as the negative control. Skin cultures of both shoulders were obtained via a detergent scrub technique the day of surgery at anterior, lateral, and posterior sites and the axilla.

**Results**

Fewer positive cultures were obtained from the BPO-treated side compared with the contralateral side ( $P = .0003$ ), and no change was shown for the CHG group ( $P = .80$ ). Shoulders treated with BPO showed a statistically significant reduction in C acnes counts compared with CHG at anterior ( $P = .03$ ) and posterior ( $P = .005$ ) portal sites. No significant difference was found at the axilla ( $P = .99$ ) or lateral portal site ( $P = .08$ ). No postoperative infections or wound complications occurred in either group.

**Conclusions**

BPO is more effective than CHG at reducing C acnes on the shoulder. Decreasing the skin burden of C acnes may reduce intraoperative wound contamination and postoperative infection. BPO should be considered as an adjunctive preoperative skin preparation considering its potential benefit, low risk, and low cost.

**Level of evidence:**

Level I, Randomized Controlled Trial, Treatment Study

## **Surgical repair of large-to-massive rotator cuff tears seems to be a better option than patch augmentation or débridement and biceps tenotomy: a prospective comparative study**

Cédric Maillot, MD, Edouard Harly, MD, Hugues Demezon, MD, Jean-Charles Le Huec, MD, PhD

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### **Background**

This prospective study compared the outcomes after 3 different treatments for large and massive rotator cuff tears.

### **Methods**

Patients with a diagnosis of large-to-massive rotator cuff tears were prospectively included. Patients were allocated in 3 groups: (1) arthroscopic complete repair (repair group), (2) open repair and xenograft patch augmentation (patch group), and (3) arthroscopic débridement and tenotomy of the long head of the biceps (débridement group). Patients were evaluated preoperatively and postoperatively at 3, 6, 12 and 24 months. The primary outcome measure was the Constant-Murley score.

### **Results**

The study included 32 consecutive patients. The mean improvement in the Constant-Murley score was +29.1 for the repair group ( $P < .01$ ), +32.2 for the patch group ( $P < .01$ ), and +20.1 for the débridement group ( $P < .01$ ) at the final follow-up examination. No differences were found between the repair and patch groups, but the difference became significant between the débridement group and the patch group ( $P < .001$ ) and also between the débridement group and the repair group ( $P < .002$ ) at 12 months and the final follow-up. Moreover, 5 complications occurred in 11 patients in the patch group, whereas there was only 1 complication in the repair group and no complications in the débridement group.

### **Conclusion**

The use of porcine dermis patches to augment repairs of massive and irreparable rotator cuff tears is not recommended because there is no benefit compared with repair without augmentation and patches result in more complications.

### **Level of evidence:**

Level II, Prospective Cohort Design, Treatment Study

## **Platelet-rich plasma in fibrin matrix to augment rotator cuff repair: a prospective, single-blinded, randomized study with 2-year follow-up**

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### **Background**

Application of autologous platelet-rich plasma in fibrin matrix (PRPFM) improves tendon healing in patients undergoing arthroscopic rotator cuff repair. We performed a prospective, randomized, single-blinded study of 76 patients, with an  $\alpha$  level of 5% and power of 80%.

### **Materials and methods**

Seventy-six patients were divided into 2 randomized groups. The treatment group underwent arthroscopic rotator cuff repair with PRPFM. The control group did not receive the PRPFM treatment. Patients were evaluated preoperatively and at 6 months and 24 months postoperatively with validated clinical outcome scores, and dynamometer examination. A magnetic resonance imaging scan was performed at 6 months postoperatively.

### **Results**

The 2 randomized groups were homogeneous. Western Ontario Rotator Cuff (WORC) scores were not statistically different at any time interval. The WORC scores changed from 1257 to 139 in the control group and from 1106 to 99 in the PRPFM group over the 24-month study period. On the Simple Shoulder Test, improvement over the study period was noted from 45% to 96% in the control group and from 49% to 96% in the PRPFM group. Strength of the supraspinatus at 24 months by dynamometer testing was 99.8% in the control group and 96.3% in the PRPFM group. Infraspinatus strength was 104% in the control group and 103% in the PRPFM group. The secondary outcome of retear occurred at a rate of 19% for the double-row technique and 7.4% for the PRPFM technique at 6 months. All our results were statistically insignificant.

### **Conclusions**

Our results showed no benefit from PRPFM used for rotator cuff repair according to the WORC Index, Simple Shoulder Test, and shoulder strength index.

### **Level of evidence:**

Level II, Randomized Controlled Trial, Treatment Study

## **Long-term clinical and radiographic outcome of rotator cuff repair with a synthetic interposition graft: a consecutive case series with 17 to 20 years of follow-up**

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### **Background**

Treatment options for irreparable cuff tears include synthetic interposition grafts, but whether such grafts can maintain acceptable shoulder function and prevent cuff tear arthropathy in the long-term is unknown.

### **Method**

This was a retrospective case series of 13 consecutive patients treated with a synthetic interposition graft made of Dacron (DuPont, Wilmington, DE, USA). Patients were examined with bilateral ultrasonography, bilateral x-ray imaging, Constant-Murley score, and Western Ontario Rotator Cuff score.

### **Results**

After a mean of 18 years (range, 17-20 years), 1 patient had died, and 12 were available for x-ray imaging and 10 also for ultrasonography and clinical scores. Cuff tear arthropathy (Hamada grade  $\geq 2$ ) had developed in 9 of 12 (75%; 95% confidence interval, 43%-95%), including 3 patients operated on with arthroplasty in the follow-up period. The mean absolute Constant-Murley score was 46 (standard deviation, 26), and the mean Western Ontario Rotator Cuff score was 59 (standard deviation, 20). In 7 of 10 patients (70%) with available ultrasonography, the graft was interpreted as not intact. All patients had a contralateral full-thickness tear, and 7 of 12 patients (58 %; 95% confidence interval, 28%-85%) had contralateral cuff tear arthropathy. The number of patients with cuff tear arthropathy was not significantly different between the shoulder repaired with a Dacron graft and the contralateral shoulder ( $P = .667$ ).

### **Conclusion**

These results indicate that a synthetic interposition graft with screw fixation could not prevent cuff tear arthropathy and preserve cuff integrity in a long-term perspective.

### **Level of evidence:**

Level IV, Case Series, Treatment Study

## **Prospective outcome assessment of arthroscopic arthrolysis for traumatic and degenerative elbow contracture**

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### **Background**

The purpose of this study was to evaluate the efficacy of arthroscopic elbow release for both traumatic and degenerative contractures from intraoperative recording through the recovery time until final follow-up.

### **Methods**

The study is based on 54 consecutive patients with extrinsic elbow contracture (traumatic in 31 and degenerative in 23) treated with arthroscopic arthrolysis by a single surgeon in 2011-2015. Range of motion (ROM) and the Mayo Elbow Performance Score (MEPS) were recorded preoperatively; intraoperatively; following release; and in the 1st, 3rd, 8th, 12th, and 26th weeks and at 2 years postoperatively.

### **Results**

Significant improvements were noted in extension, flexion, and range of motion, measured both intraoperatively and at all follow-up visits. The greatest improvement in the range of motion was achieved at the time of surgery (from  $89^\circ \pm 28^\circ$  to  $131^\circ \pm 14^\circ$ ,  $P < .001$ ); it then decreased at 1 week to  $103^\circ \pm 22^\circ$  ( $P < .001$ ) and slowly recovered to reach  $124^\circ \pm 22^\circ$  after 2 years. This was better than the preoperative value ( $P < .001$ ) but worse than the intraoperative value ( $P = .002$ ). A similar pattern was observed in both traumatic and degenerative contractures. The MEPS improved from  $73 \pm 12$  preoperatively to  $93 \pm 14$  at the final evaluation ( $P < .001$ ). The ROM and MEPS results at every follow-up were comparable for both traumatic and degenerative contractures. ROM improved regardless of the severity of contracture.

### **Conclusions**

Arthroscopic elbow arthrolysis was similarly efficient in ROM restoration in both traumatic and degenerative contractures and regardless of the severity of contracture. After early deterioration, the achieved gain slowly recovers over a period of 6 months but may not recover to the ranges achieved during arthroscopy.

### **Level of evidence:**

Level IV, Case Series, Treatment Study

**Effects of Bone Incorporation After Arthroscopic Stabilization Surgery for Bony Bankart Lesion Based on Preoperative Glenoid Defect Size**

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**Background**

Recurrent shoulder instability occurs more frequently after soft tissue surgery when the glenoid defect is greater than 20%. However, for lesions less than 20%, no scientific guidance is available regarding what size of bone fragments may affect shoulder functional restoration after bone incorporation.

**Purpose/Hypothesis**

The purpose was to analyze how preoperative glenoid defect size and bone fragment incorporation alter postoperative clinical outcomes, we compared the functional outcomes of shoulders with and without bony Bankart lesion. It was hypothesized that differences in postoperative clinical outcomes between patients with and without bony fragments would be found only in patients with a larger glenoid defect.

**Methods**

A total of 223 patients who underwent arthroscopic stabilization surgery for recurrent anterior shoulder instability were divided into two groups based on the presence of anterior glenoid bone fragments. In each group, postoperative shoulder functional outcomes, sports activity level, and recurrence rates were evaluated according to preoperative glenoid defect size (small, <10%; medium, 10%-15% and 15%-20%; large, >20%).

**Results**

In patients with small or medium defects, no significant differences were found in postoperative clinical outcomes and sports activity levels between the two groups. However, in patients with a large defect, the patients with bone fragments (mean  $\pm$  SD American Shoulder and Elbow Surgeons [ASES] score,  $92.3 \pm 2.7$ ; Rowe score,  $90.9 \pm 5.4$ ) showed significantly superior clinical outcomes compared with patients who did not have fragments (ASES score,  $87.3 \pm 6.2$ ,  $P = .02$ ; Rowe score,  $84.8 \pm 7.3$ ,  $P = .04$ ). Among patients without bone fragments, recurrence increased significantly with increasing preoperative glenoid defect size (recurrence rates: 0% in small defects, 7.4% in medium defects, 22.2% in large defects), whereas patients with bone fragments showed no tendency for increasing or decreasing recurrence rates (0% in small defects, 7.9% in medium defects, 5.9% in large defects).

**Conclusion**

In the treatment of bony Bankart lesion, the effect of bone fragment incorporation was different according to preoperative glenoid defect size. In patients with preoperative glenoid defects less than 20% of the glenoid width, bone fragment incorporation after arthroscopic bony Bankart repair did not alter clinical outcomes, sports activity levels, or recurrence rates, whereas in patients with defects greater than 20% of the glenoid width, bone fragment incorporation improved clinical outcomes and recurrence rates.

# **An Intra-articular Steroid Injection at 6 Weeks Postoperatively for Shoulder Stiffness After Arthroscopic Rotator Cuff Repair Does Not Affect Repair Integrity**

In-Bo Kim, MD, Dong Wook Jung, MD

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## **Background**

Shoulder stiffness is a common complication after arthroscopic rotator cuff repair. However, there is no consensus on the treatment of stiffness after repair. Although one treatment option is an intra-articular steroid injection, it may negatively affect repair integrity, and there is a paucity of literature regarding the timing of intra-articular injections for stiffness after repair and its effect on repair integrity.

## **Purpose**

To compare repair integrity and clinical outcomes after an intra-articular steroid injection administered at 6 weeks and 12 weeks postoperatively for shoulder stiffness after arthroscopic rotator cuff repair.

## **Study Design**

Cohort study; Level of evidence, 3.

## **Methods**

Patients who developed stiffness after arthroscopic rotator cuff repair were given a series of 3 intra-articular steroid injections every 4 weeks from 6 (6-week group) and 12 weeks (12-week group) postoperatively. The control group had rotator cuff tears but neither stiffness nor injections. Shoulder range of motion (ROM), the Korean Shoulder Scoring System (KSS) score, and the University of California, Los Angeles (UCLA) shoulder score were assessed preoperatively with a minimum of 2-year follow-up. Repair integrity was assessed using magnetic resonance imaging at 6 months postoperatively.

## **Results**

Seventy-four of 209 patients (35.4%) who underwent arthroscopic rotator cuff repair developed stiffness. There were no significant differences in retear rates among the 6-week (5.7%, 2/35 patients), 12-week (10.3%, 4/39 patients), and control groups (14.1%, 19/135 patients) ( $P = .374$ ). Both the 6- and 12-week groups showed significant improvement in ROM (both  $P < .001$ ), KSS scores (both  $P < .001$ ), and UCLA scores (both  $P < .001$ ) at the final follow-up. The 6-week group showed significantly better ROM ( $P < .001$ ), KSS scores ( $P < .001$ ), and UCLA scores ( $P < .001$ ) than the 12-week group at 3 months postoperatively. However, both the 6- and 12-week groups showed significantly lower KSS ( $81.3 \pm 12.0$  [ $P = .004$ ] and  $83.4 \pm 8.6$  [ $P = .035$ ], respectively) and UCLA ( $29.3 \pm 4.6$  [ $P = .006$ ] and  $30.0 \pm 3.3$  [ $P = .042$ ], respectively) scores than the control group ( $90.4 \pm 13.6$  and  $32.3 \pm 4.7$ , respectively) at the last follow-up.

## **Conclusion**

An intra-articular steroid injection administered at 6 weeks postoperatively for shoulder stiffness after arthroscopic rotator cuff repair may be effective for reducing patients' pain and improving shoulder ROM at 3 months postoperatively without compromising repair integrity.

## **Risk Factors and Outcomes of Revision Arthroscopic Posterior Shoulder Capsulolabral Repair**

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### **Background**

Risk factors and outcomes of revision arthroscopic posterior capsulolabral repair of the shoulder are currently not well defined.

### **Hypothesis**

Athletes who require revision arthroscopic posterior unidirectional capsulolabral repair will have poorer outcomes and return to play when compared with those undergoing primary procedures, with risk factors including younger age, injury size, bone loss, and anchor number.

### **Study Design**

Case-control study; Level of evidence, 3.

### **Methods**

A total of 297 shoulders that underwent arthroscopic posterior capsulolabral repair at minimum 2-year follow-up were reviewed. In addition to surgical data, the American Shoulder and Elbow Surgeons scoring system with subjective stability, range of motion, strength, and pain scores as well as return to sport were compared pre- and postoperatively between those who did and did not require revision surgery. Magnetic resonance arthrogram measurements of glenoid labral, chondral, and bone version and labral and bone width were also compared.

### **Results**

Nineteen shoulders required revision surgery (6.4%) at 8.9-year follow-up. Significant risk factors included female sex ( $P = .001$ ), dominant shoulder ( $P = .005$ ), and concomitant rotator cuff injury ( $P = .029$ ). Patients with  $\leq 3$  anchors were more likely to require revision (odds ratio = 3.48). Smaller glenoid bone width was a risk factor for requiring future revision surgery ( $P < .001$ ), but glenoid labral, chondral, and bone version and labral width were not risk factors. All patients had significant improvements in American Shoulder and Elbow Surgeons, pain, range of motion, and strength scores after the original surgery; however, those who required revision surgery had less improvement ( $P < .05$ ). Stability improved significantly for nonrevisions ( $P < .001$ ) but did not for revisions ( $P = .662$ ). In the nonrevision group, 64.3% returned to sport at the same level, which was significantly higher than the 15.4% of the revision group ( $P = .004$ ). Overall, 78.6% of the nonrevision group and 61.6% of the revision group returned to sport at some level ( $P = .280$ ).

### **Conclusion**

Athletes underwent revision arthroscopic posterior capsulolabral repair at an incidence of 6.4%. Revision patients had significantly poorer outcome scores and return to play when compared with those who did not undergo revision surgery with risk factors being dominant shoulder surgery, female sex, concomitant rotator cuff injury, the use of 3 or fewer anchors, and smaller glenoid bone width. These data are essential for patient selection, optimal treatment techniques, and patient education as posterior shoulder instability failure requiring revision has not previously been evaluated.

[BACK](#)

## **Does Anchor Placement on the Glenoid Affect Functional Outcome After Arthroscopic Bankart Repair?**

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### **Background**

In arthroscopic Bankart repair, anchor positions can affect glenoid labral height and functional outcomes.

### **Purpose**

To evaluate anchor placement on the glenoid during Bankart lesion repair and determine which placement would lead to better functional outcomes.

### **Study Design**

Cohort study; Level of evidence, 3.

### **Method**

This study included 90 patients (74 males, 16 females; average age, 23.7 years; range, 18-47 years) who underwent surgery for Bankart lesions between December 2009 and March 2014. The mean follow-up duration was 32.7 months (range, 26-48 months). We divided anchor positions into 2 groups: on the glenoid face and at the glenoid edge. The anchor position on the glenoid and the labral height were examined with computed tomography (CT) arthrography at 4.5-month follow-up, and Rowe scores were calculated at 2-year follow-up.

### **Results**

The group with the anchor placed on the glenoid face contained 63 patients, and the group with the anchor placed at the glenoid edge or rim contained 27 patients. Mean labral heights at 4.5 months postoperatively in the 2 groups were  $5.4 \pm 0.22$  mm and  $3.2 \pm 0.16$  mm, respectively ( $P < .01$ ), and mean Rowe scores at 2 years were 94.7 and 79.5, respectively ( $P < .01$ ). Rowe scores calculated at 2-year follow-up were significantly related to anchor position ( $P < .01$ ).

### **Conclusion**

Anchors positioned on the glenoid face resulted in the greatest restored labral height and better functional outcome (Rowe score). Thus, anchor placement on the glenoid face should be considered, as it may yield better functional outcome in arthroscopic Bankart repair.

## **Clinical Outcomes, Tendon Integrity, and Shoulder Strength After Revision Rotator Cuff Reconstruction: A Minimum 2 Years' Follow-up**

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### **Background**

The retear rate after primary rotator cuff (RC) reconstruction is high and commonly leads to poorer clinical outcomes and shoulder function. In the case of primary failure, revision RC reconstruction (RCR) has become increasingly important to re-create RC integrity and improve outcomes. To date, clinical and structural outcomes after RCR have not been sufficiently investigated and described at midterm follow-up.

### **Hypothesis/Purpose**

The purpose was to evaluate the clinical and radiological outcomes after revision RCR. It was hypothesized that revision RCR significantly improves clinical outcomes and that the outcomes positively correlate with tendon integrity on magnetic resonance imaging (MRI).

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

### **Methods**

Patients who underwent revision RCR between 2008 and 2014 were retrospectively evaluated with a minimum follow-up of 2 years. Outcomes were assessed by a clinical examination, a visual analog scale for pain (VAS), the Constant Score (CS), the American Shoulder and Elbow Surgeons (ASES) score, and the Disabilities of the Arm, Shoulder and Hand (DASH) score. Tendon integrity was determined using 3-T MRI and graded according to the Sugaya classification.

### **Results**

Thirty-one of 40 patients (77.5%) were available for the final assessment at a mean follow-up of  $50.3 \pm 20.4$  months. Clinical outcome scores significantly improved from preoperatively to postoperatively for the CS ( $39.7 \pm 16.7$  to  $65.1 \pm 19.7$ ;  $P < .001$ ), ASES ( $44.2 \pm 17.7$  to  $75.2 \pm 24.8$ ;  $P < .001$ ), and DASH ( $68.6 \pm 15.1$  to  $21.5 \pm 19.1$ ;  $P < .001$ ). The VAS score decreased from  $6.1 \pm 1.8$  preoperatively to  $1.3 \pm 1.8$  at final follow-up ( $P < .001$ ). MRI demonstrated a retear rate of 55.5%. No differences in CS, ASES, and DASH scores were detected between patients with an intact repair and failure. Abduction strength was not significantly different in patients with an intact repair and retears ( $55.5$  N vs  $44.0$  N, respectively,  $P = .52$ ).

### **Conclusion**

Revision RCR improves clinical outcomes and shoulder function at midterm follow-up. The clinical outcome scores were comparable in patients with an intact repair and those with failed RC healing. Therefore, tendon integrity was not correlated with better clinical outcomes after revision RCR at final follow-up.

## **Arthroscopic Superior Capsule Reconstruction Can Eliminate Pseudoparalysis in Patients With Irreparable Rotator Cuff Tears**

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### **Background**

Patients with pseudoparalysis and irreparable rotator cuff tears have very poor function. The authors developed a superior capsule reconstruction (SCR) technique for irreparable rotator cuff tears that restores shoulder stability and muscle balance, improving shoulder function and relieving pain.

### **Purpose**

To evaluate whether arthroscopic SCR reversed preoperative pseudoparalysis in patients with irreparable rotator cuff tears.

### **Study Design**

Case series; Level of evidence, 4.

### **Methods**

One hundred consecutive patients with irreparable rotator cuff tears underwent arthroscopic SCR with fascia lata autografts; 7 patients with deltoid weakness from cervical or axillary nerve palsy and 5 with severe presurgical shoulder stiffness were excluded. The remaining 88 were allocated to 3 groups according to their preoperative active shoulder elevation: no pseudoparalysis (45 patients; mean age, 66.2 years; mean tear size, 3.5 cm), moderate pseudoparalysis (28 patients, 68.3 years, 3.5 cm), and severe pseudoparalysis (15 patients, 62.3 years, 4.9 cm). Clinical outcome, active shoulder range of motion, acromiohumeral distance, and healing rate were compared between patients with and without pseudoparalysis, as well as before surgery and at final follow-up (35-110 months).

### **Results**

American Shoulder and Elbow Surgeons score, active elevation, active external rotation, and acromiohumeral distance increased significantly after arthroscopic SCR among all patients. Graft healing rates did not differ among the groups ( $P = .73$ ): 98% (44 of 45) for no pseudoparalysis, 96% (27 of 28) for moderate pseudoparalysis, and 87% (13 of 15) for severe pseudoparalysis. Pseudoparalysis was reversed in 96% (27 of 28) of patients with preoperative moderate pseudoparalysis and 93% (14 of 15) with preoperative severe pseudoparalysis. Both patients with residual pseudoparalysis postoperatively (1 of 28 with preoperative moderate pseudoparalysis, 1 of 15 with preoperative severe pseudoparalysis) had graft tears.

### **Conclusion**

Arthroscopic SCR restored superior glenohumeral stability and improved shoulder function among patients with or without pseudoparalysis who had previously irreparable rotator cuff tears. In the absence of postoperative graft tear, arthroscopic SCR reversed preoperative pseudoparalysis. Graft healing rates after arthroscopic SCR did not differ between patients with and without pseudoparalysis.

[BACK](#)

## **Radiographic Analysis of Glenoid Size and Shape After Arthroscopic Coracoid Autograft Versus Distal Tibial Allograft in the Treatment of Anterior Shoulder Instability**

Ivan H. Wong, MD, FRCS (C), Dip. Sports Medicine, MACM, John Paul King, MD, Gordon Boyd, MD, FRCP Diagnostic Imaging, FRCP Nuclear Medicine, Michael Mitchell, MD, FRCP Diagnostic Imaging, Catherine Coady, MD, FRCS (C)

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### **Background**

The Latarjet procedure for autograft transposition of the coracoid to the anterior rim of the glenoid remains the most common procedure for reconstruction of the glenoid after shoulder instability. The anatomic glenoid reconstruction using distal tibial allograft has gained popularity and is suggested to better match the normal glenoid size and shape. However, concerns about decreased healing and increased resorption arise when an allograft bone is used.

### **Purpose**

To use radiological findings to evaluate the arthroscopic reconstruction of the glenoid with respect to the size, shape, healing, and resorption of coracoid autograft versus distal tibial allograft.

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

### **Methods**

A retrospective review was performed of 48 consecutive patients who had an arthroscopic bony reconstruction of the glenoid (12 coracoid autograft, 36 distal tibial allograft), diagnosed anterior shoulder instability, and computed tomography (CT)–confirmed glenoid bone loss more than 20%. Coracoid autograft was performed only when tibial allograft was not accessible from a bone bank. Two fellowship-trained musculoskeletal radiologists reviewed pre- and postoperative CT scans at a minimum follow-up of 6 months for the following: graft position, glenoid concavity, cross-sectional area, width, version, total area, osseous union, and graft resorption. Clinical outcome was noted in terms of instability, subluxation, and dislocation at a minimum follow-up of 2 years. Simple logistic regression, 2-tailed independent-sample t tests, paired t tests, and Fisher exact tests were performed.

### **Results**

Graft union was seen in 9 of the 12 patients (75%) who had coracoid autograft and 34 of the 36 patients (94%) who had tibial allograft (odds ratio, 5.66; 95% CI, 0.81-39.20;  $P = .08$ ). The odds ratio comparing allograft to coracoid for overall resorption was 7.00 (95% CI, 1.65-29.66;  $P = .008$ ). Graft resorption  $\geq 50\%$  was seen in 3 (8%) of the patients who had tibial allograft and none of the patients who had coracoid autograft. Graft resorption less than 50% was seen in the majority of patients in both groups: 27 (73%) patients with tibial allograft and 5 (42%) patients with coracoid autograft. No statistically significant difference was found between the 2 procedures regarding anteroposterior diameter of graft ( $P = .81$ ) or graft cross-sectional area ( $P = .93$ ). However, a significant difference was observed in step formation between the 2 procedures ( $P < .001$ ). Two patients experienced subluxations in the coracoid group (16%) as well as 2 patients in the tibial allograft group (6%) with a  $P$  value of .25.

### **Conclusion**

Arthroscopic anatomic glenoid reconstruction via distal tibial allograft showed similar bony union but higher resorption compared with coracoid autograft. Even so, no statistically significant difference was found between the 2 procedures regarding final graft surface area, the size of grafts, and the anteroposterior dimensions of the reconstructed glenoids. These short-term results suggest that distal tibial allografts can be used as an alternative to coracoid autograft in the recreation of glenoid bony morphologic features.

[BACK](#)

## **Stabilization of Acute High-Grade Acromioclavicular Joint Separation: A Prospective Assessment of the Clavicular Hook Plate Versus the Double Double-Button Suture Procedure**

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### **Background**

The stabilization strategy for acute high-grade acromioclavicular (AC) joint separations with AC-stabilizing clavicular hook plate (cHP) or coracoclavicular (CC)–stabilizing double double-button suture (dDBS) is still under consideration.

### **Hypothesis**

The CC-stabilizing dDBS is superior to the cHP according to an AC-specific radiologic assessment and score system.

### **Study Design**

Cohort study; Level of evidence, 2.

### **Methods**

Seventy-three consecutive patients with acute high-grade AC joint separation were prospectively followed in 2 treatment groups (64.4% randomized, 35.6% patient-selected treatment): open reduction and cHP (cHP group) or arthroscopically assisted dDBS (dDBS group) performed within 14 days of injury. Patients were prospectively analyzed by clinical scores (Taft, Constant score [CS], numeric analog scale for pain) and AC-specific radiographs (AC distance, CC distance [CCD], relative CCD [rCCD;  $100 / \text{AC distance} \times \text{CCD}$ ]) at points of examination (preoperative and 6, 12, and 24 months). The minimal clinically important differences (MCIDs) were assessed by the anchor-based method.

### **Results**

Twenty-seven of 35 patients (mean age  $\pm$  SD:  $37.7 \pm 9.7$  years) after cHP implantation and 29 of 38 patients ( $34.2 \pm 9.7$  years) after dDBS implantation were continuously followed until the 24-month follow-up. All patients showed significantly increased scores after surgery as compared with preoperative status (all  $P < .05$ ). As compared with GI, GII had significantly better outcomes at 24 months (Taft: cHP =  $9.4 \pm 1.7$  vs dDBS =  $10.9 \pm 1.1$ ,  $P < .05$ , MCID = 2.9; CS: cHP =  $90.2 \pm 7.8$  vs dDBS =  $95.3 \pm 4.4$ ,  $P < .02$ , MCID = 16.6) and at 24 months for Rockwood IV/V (Taft: cHP =  $9.4 \pm 1.7$  vs dDBS =  $11.1 \pm 0.8$ ,  $P < .0005$ ; CS: cHP =  $90.1 \pm 7.7$  vs dDBS =  $95.5 \pm 3.1$ ,  $P < .04$ ). Clinically assessed horizontal instability persisted in 18.52% (GI) and 6.89% (GII;  $P = .24$ ). The rCCD showed equal loss of reduction at 24 months (GII = 130.7% [control = 111%] vs GI = 141.8% [control = 115%], MCID = 11.1%).

### **Conclusion**

This prospective study showed significantly superior outcomes in all clinical scores between GII and GI. The subanalysis of the high-grade injury type (Rockwood IV/V) revealed that these patients showed significant benefits from the dDBS procedure in the clinical assessments. The cHP procedure resulted in good to excellent clinical outcome data and displayed an alternative procedure for patients needing less restrictive rehabilitation protocols.

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## **Contrast-Enhanced Ultrasound Determines Supraspinatus Muscle Atrophy After Cuff Repair and Correlates to Functional Shoulder Outcome**

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### **Background**

Muscle degeneration as a consequence of rotator cuff tears is mainly assessed by magnetic resonance imaging. Contrast-enhanced ultrasound (CEUS) is a new functional imaging method to assess microvascular perfusion as a fundamental parameter of muscle tissue vitality. In this cross-sectional study, the authors evaluated supraspinatus muscle perfusion after cuff repair and analyzed its association with functional shoulder outcome and the grade of echogenicity in B-mode ultrasound indicating fatty infiltration.

### **Hypothesis**

The authors expected reduced microperfusion of the operated versus the contralateral supraspinatus muscle and a correlation of the muscular microperfusion with functional shoulder outcome.

### **Study Design**

Cross-sectional study; Level of evidence, 3.

### **Methods**

Patients who received unilateral repair of the supraspinatus tendon between 2009 and 2014 were invited for a single follow-up examination. Functional scores were assessed, including the Constant-Murley score and American Shoulder and Elbow Surgeons score. CEUS examination was performed bilaterally in an oblique sagittal plane of the supraspinatus fossa. Perfusion was quantified by the parameters wash-in perfusion index (WiPI) and peak enhancement via VueBox quantification software. The results of the Constant-Murley score, American Shoulder and Elbow Surgeons score, and perfusion parameters were referenced to the contralateral shoulder. Echogenicity of the supraspinatus muscle was classified with a 3-point scale as compared with the trapezius muscle.

### **Results**

Sixty-seven patients were available, with a mean follow-up of  $38.0 \pm 18.5$  months. Functional assessment showed impaired shoulder function on the operated shoulder as compared with the contralateral side (relative Constant Score [CS],  $80\% \pm 19\%$ ). CEUS revealed diminished perfusion on the operated shoulder (WiPI,  $55.1\% \pm 40.2\%$ ,  $P < .001$ ). A strong correlation could be demonstrated between the perfusion deficit and functional impairment (relative WiPI and CS:  $r_s = .644$ ,  $P < .001$ ). Higher grade of echogenicity in B-mode ultrasound was associated with reduced perfusion.

### **Conclusion**

CEUS could visualize impaired supraspinatus muscle perfusion after rotator cuff repair as compared with the contralateral, healthy shoulder. With its ability to quantify microvascular perfusion as a surrogate parameter for muscle vitality and function, CEUS may serve as a quantitative method to evaluate rotator cuff muscles.

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## **Risk Factors for Failure of Arthroscopic Revision Anterior Shoulder Stabilization**

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### **Background:**

Recurrent anterior instability following a failed Bankart repair in the shoulder represents a challenging clinical scenario. Few studies have examined the role of arthroscopic revision anterior stabilization as a treatment option in these cases. The purpose of this study was to evaluate the outcomes of arthroscopic revision anterior stabilization for patients with recurrent instability after a failed index procedure.

### **Methods:**

Ninety-two patients underwent arthroscopic revision anterior stabilization after a failed index (open or arthroscopic) stabilization procedure. Sixty-five patients with a minimum of 2 years of follow-up were included in this study. The mean age at the time of revision surgery was 26 years (range, 15 to 57 years). The rate of recurrent instability and risk factors for failure were evaluated; the mean duration of follow-up was 4.7 years (range, 2 to 10.8 years). Glenoid and humeral bone loss were quantitatively assessed using preoperative T1-weighted magnetic resonance arthrograms to determine if the lesions were on-track or off-track.

### **Results:**

Twenty-seven (42%) of the patients experienced recurrent instability at a mean of 2.3 years after arthroscopic revision anterior stabilization. On multivariate analysis, the presence of an off-track lesion, an age of <22 years, and ligamentous laxity were independent predictors of recurrence (p = 0.022, 0.028, and 0.031, respectively). Among a cohort with these risk factors excluded, the failure rate was 19%.

### **Conclusions:**

Arthroscopic revision anterior stabilization is associated with a high rate of recurrent instability, and patient selection is of critical importance in order to minimize recurrence.

### **Level of Evidence:**

Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

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## Lower Extremity

Arthroscopy, Volume 34, Issue 9

### **The Cost-Effectiveness of Meniscal Repair Versus Partial Meniscectomy in the Setting of Anterior Cruciate Ligament Reconstruction**

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#### **Purpose**

To compare the cost-effectiveness of anterior cruciate ligament (ACL) reconstruction with meniscal repair to ACL reconstruction with partial meniscectomy.

#### **Methods**

A decision-analytic Markov disease progression model with a 40-year horizon was created simulating outcomes after both meniscal repair and partial meniscectomy at the time of ACL reconstruction. Event probabilities, costs, and utilities were used for the index procedures. The development of osteoarthritis and subsequent knee replacement were either calculated or selected from published literature. Difference in cost, difference in quality-adjusted life-years (QALYs), and incremental cost-effective ratio were calculated to determine which index procedure is most cost-effective.

#### **Results**

There is total direct cost from ACL reconstruction with meniscus repair of \$17,898 compared with that with partial meniscectomy of \$24,768 (cost savings of \$6,870). There was an estimated gain of 18.00 QALYs after ACL reconstruction with meniscus repair compared with 17.16 QALYs with partial meniscectomy (increase of 0.84 QALYs). In this scenario, meniscus repair is the dominant index procedure at the time of ACL reconstruction.

#### **Conclusions**

Meniscal repair at the time of ACL reconstruction is more cost-effective than partial meniscectomy.

#### **Level of Evidence**

Level IV, economic and decision analysis.

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## **Use of the 5-Strand Hamstring Autograft Technique in Increasing Graft Size in Anterior Cruciate Ligament Reconstruction**

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### **Background**

To determine the extent to which a strategy of routinely preparing a 5-strand hamstring autograft would increase graft size in anterior cruciate ligament (ACL) reconstruction.

### **Methods**

A total of 64 patients were enrolled in a prospective randomized controlled study comparing 5-strand and quadrupled semitendinosus-gracilis autografts in single-bundle ACL reconstruction (5-strand group, n = 32; 4-strand group, n = 32). In the 5-strand group, the diameter of the 4-strand construct and the subsequent 5-strand graft used were measured, whereas in the 4-strand group, the diameter of the quadrupled graft used was measured. Quadrupled graft diameter and hamstring tendon lengths were correlated with patient gender, height, weight, and body mass index (BMI).

### **Results**

The mean diameter of the final graft used in the 5-strand group was  $8.8 \pm 0.8$  mm, whereas that in the 4-strand group was  $7.8 \pm 0.7$  mm ( $P < .001$ ). The mean increase in graft size achieved with the use of the 5-strand technique was  $1.4 \pm 0.3$  mm. In the 5-strand group, 24 of 32 (75%) patients had graft diameters exceeding 8 mm compared with 9 of 32 (28%) patients in the 4-strand group ( $P < .001$ ). Quadrupled graft diameter was significantly correlated with patient height and BMI, whereas the gracilis and semitendinosus lengths were significantly correlated with patient height.

### **Conclusions**

The 5-strand hamstring autograft provides a significantly larger diameter graft compared with the quadrupled hamstring autograft in ACL reconstruction. Graft sizes exceeding 8 mm are achievable in 75% of patients with the routine application of this technique. This is significantly more than that obtained with the standard quadrupled hamstring graft. Hamstring tendon length and quadrupled hamstring graft diameter are also significantly correlated with patient height.

### **Level of Evidence**

Level 1, prospective randomized controlled trial.

## **Single-Bundle Versus Double-Bundle Anterior Cruciate Ligament Reconstruction—5-Year Results**

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### **Purpose**

To compare anatomic single-bundle (SB) with double-bundle (DB) anterior cruciate ligament reconstruction (ACL-R) and to evaluate the respective clinical outcome results.

### **Methods**

In a prospective randomized study, 64 patients were included and separated into 2 groups. Anatomic SB and DB ACL-Rs were performed with hamstring tendons. Five years after surgery, the follow-up (FU) examination comprised International Knee Documentation Committee (IKDC) 2000, Laxitester (ORTEMA Sport Protection, Markgroeningen, Germany) measurement, and radiograph evaluation. Power calculation was performed to achieve a 95% confidence interval and 80% power on the base of 7-point IKDC subjective difference between the groups.

### **Results**

A total of 53 patients (83% FU) were examined at  $63.2 \pm 4.7$  months after surgery: 28 patients in the DB group and 25 patients in the SB group. IKDC subjective (SB:  $92.8 \pm 6.2$ , DB:  $91.6 \pm 7.1$ ;  $P = .55$ ) and objective scores (grade A SB/DB 20%/25%, B SB/DB 72%/57%, C SB/DB 8%/18%, D SB/DB 4%/0%;  $P = .45$ ) showed no differences comparing both groups. The Laxitester measurements showed no significant difference in regard to anterior-posterior translation in neutral, internal, and external rotation or to rotation angles ( $P = .79$ ). No difference was seen between the groups regarding osteoarthritic changes and tunnel widening.

### **Conclusions**

At the 5-year FU, no advantage for either the DB or SB technique in ACL-R can be seen with regard to patient-related and objective outcome measures.

### **Level of Evidence**

Level I, prospective randomized controlled clinical trial.

## **Early Structural Results After Anatomic Triple Bundle Anterior Cruciate Ligament Reconstruction Validated by Tunnel Location, Graft Orientation, and Static Anteroposterior Tibia-Femur Relationship**

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### **Purpose**

To elucidate how closely the structural characteristics of the anterior cruciate ligament (ACL) grafts after anatomic triple bundle (ATB) reconstruction resembled those of the normal ACL.

### **Methods**

From 2012 to 2016, patients who underwent primary ATB ACL reconstruction using hamstring tendon autografts and the same number of healthy control subjects were included. Using magnetic resonance imaging (MRI) taken at 6 months postoperatively, ACL graft orientation was evaluated by the angles against the tibial plateau measured in the sagittal and oblique coronal planes at the anteromedial and posterolateral portions (ACL-tibial plateau angle [ATA]). For factors affecting the graft orientation, the static tibiofemoral relationship was evaluated by anteroposterior tibial translocation (APTT) in the identical MRI using a previously established method, and tunnel locations were evaluated using the quadrant method. To test equivalence, the widely used two one-sided test procedure was performed, with the equivalence margins of 5° and 3 mm for ATA and APTT, respectively.

### **Results**

Thirty-five patients were enrolled for each group. ATAs were not significantly different, and the 95% confidence interval (CI) of these differences was within 5° (sagittal:  $P = .211$  [95% CI, -2.9 to 0.6]; oblique coronal ATA for the anteromedial and posterolateral portions:  $P = .269$  [95% CI, -1.9 to 0.5] and  $P = .456$  [95% CI, -2.1 to 0.9], respectively). The difference in APTT was neither statistically nor clinically significant ( $P = .114$ ; 95% CI, -2.0 to 0.2).

### **Conclusions**

These data suggest that ACL grafts using the ATB technique achieved a graft orientation equivalent to that of the normal ACL, with an equivalent postoperative anteroposterior tibiofemoral relationship in the static MRI. Thus, the ATB ACL reconstruction technique with the presented tunnel locations produced grafts that were similar to the native ACL in orientation.

### **Level of Evidence**

Level III, case-control study.

## **Intraoperative Preconditioning of Fixed and Adjustable Loop Suspensory Anterior Cruciate Ligament Reconstruction With Tibial Screw Fixation—An In Vitro Biomechanical Evaluation Using a Porcine**

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### **Purpose**

To evaluate the effect of preconditioning according to intraoperative workflow on initial tension and elongation behavior for femoral adjustable loop devices (ALDs) and closed loop devices (CLDs) in suspensory anterior cruciate ligament reconstruction (ACLR) with tibial screw fixation in a biomechanical in vitro study.

### **Methods**

Three ACLR groups with tibial screw fixation were biomechanically tested in a full-construct setup using porcine tibias. Groups (n = 8 per group) varied by femoral fixation method and consisted of a CLD (group 3) and ALD fixation with (group 2) and without simulated intraoperative preconditioning (group 1). The change in tension after screw insertion and the displacement to restore the initial loading situation were measured. Grafts underwent dynamic cycling (1,000 cycles at 0.75 Hz) using both a position and a force control mode.

### **Results**

Data are presented as mean [standard deviation]. Placement of an interference screw induced a graft tension loss of 62% (49.4 [0.4] N vs 19.0 [10.0] N,  $P < .001$ ) by introducing a laxity of 0.53 [0.26] mm. Intraoperative preconditioning led to a higher initial load level (228.3 [19.8] N) compared with unconditioned ALD (156.1 [25.5] N,  $P < .001$ ) and CLD groups (156.6 [12.8] N,  $P < .001$ ) with less force decrease over position-controlled cyclic loading. Furthermore, initial (−0.22 [0.16] mm) and dynamic elongation (0.88 [0.23] mm) were reduced compared with the unconditioned ALD (0.65 [0.35] mm,  $P < .001$ ; and 1.56 [0.19] mm,  $P < .001$ ) and CLD groups (0.16 [0.26] mm,  $P < .001$ ; and 1.64 [0.24] mm,  $P < .001$ ).

### **Conclusions**

ACLR with femoral ALD fixation and intraoperative preconditioning allows for restoration of time-zero screw-imparted slack and leads to significantly reduced cyclic elongation in accordance with native ACL function. Both ALD and CLD control groups behaved similarly, with total elongation less than 3 mm including time-zero slack.

### **Clinical Relevance**

Although the clinical relevance of time-zero graft tension loss is uncertain, the use of an ALD in concert with tibial screw fixation may be favorable to allow for tension optimization.

## **Race and Insurance Status Are Associated With Surgical Management of Isolated Meniscus Tears**

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### **Purpose**

The purpose of this study was to perform a population-level analysis to evaluate the effect of socioeconomic markers on the use of meniscus surgery in patients with meniscus tears.

### **Methods**

We queried all hospital-based clinic visits from 2011 to 2014 in the Statewide Planning and Research Cooperative System database, which also contains all New York inpatient/outpatient visits. Patients with known prior knee surgery, meniscus tear before 2011, or other ligament injuries were excluded. The primary outcome was a meniscus procedure (meniscectomy or meniscus repair). Survival analysis was used to calculate the rate of meniscus surgery within 6 months. A multivariate model identified patient factors (age, sex, race, and payer) associated with surgical intervention.

### **Results**

There were 32,012 patients identified who met the inclusion criteria. The rate of meniscus procedure within 6 months of diagnosis was 49.6%. Meniscectomy was performed in 98.8% of cases compared with 1.2% for meniscus repair. Rates of meniscus procedures were higher in patients who were older, male, and white, as well as those first diagnosed by a surgeon. The highest rates of meniscus procedures were in those with private, worker's compensation, or other insurance types. Multivariable analysis showed that female sex, non-white race, and public or self-pay insurance were independently associated with lower rates of meniscus surgery.

### **Conclusions**

These results suggest both insurance-based and race-based disparities regarding surgical treatment. Additionally, the strongest variable for surgical management was a meniscus tear being first diagnosed by a surgeon.

### **Level of Evidence**

Level of Evidence IV, retrospective case-control study.

## **Two Different Knee Rotational Instabilities Occur With Anterior Cruciate Ligament and Anterolateral Ligament Injuries: A Robotic Study on Anterior Cruciate Ligament and Extra-articular Reconstructions in Restoring Rotational Stability**

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### **Purpose**

To determine the effect of 2 extra-articular reconstructions on pivot-shift rotational stability and tibial internal rotation as a basis for clinical recommendations.

### **Methods**

A robotic simulator tested 15 cadaver knees. Group 1 (anterior cruciate ligament [ACL] cut) underwent ACL bone-patellar tendon-bone reconstruction followed by sectioning the anterolateral structures and an extra-articular, manual-tension iliotibial band (ITB) tenodesis. Group 2 (ACL intact) tested the rotational stabilizing effect of a low-tension ITB tenodesis before and after sectioning the anterolateral ligament/ITB structures. Lateral and medial tibiofemoral compartment translations and internal-external tibial rotations were measured under Lachman, 5N·m tibial rotation, and 2 pivot-shift simulations using 4-degree-of-freedom loading. Statistical equivalence was defined within 2 mm tibiofemoral compartment translation and 2° tibial rotation at  $P < .05$ .

### **Results**

The bone-patellar tendon-bone ACL reconstruction (group 1) restored pivot-shift lateral compartment translation within 0.7 mm (95% confidence interval [CI], -0.6 to 1.9;  $P = .70$ ) of normal. The internal rotation limit was not affected by ACL sectioning or reconstruction. After anterolateral ligament/ITB sectioning there was no change in pivot-shift lateral compartment translation, however internal rotation increased 2.9° (95% CI, 0.6-5.2;  $P = .99$ ) at 90° flexion. The manual-tension ITB tenodesis (fixated 13-22 N tension) decreased pivot-shift lateral compartment translation 4.8 mm (95% CI, 1.4-8.1;  $P = .99$ ) and internal rotation by 21.9° (95% CI, 13.2-30.6;  $P = .99$ ) at 90° flexion. The ACL forces decreased 45.8% in the pivot-shift test. In group 2 knees, with the ACL intact, the anterolateral ligament/ITB sectioning had no effect on pivot-shift translations; however, the internal rotation limit increased by 4.3° (95% CI, 1.9-6.8;  $P = .99$ ) at 60° flexion. The low-tension ITB tenodesis (fixated 8.9 N tension) had no effect on pivot-shift translations and corrected internal tibial rotation with a mild overconstraint of 4.2° (95% CI, 1.9-6.8;  $P = .99$ ) at 60° flexion.

### **Conclusions**

A low-tension ITB tenodesis, fixated at neutral tibial rotation to avoid constraining internal tibial rotation, has no effect in limiting abnormal pivot-shift subluxations.

### **Clinical Relevance**

A low-tension ITB tenodesis has limited clinical utilization as the pivot-shift subluxations are not affected, assuming appropriate tensioning to not overconstrain internal tibial rotation.

## **Arthroscopic Partial Meniscectomy Versus Physical Therapy for Degenerative Meniscus Lesions: How Robust Is the Current Evidence? A Critical Systematic Review and Qualitative Synthesis**

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### **Purpose**

The purpose of this systematic review was to investigate study quality and risk of bias for randomized trials comparing partial meniscectomy with physical therapy in middle-aged patients with degenerative meniscus tears.

### **Methods**

A systematic review of Medline, Embase, Scopus, and Google Scholar was performed from 1990 through 2017. The inclusion criteria were at least 1 validated outcome score, and middle-aged patients (40 years and older) with a degenerative meniscus tear. Studies with a sham arm, and acute and concomitant injuries were excluded. Risk of bias was assessed with the Cochrane Risk of Bias Tool. The quality of studies was assessed with the Cochrane GRADE tool and quality assessment tool (Effective Public Health Practice Project). Publication bias was assessed by funnel plot and Egger's test. The I<sup>2</sup> statistics was calculated a measure of statistical heterogeneity.

### **Results**

Six studies were included, and all were assessed as having a high risk of bias. There was no publication bias ( $P = .23$ ). All studies were downgraded (low,  $n = 5$ ; very low,  $n = 1$ ). The Effective Public Health Practice Project assessed 1 study as strong, 2 as moderate, and 3 as weak. The overall results demonstrated moderate to low quality of the included studies. The I<sup>2</sup> statistic was 96.2%, demonstrating substantial heterogeneity between studies.

### **Conclusions**

The results of this systematic review strongly suggest that there is currently no compelling evidence to support arthroscopic partial meniscectomy versus physical therapy. The studies evaluated here exhibited a high risk of bias, and the weak to moderate quality of the available studies, the small sample sizes, and the diverse study characteristics do not allow any meaningful conclusions to be drawn. Therefore, the validity of the results and conclusions of prior systematic reviews and meta-analyses must be viewed with extreme caution. The quality of the available published literature is not robust enough at this time to support claims of superiority for either alternative, and both arthroscopic partial meniscectomy or physical therapy could be considered reasonable treatment options for this condition.

### **Level of evidence**

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

## **Most Military Service Members Return to Activity Duty With Limitations After Surgery for Femoroacetabular Impingement Syndrome: A Systematic Review**

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### **Purpose**

Determine which proportion of active-duty service members return to duty (RTD), RTD without limitations, which surgical intervention returns these personnel at a better proportion and with the ability to perform their military duties after surgery compared with the pre-injury state.

### **Methods**

A computer-assisted search of MEDLINE, EMBASE and SCOPUS databases was performed with keywords related to RTD for femoroacetabular impingement (FAI) syndrome. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines were used for study methodology. Methodologic quality of individual studies was assessed with the Methodological Index for Non-Randomized Studies scale.

### **Results**

A total of 5 studies (884 service members/886 hips) qualified for inclusion. Limited evidence from level III to IV studies indicates that service members RTD at a proportion ranging from 57% (95% confidence interval [CI]: 53% to 62%) to 84% (95% CI: 73% to 91%), but only 39% (95% CI: 35% to 44%) to 59% (95% CI: 49% to 69%) do so without limitations. Mean duration of follow-up was  $33.2 \pm 11.3$  months. No studies reported on actual duty requirements before versus after surgery, RTD criteria, or career longevity. Only 1 of 5 studies reported the RTD time-frame (mean 5 months). Only 2 of 5 studies reported complications, with a rate of  $9.4\% \pm 6.3\%$ . Three of 5 studies reported failures at a rate of  $7.2\% \pm 4.7\%$ , respectively. Femoroplasty (mean 56% of procedures in 4 studies) and acetabuloplasty (mean 55% of procedures in 4 studies) were the most commonly used procedures in studies reporting.

### **Conclusions**

RTD is poorly defined in the included studies. Limited evidence substantiates that approximately 75% of service members remain on active duty for at least 1 to 2 years after surgery for FAI syndrome, whereas only approximately 47% do so without limitations at mid-term follow-up. Similarly, despite improvements in patient-reported outcome measures, service members still report continued pain and functional limitations after FAI syndrome surgery.

### **Level of Evidence**

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

## **Imaging Diagnosis of Injury to the Anterolateral Ligament in Patients With Anterior Cruciate Ligaments: Association of Anterolateral Ligament Injury With Other Types of Knee Pathology and Grade of Pivot-Shift Examination: A Systematic Review**

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### **Purpose**

The purpose of this study is to systematically review the literature to evaluate the reliability, or the ability of a repeated measurement to yield consistent results, and validity of ultrasound (US) and magnetic resonance imaging (MRI) at evaluating anatomy and pathology of the anterolateral ligament of the knee (ALL) in the setting of anterior cruciate ligament (ACL) injuries. Furthermore, the incidence and association of ALL injury with the pivot-shift examination, and other structural injuries, will be reviewed for additional clinical relevance.

### **Methods**

Adhering to Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, 2 reviewers independently searched the Medline, Embase, Cochrane, EBSCOhost, OVID, and Web of Science databases for all studies related to imaging of the ALL. All eligible articles and their references were screened by both reviewers. Studies discussing diagnostic imaging of the ALL with regard to identification of injury to the structure in patients with suspected ACL injury were included. No restrictions regarding date of publication, type of publication, or language in the included article were applied. The exclusion criteria included commentaries, case reports, and studies that did not attempt to identify the ALL as a discrete structure. Quality assessment and data extraction was performed for each included study before final analysis was performed.

### **Results**

A total of 13 articles were included for final analysis. In the included studies, at least 1 portion of the ALL could be visualized on MRI in 76% to 100% of knees, and injury to the ALL was identified in 10.8% to 62.5% of patients. Inter- and intraobserver reliabilities ranged from moderate to almost perfect. There was a consensus among studies that ALL injuries were significantly associated with injuries to the lateral collateral ligament, popliteus tendon, iliotibial band, and bony contusions to the lateral tibia and femur. Most of the included studies found a significant association of injuries to the ALL and a high-grade pivot-shift examination. Only 2 studies used US to evaluate for injury to the ALL, and both studies had almost perfect interobserver reliability. Only 1 study confirmed initial diagnoses at the time of the ACL reconstruction surgery.

### **Conclusions**

In patients with ACL injuries, concomitant ALL injuries can be identified on MRI or US with high levels of inter- and intraobserver reliability, and are often associated with a high-grade pivot-shift examination, lateral collateral ligament injury, and lateral femoral condyle and tibial plateau bone bruises.

### **Level of Evidence**

Level IV, systematic review of level II-IV studies.

[BACK](#)

**Bone–patellar tendon–bone autograft could be recommended as a superior graft to hamstring autograft for ACL reconstruction in patients with generalized joint laxity: 2- and 5-year follow-up study**

Sung-Jae Kim, Chong Hyuk Choi, Sung-Hwan Kim, Su-Keon Lee, Wonyong Lee, Taeyup Kim, Min Jung

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**Purpose**

The present study aimed to compare 2- and 5-year outcomes of ACL reconstruction between patients with and without generalized joint laxity and to perform comparative evaluation between two types of grafts used for ACL reconstruction in patients with generalized joint laxity.

**Methods**

Two hundred and thirty-seven patients who underwent ACL reconstruction from 2001 to 2008 were included. Patients were classified into two groups according to the presence or the absence of generalized joint laxity, and further subdivided into two subgroups based on the type of graft used: bone–patellar tendon–bone (BPTB) or hamstring. Generalized joint laxity was assessed with the Beighton and Horan criteria using a point scoring system. Stability reflected by the Lachman test, pivot-shift test, and anterior translation measured with KT-2000, and functional outcomes reflected by Lysholm knee score, and International Knee Documentation Committee (IKDC) subjective score were investigated. IKDC objective grade and radiographic grade were also assessed. Clinical assessments were conducted preoperatively and at 2 and 5 years after operation.

**Results**

Two-year follow-up results showed that patients with generalized joint laxity receiving hamstring grafts had poorer outcomes than those without generalized joint laxity. Five-year follow-up results showed that patients with generalized joint laxity experienced poorer outcomes than patients without generalized joint laxity, irrespective of the type of graft. Comparison of grafts used showed that, in patients with generalized joint laxity, BPTB graft provided significantly better stability and functional outcomes than hamstring graft at both 2- and 5-year follow-ups. Comparisons between serial outcomes measured at 2 and 5 years demonstrated that stability and functional outcomes deteriorated over time in patients with generalized joint laxity.

**Conclusions**

Less satisfactory stability and functional outcomes were noted in patients with generalized joint laxity, compared to patients without generalized joint laxity. Comparisons of stability and functional outcomes after ACL reconstruction in patients with generalized joint laxity between two different grafts demonstrated that BPTB graft achieves better results than hamstring graft.

**Level of evidence**

III, a retrospective cohort study.

## **Lateral displacement, sulcus angle and trochlear angle are associated with early patellofemoral osteoarthritis following anterior cruciate ligament reconstruction**

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### **Purpose**

Patellofemoral osteoarthritis (PFOA) occurs in approximately half of anterior cruciate ligament (ACL)-injured knees within 10–15 years of trauma. Risk factors for post-traumatic PFOA are poorly understood. Patellofemoral alignment and trochlear morphology may be associated with PFOA following ACL reconstruction (ACLR), and understanding these relationships, particularly early in the post-surgical time period, may guide effective early intervention strategies. In this study, patellofemoral alignment and trochlear morphology were investigated in relation to radiographic features of early PFOA 1-year post-ACLR.

### **Methods**

Participants (aged 18–50 years) had undergone ACLR approximately 1 year prior to being assessed. Early PFOA was defined as presence of a definite patellofemoral osteophyte on lateral or skyline radiograph. Sagittal and axial plane alignment and trochlear morphology were estimated using MRI. Using logistic regression, the relationship between alignment or morphology and presence of osteophytes was evaluated.

### **Results**

Of 111 participants [age  $30 \pm 8.5$ ; 41 (37%) women], 19 (17%) had definite osteophytes, only two of whom had had patellofemoral chondral lesions noted intra-operatively. One measure of patellar alignment (bisect offset OR 1.1 [95% confidence interval 1.0, 1.2]) and two measures of trochlear morphology (sulcus angle OR 1.1 [1.0, 1.2], trochlear angle OR 1.2 [1.0, 1.5]) were associated with patellofemoral osteophytes.

### **Conclusions**

Patellofemoral malalignment and/or altered trochlear morphology were associated with PFOA 1 year following ACLR compared to individuals post-ACLR without these features. Clarifying the role of alignment and morphology in post-traumatic PFOA may contribute to improving early intervention strategies aimed at secondary prevention.

### **Level of evidence**

IV.

## **Trochleoplasty techniques provide good clinical results in patients with trochlear dysplasia**

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### **Purpose**

The aim of this systematic review is to compare the clinical outcomes of patients treated with different trochleoplasty procedures, the rate of complications and recurrence of patellar dislocation.

### **Methods**

A systematic review of the literature was performed, in accord with the PRISMA guidelines. PubMed, MEDLINE, CINAHL, Cochrane, EMBASE and Google Scholar databases were comprehensively searched using the keyword combinations, "Dejour trochleoplasty", "Bereiter Trochleoplasty", "Albee Trochleoplasty", "Recession Trochleoplasty", "Trochlear Dysplasia", "Instability", "Adult", "Clinical Outcome" and "Surgery".

### **Results**

Three-hundred and ninety-two knees in 371 patients were included. Bereiter U-shaped deepening trochleoplasty was the most commonly used technique for the treatment of trochlear dysplasia in the included studies with the lowest rate of recurrence and post-operative ROM deficiency. On the other hand, Dejour V-shaped deepening trochleoplasty showed the highest mean post-operative value of Kujala score with 79.3 (SD 8.4) points. Statistical differences were found in terms of redislocation rate between Goutallier procedure and Bereiter trochleoplasty ( $p < 0.05$ ) and in terms of post-operative osteoarthritis between Bereiter and Dejour procedures ( $p < 0.05$ ).

### **Conclusion**

Bereiter trochleoplasty seems to be the most efficiency procedure in terms of post-operative patellar redislocation, post-operative osteoarthritis and ROM, but the highest mean post-operative Kujala score is obtained by Dejour procedure. Therefore, none of the surgical techniques analysed highlighted a real superiority. Randomised clinical trials are needed to establish whether of available surgical technique is the best to treat patient with trochlear dysplasia. The clinical relevance of this paper is that the three most popular trochleoplasty techniques are associated with significantly improved stability and function, showing a relatively low rate of osteoarthritis and pain, and a moderate rate of complications.

### **Level of evidence**

Systematic review, Level IV.

[BACK](#)

## **Modern synthetic material is a safe and effective alternative for medial patellofemoral ligament reconstruction**

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KSSTA, September 2018, Volume 26, Issue 9, pp 2716-2721

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### **Purpose**

Medial patellofemoral ligament (MPFL) reconstruction is often performed using gracilis autografts, which may be associated with donor site morbidity and complications. The use of a synthetic material can circumvent a harvest operation and has previously been demonstrated to be effective in other types of reconstructive procedures and may be effective in MPFL reconstruction. This study reports the clinical result with the use of a modern ultra-high molecular weight polyethylene with a braided jacket of polyester tape (FT) in MPFL reconstruction compared to using standard autografts.

### **Methods**

Data were collected prospectively in 50 MPFL reconstructions. The first 27 underwent reconstruction using gracilis tendon (GT) autograft; the following 23 patients were treated with FT. All patients were clinically and radiologically assessed and underwent pre- and post-operative scoring using the Kujala score, Bartlett score, Tegner activity rating scale, SF-12 score and Lysholm score. Statistical significance was tested between groups using ANOVA with repeated measures.

### **Results**

There were no significant differences in the pre-operative scores between the FT and GT groups (n.s.). Both groups showed significant improvements across all scoring modalities between pre- and post-operative periods 12, 24 and 48 months of follow-up ( $p < 0.05$ ). There were no significant differences in knee function scores between the GT and FT groups.

### **Conclusion**

The use of FiberTape in MPFL reconstruction is safe and effective, and it significantly improves patient's quality of life and related post-operative outcome measures. There were no significant differences in all knee scores compared to GT autografts. Using this technique for MPFL reconstruction, tendon harvesting is unnecessary and hence eliminates donor site morbidity-associated complications.

### **Level of evidence**

II.

## **Double-bundle anatomical medial patellofemoral ligament reconstruction with lateral retinaculum plasty can lead to good outcomes in patients with patellar dislocation**

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### **Purpose**

To evaluate the clinical outcomes of double-bundle anatomical medial patellofemoral ligament (MPFL) reconstruction combined with lateral retinaculum plasty versus isolated MPFL reconstruction for patellar dislocation.

### **Methods**

From 2011 to 2013, 64 patients underwent either double-bundle anatomical MPFL reconstruction combined with lateral retinaculum plasty (Group A, 32 patients), or isolated MPFL reconstruction (Group B, 32 patients). Clinical evaluations were performed 2 years post-operatively and included determination of the number of patients with patellar redislocation, the patellar tilt angle, lateral patellar shift, subjective symptoms, and functional outcomes as evaluated with the Kujala score and Lysholm score.

### **Results**

No dislocation or subluxation occurred during the 25-month follow-up. Radiographically, the patellar tilt angle was  $6.0^{\circ} \pm 1.7^{\circ}$  in Group A and  $6.7^{\circ} \pm 2.0^{\circ}$  in Group B, without a significant difference (n. s). The lateral patellar shift was  $8.0 \pm 2.6$  mm in Group A and  $8.5 \pm 2.4$  mm in Group B (n. s). The mean Kujala score was  $91.8 \pm 3.7$  in Group A and  $91.5 \pm 3.6$  in Group B post-operatively (n. s), and the mean Lysholm score was  $92.5 \pm 3.8$  and  $90.8 \pm 4.9$ , respectively (n. s).

### **Conclusions**

Double-bundle anatomical MPFL reconstruction with lateral retinaculum plasty is a promising procedure that provides a new option for patellar dislocation.

### **Level of evidence**

III.

## **Bone morphology and morphometry of the lateral femoral condyle is a risk factor for ACL injury**

Sebastiano Vasta, Renato Andrade, Rogério Pereira, Ricardo Bastos, Antonino Giulio Battaglia, Rocco Papalia, João Espregueira-Mendes

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### **Purpose**

The purpose of this study was to investigate the influence of the knee lateral compartment bony morphology and morphometry on risk of sustaining an anterior cruciate ligament (ACL) injury.

### **Methods**

A total of 400 age and sex-matched patients (200 ACL-ruptured and 200 ACL-intact) were included. The lateral femoral and tibial bone morphology and morphometric parameters were measured on knee lateral radiographs, taken at 30° of knee flexion with overlapping of the femoral condyles. Radiographic measurements included: anteroposterior-flattened surface of the femur's lateral condyle (XY); femur's diaphysis anteroposterior distance (A); anteroposterior distance of the femur's lateral condyle (B); height of the femur's lateral condyle (C); anteroposterior distance of the tibial plateaus (AB); tibial slope. In addition, three morphological ratios were calculated: B/AB; B/XY; XY/AB (Porto ratio).

### **Results**

Most of bone morphological parameters were different between genders ( $P < 0.05$ ). ACL-ruptured female subjects showed statistical significant smaller condyle heights (C), smaller distances of the flattened surface of the distal femoral condyle (XY), smaller tibial plateau anteroposterior distances (AB), and higher XY/AB ratio ( $P < 0.05$ ). ACL-ruptured male subjects had statistical significant smaller condyle height (C), anteroposterior distance of the femur's lateral condyle (B), tibial plateau anteroposterior distances (AB), and tibial slope ( $P < 0.05$ ). Multivariate logistic regression model showed that five morphological parameters (A, XW, XY, XZ, and AB) were significantly associated with ACL rupture (AUC = 0.967,  $P < 0.001$ ). Calculated ratios (XY/AB; B/AB; B/XY) showed a significant accuracy in identifying individuals with ACL injury ( $P < 0.001$ ).

### **Conclusions**

The most important finding of this study was that the calculated ratios (XY/AB; B/AB; B/XY) showed a significant accuracy in identifying the individuals with and without an ACL injury. Within this line, a longer flat surface of the lateral femoral condyle or higher Porto ratio (XY/AB) is associated with a lower the risk of ACL injury. Moreover, when considering the combination of five primary bone morphology and morphometric parameters (A, XW, XY, XZ, and AB), the accuracy in identifying these individuals was excellent (AUC = 0.967). These findings may contribute to injury risk assessment, sports participation, and injury prevention counseling and surgical planning refining by identifying high-risk patients who would benefit from the addition of associated procedures to the anatomic ACL reconstruction aiming the improvement of knee stability and decrease the risk of further injuries.

### **Level of evidence**

III, case-control study.

[BACK](#)

## **Increased extrusion and ICRS grades at 2-year follow-up following transtibial medial meniscal root repair evaluated by MRI**

Daniel J. Kaplan, Erin F. Alaia, Andrew P. Dold, Robert J. Meislin, Eric J. Strauss, Laith M. Jazrawi, Michael J. Alaia

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### **Purpose**

The purpose of the current study was to evaluate the short-term results of meniscal root repair surgery, assessing clinical and radiographic outcomes, utilizing MRI to assess root healing and extent of post-operative extrusion.

### **Methods**

This was a single-center, retrospective study evaluating patients who had undergone a medial meniscus posterior root repair using a transtibial pullout technique with two locking cinch sutures. Demographic data were collected from patient charts. Clinical outcomes were assessed with pre- and post-operative IKDC and Lysholm scores. Pre-op scores were taken at the patients' initial clinical visit, mean 1.55 months prior to surgery ( $\pm 1.8$  months, min 0.3, max 7.3). Radiographic outcomes were assessed with MRI evaluation of root healing, meniscal extrusion, and cartilage degeneration using ICRS criteria. Tunnel placement was evaluated and compared to the anatomic footprint.

### **Results**

Eighteen patients (47.2 years  $\pm 11.9$ ) were evaluated at mean follow-up of 24.9 months ( $\pm 7.2$ , min 18.4, max 35.6). The IKDC score significantly increased from 45.9 ( $\pm 12.6$ ) pre-operatively to 76.8 ( $\pm 14.7$ ) post-operatively ( $p < 0.001$ ). Lysholm scores also increased from 50.9 ( $\pm 7.11$ ) to 87.1 ( $\pm 9.8$ ) ( $p < 0.001$ ). Mean tunnel placement was 5.3 mm ( $\pm 3.5$ , range 0–11.8) away from the anatomic footprint. Mean extrusion increased from 4.74 mm ( $\pm 1.7$ ) pre-operatively to 5.98 ( $\pm 2.8$ ) post-operatively ( $p < 0.02$ ). No patients with  $> 3$  mm of extrusion on pre-operative MRI had  $< 3$  mm of extrusion on post-operative MRI. Both medial femoral condyle and medial tibial plateau ICRS grades worsened significantly ( $p < 0.02$  and  $p < 0.01$ , respectively). On MRI, one root appeared completely healed, 16 partially healed, and one not healed.

### **Conclusion**

Patients treated with the transtibial suture pull-out technique with two locking cinch sutures had improved clinical outcomes, but only partial healing in the majority of cases, increased extrusion, and progression of medial compartment cartilage defect grade on follow-up MRI. Patients should be counseled that although clinical outcomes in the short term may be optimistic, long-term outcomes regarding progression to degenerative arthritis may not be as predictable.

### **Clinical level of evidence**

III.

[BACK](#)

## **Trochleoplasty procedures show complication rates similar to other patellar-stabilizing procedures**

Jordy D. P. van Sambeek, Sebastiaan A. W. van de Groes, Nico Verdonshot, Gerjon Hannink

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### **Purpose**

Trochleoplasty aims to restore patellar stability. Various techniques have been described and almost all authors report successful results. However, the procedure has a significant risk of complications. Purpose of this study was to perform a systematic review and meta-analysis of the available literature to assess the rate of complications after the various techniques used for trochleoplasty procedures.

### **Materials and methods**

MEDLINE, EMBASE, Web of Science and Cochrane Library databases were searched. Studies on patients with recurrent patellar instability treated with a trochleoplasty with or without additional procedure, and reported complications were included. The primary outcome was the rate of complications per technique. A meta-analysis was performed whenever three or more studies per surgical technique could be included.

### **Results**

The selection process resulted in 20 studies included for analysis. A lateral facet elevating trochlear osteotomy was reported by two studies, ten studies reported on a Bereiter trochleoplasty, five on a Dejour trochleoplasty, one on an arthroscopic technique, one on a 'modified' technique and one on a recession wedge trochleoplasty. Meta-analysis showed that proportion of recurrent dislocation was 0.04 (95% CI 0.02–0.07) for Bereiter trochleoplasty and 0.02 (95% CI 0–0.08) for Dejour trochleoplasty. These proportions were 0.06 (95% CI 0.02–0.13) and 0.09 (95% CI 0.03–0.27) for recurrent instability, 0.07 (95% CI 0.02–0.19) and 0.12 (95% CI 0.00–0.91) for patellofemoral osteoarthritis and 0.08 (95% CI 0.04–0.14) and 0.20 (95% CI 0.11–0.32) for further surgery respectively.

### **Conclusion**

This study demonstrates that the complications after a Bereiter and Dejour trochleoplasty including additional procedures are in the range of those of other patellar stabilizing procedures. For four other techniques, no meta-analysis could be performed. The clinical relevance of this study is that it provides clinicians with the best currently available evidence on the rate of complications after trochleoplasty procedures. This can be helpful in the process of deciding whether or not to perform such a procedure, and can be used to better inform patients about the advantages and disadvantages of different trochleoplasty procedures.

### **Level of evidence**

Level IV.

[BACK](#)

## **Poly-traumatic multi-ligament knee injuries: is the knee the limiting factor?**

Jarret M. Woodmass, Nick R. Johnson, Rohith Mohan, Aaron J. Krych, Bruce A. Levy, J. Stuart

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### **Purpose**

Multi-ligament knee injuries (MLKI) from a high-velocity accident are rare but potentially devastating. This matched cohort analysis compares knee functional outcomes after multiple ligament reconstruction in poly-trauma patients to those that occurred in isolation.

### **Methods**

Sixty-two patients with MLKI that occurred either as a component of polytrauma or had occurred in isolation were matched according to age, sex, and knee dislocation grade. Functional outcomes and knee physical examination were assessed at a 2-year follow-up. New Injury Severity Score (NISS) was calculated based on the poly-traumatic injury pattern. Risk factors for worse outcomes in the poly-trauma cohort were analyzed.

### **Results**

The mean IKDC, Lysholm, and NISS scores in the polytrauma cohort were  $57.2 \pm 21.9$ ,  $62 \pm 22$ , and  $40.9 \pm 20.4$ , respectively, at a mean of 67 months (range 24–220). The isolated knee injury group was followed for a mean of 74 months (range 24–266) with mean IKDC and Lysholm scores of  $71.1 \pm 26.5$  and  $78 \pm 23$ , respectively. Patients in the control cohort had significantly higher IKDC ( $p = 0.01$ ) and Lysholm scores, ( $p = 0.003$ ). There were no major differences between the two groups in regards physical examination findings at final follow-up. None of the analyzed risk factors was predictive of poor outcome.

### **Conclusion**

When comparing knees with similar multi-ligament and neurovascular injury patterns, patients who sustained their injury as a result of poly-trauma demonstrated significantly lower functional scores following reconstruction. This is despite restoration of similar knee stability and range of motion. The functional outcomes following MLKI reconstruction in poly-traumatized patients are influenced by factors other than the knee including concomitant injuries and psychosocial factors.

### **Level of evidence**

Therapeutic Level III.

## **In Search of the Spherical Femoroplasty: Cam Overresection Leads to Inferior Functional Scores Before and After Revision Hip Arthroscopic Surgery**

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### **Background**

Femoroplasty performed for the treatment of cam-type femoroacetabular impingement (FAI) has become a common procedure. Underresection may result in residual FAI. Conversely, overresection may disrupt the labral seal, which is responsible for chondroprotective fluid dynamics of the hip.

### **Hypothesis/Purpose**

It was hypothesized that cam overresection negatively affects hip function. The purpose was to examine the effect of the accuracy of previous femoroplasty on hips presenting for revision hip arthroscopic surgery.

### **Study Design**

Cohort study; Level of evidence, 3.

### **Methods**

Data were prospectively collected for patients presenting for revision hip arthroscopic surgery between June 2010 and August 2014. On the basis of measurements on Dunn view radiographs, cases were divided into 3 groups: overresection (OR group) in which overresection measured over 5% of the diameter of the femoral head, underresection (UR group) in which there was a residual cam lesion (alpha angle >60°), and neutral resection (neutral group). Data collection included the modified Harris Hip Score (mHHS), Nonarthritic Hip Score (NAHS), Hip Outcome Score—Sports-Specific Subscale, and visual analog scale at presentation and at a minimum 2-year follow-up after revision hip arthroscopic surgery and rates of conversion to total hip arthroplasty (THA).

### **Results**

One hundred thirty hips (120 patients) were included. Twenty hips (15.4%) were classified as the OR group, 16 (12.3%) as the UR group, and 94 (72.3%) as the neutral group. The mean follow-up was  $39.6 \pm 15.9$  months. The mHHS and NAHS values at presentation were lower in the OR group compared with the UR group ( $50.2 \pm 15.5$  vs  $64.7 \pm 19.4$  [ $P = .033$ ] and  $48.5 \pm 18.6$  vs  $63.0 \pm 19.1$  [ $P = .044$ ], respectively). The mHHS value at a minimum 2-year follow-up after revision was lower for the OR group ( $66.7 \pm 19.8$ ) than for the UR group ( $81.0 \pm 14.5$ ) ( $P = .031$ ). Conversion to THA was more common in the OR group than in the UR group (30% vs 0%, respectively;  $P = .024$ ). Fifty percent of cases in the OR group, 69.9% in the neutral group, and 75% in the UR group met the minimal clinically important difference for the mHHS ( $\Delta$ ). The latest mHHS value reached the patient acceptable symptomatic state (PASS) in 35% of the cases in the OR group, 53.2% in the neutral group, and 75% in the UR group. Hips in the OR group had a significantly lower chance of reaching the PASS than the UR group (odds ratio, 0.1795 [95% CI, 0.0418-0.7711];  $P = .0209$ ).

**Conclusion**

Cam overresection of more than 5% of the diameter of the femoral head on the Dunn view predicts inferior clinical outcomes compared with cam underresection in this population. Furthermore, overresection predicts inferior outcomes after revision hip arthroscopic surgery and higher rates of conversion to THA.

## **The Importance of Comprehensive Cam Correction: Radiographic Parameters Are Predictive of Patient-Reported Outcome Measures at 2 Years After Hip Arthroscopy**

Drew A. Lansdown, MD, Kyle Kunze, BS, Gift Ukwuani, MD, Brian R. Waterman, MD, Shane J. Nho, MD

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### **Background**

The specific influence of preoperative and postoperative radiographic measurements on patient-reported outcome measures after hip arthroscopy for femoroacetabular impingement (FAI) remains unclear.

### **Purpose**

To investigate the relationship between radiographic measurements and 2-year outcomes after hip arthroscopy for the treatment of FAI.

### **Study Design**

Case series; Level of evidence, 4.

### **Methods**

A clinical registry of patients undergoing primary hip arthroscopy for FAI between January 1, 2012, and December 31, 2014, was queried. Outcome measures included the Hip Outcome Score (HOS) Activities of Daily Living (ADL), HOS Sport-Specific Subscale (SSS), modified Harris Hip Score (mHHS), and visual analog scale (VAS) for pain and satisfaction. Preoperative and postoperative radiographic measurements were recorded. Univariate analysis was conducted to identify relationships between all radiographic and demographic variables and outcome scores. A multivariate regression analysis, controlling for demographic factors, was used to identify independent associations between radiographic measurements on plain radiographs and patient-reported outcomes.

### **Results**

The authors identified 707 patients who underwent primary hip arthroscopic management for FAI who were included for analysis. Two-year outcome surveys were completed for 78% to 84% of patients. The mean age of the patients was  $33.2 \pm 12.3$  years, and 64.4% of the patients ( $n = 456$ ) were female. The mean anteroposterior (AP) alpha angle decreased by  $34.3^\circ$  ( $P < .0001$ ), false profile alpha angle by  $25.2^\circ$  ( $P < .0001$ ), Dunn lateral alpha angle by  $28.9^\circ$  ( $P < .0001$ ), lateral center edge angle by  $2.6^\circ$  ( $P < .0001$ ), and anterior center edge angle by  $3.4^\circ$  ( $P < .0001$ ). The HOS-ADL score increased from  $65.7 \pm 18.7$  preoperatively to  $85.9 \pm 16.7$  postoperatively ( $P < .0001$ ), HOS-SSS increased from  $43.4 \pm 23.1$  to  $72.6 \pm 27.2$  ( $P < .0001$ ), and mHHS increased from  $57.7 \pm 14.0$  to  $79.1 \pm 17.2$  ( $P < .0001$ ). With multivariate analysis, independent predictors of the postoperative HOS-ADL score included the preoperative false profile alpha angle (beta =  $-0.16$ ,  $P = .028$ ). Independent predictors of HOS-SSS score were preoperative AP alpha angle (beta =  $-0.33$ ,  $P = .032$ ) and preoperative false profile alpha angle (beta =  $-0.28$ ,  $P = .041$ ). For the postoperative mHHS score, independent predictors included preoperative AP alpha angle (beta =  $-0.18$ ,  $P = .046$ ), preoperative false profile alpha angle (beta =  $-0.20$ ,  $P = .014$ ), and postoperative false profile alpha angle (beta =  $-0.48$ ,  $P = .035$ ). The preoperative AP alpha angle (beta =  $0.28$ ,  $P = .024$ ) was a significant predictor for the postoperative VAS pain score. The preoperative false profile alpha angle (beta =  $-0.34$ ,  $P = .040$ ) was a significant predictor for the postoperative VAS satisfaction score.

[BACK](#)

**Conclusion**

The authors observed that radiographic measurements, specifically the preoperative false profile alpha angle, AP alpha angle, and postoperative false profile alpha angle, are independent predictors of 2-year clinical outcomes. The femoral-side measurements were the strongest independent predictors of outcomes, especially measurements of the anterior and lateral-based CAM lesion.

## **Primary Circumferential Acetabular Labral Reconstruction: Achieving Outcomes Similar to Primary Labral Repair Despite More Challenging Patient Characteristics**

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### **Background**

Treatment of acetabular labral tears with moderate or severe intrasubstance damage or segmental defects remains a substantial challenge. Circumferential labral reconstruction with iliotibial band allograft is a relatively new technique that has been proposed to restore stability and eliminate high-stress junction points.

### **Purpose**

To compare outcomes between hips treated with primary allograft circumferential labral reconstruction and primary labral repair.

### **Study Design**

Cohort study; Level of evidence, 3.

### **Methods**

All consecutive hips between 2014 and 2015 that underwent primary reconstruction or primary repair by the senior surgeon were included and compared. Hips that had a prior intra-articular procedure were excluded. Patient-reported outcome (PRO) scores and visual analog scales were completed by patients within 1 week before surgery and between 22 and 26 months postoperatively. PROs included the modified Harris Hip Score, the International Hip Outcome Tool, and the 12-Item Short Form Health Survey for physical health. Pain and satisfaction were assessed with visual analog scales. Crude and inverse probability of treatment weighting comparisons of PROs between groups were performed.

### **Results**

A total of 162 hips met the inclusion criteria for this study, including 99 labral repairs and 63 complete labral reconstructions. Patients who underwent labral reconstruction were, on average, older (43.4 vs 29.5 years;  $P < .01$ ), had a slightly higher body mass index (24.6 vs 23.0;  $P < .01$ ), had hips with a higher Tönnis grade (grade 1 or 2: 25% vs 9%;  $P < .01$ ), had higher preoperative pain scores (49.9 vs 41.5;  $P = .01$ ), and had hips with more severe pathology (68% vs 5%;  $P < .01$ ) as compared with patients with labral repair hips. Five (5%) labral repair hips and 5 (8%) labral reconstruction hips failed treatment ( $P = .48$ ). Among hips that did not fail ( $n = 94$  repairs,  $n = 58$  reconstructions), all demonstrated statistically significant improvements in PROs, and there was no statistical difference in PROs between groups after weighting ( $P > .05$ ).

### **Conclusion**

Primary circumferential labral reconstruction is a viable treatment option with promising short-term outcomes for hips that demonstrate moderate or severe labral damage. Despite less favorable preoperative characteristics, labral reconstruction offers similar outcomes when compared with labral repair in hips with less severe pathology.

**Return to Sport and Performance After Hip Arthroscopy for Femoroacetabular Impingement in 18- to 30-Year-Old Athletes: A Cross-sectional Cohort Study of 189 Athletes**

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**Background**

A recent systematic review found that 87% of athletes return to sport after hip surgery for femoroacetabular impingement syndrome. However, the proportion of athletes returning to preinjury sport at their preinjury level of sport is less clear.

**Purpose** The main purpose of this study was to determine the rate of athletes returning to preinjury sport at preinjury level including their associated sports performance after hip arthroscopy for femoroacetabular impingement syndrome. Furthermore, self-reported hip and groin function was investigated.

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

**Methods**

Eligible subjects were identified in the Danish Hip Arthroscopy Registry. A self-reported return to sport questionnaire was used to collect data after hip arthroscopy. If athletes reported they were engaged in preinjury sport at their preinjury level, the associated sports performance and participation were assessed as either (1) optimal sports performance including full sports participation; (2) impaired sports performance, but full sports participation; or (3) impaired sports performance including restricted sports participation. Self-reported hip and groin function was assessed for all athletes by use of the Copenhagen Hip and Groin Outcome Score.

**Results**

The study included 189 athletes (mean  $\pm$  SD age at follow-up, 26.9  $\pm$  3.4 years) at a mean  $\pm$  SD follow-up of 33.1  $\pm$  16.3 months after surgery. At follow-up, 108 athletes (57.1%) were playing preinjury sport at preinjury level, whereas the remaining 81 athletes (42.9%) failed to return to preinjury sport at preinjury level. Of the 108 athletes engaged in their preinjury sport at preinjury level at follow-up, 32 athletes (29.6%) reported optimal sports performance including full sports participation, corresponding to 16.9% of the study sample. Better self-reported hip and groin function was observed in athletes who were engaged in preinjury sport at preinjury level compared with athletes who were not.

**Conclusion**

Fifty-seven percent of athletes returned to preinjury sport at their preinjury level. This is considerably lower than a previously reported return to sport rate of 87% and may reflect that the present study used a clear and strict definition of return to sport. Of note, only one-third of athletes who returned to preinjury sport at preinjury level reported their sports performance to be optimal, corresponding to 16.9% of the study sample. Better self-reported hip and groin function was observed in athletes who were playing preinjury sport at preinjury level compared with athletes who were not.

[BACK](#)

## **Career Length and Performance Among Professional Baseball Players Returning to Play After Hip Arthroscopy**

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### **Background**

Hip arthroscopy has been shown to be effective for management of symptomatic femoroacetabular impingement (FAI) in professional athletes; however, it is unclear how hip arthroscopy affects career length and performance when professional baseball players return to play.

### **Purpose**

To determine the career length, performance, and return-to-play rates of professional baseball players after undergoing arthroscopy for symptomatic FAI.

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

### **Methods**

Forty-four professional baseball players (51 hips) underwent hip arthroscopy for FAI between 2000 and 2015 by a single surgeon. Data were retrieved for each player from MLB.com, MiLB.com, Baseballreference.com, and individual team websites. Age, surgical procedure, and intraoperative findings were also used in analysis. Return to play was defined as playing in a preseason or regular season major or minor league game after arthroscopy. Career length was measured as total years played before and after arthroscopy. Performance measures included earned run average for pitchers, batting average for position players, and games played for all players.

### **Results**

Of the 44 players, there were 21 pitchers and 23 position players. Ninety-five percent ( $n = 42$ ) were able to return to professional baseball after hip arthroscopy. The mean career length for all players was 9.5 years. The mean career length after return to play was 3.6 seasons (range, 1-14 seasons). Pitchers had a mean career length of 8.7 years (3.3 after surgery), and position players averaged a career length of 10 years (3.9 after surgery). There were no differences in performance measures between preinjury and postoperative values.

### **Conclusion**

Professional baseball players undergoing hip arthroscopy for FAI returned to sport and had similar performance as they did before injury. The average career length was 9.5 years. In our study cohort, more pitchers than position players underwent hip arthroscopy. Hip arthroscopy appears to be an effective surgical intervention, allowing for return to play after complete recovery.

[BACK](#)

## High Rate of Return to High-Intensity Interval Training After Arthroscopic Management of Femoroacetabular Impingement Syndrome

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### Background

Since the inception of CrossFit in 2000, the popularity of high-intensity interval training (HIIT) in the United States has risen dramatically. While HIIT is a highly efficient exercise for weight loss and improved conditioning, some literature reports injuries in up to 34% of HIIT participants. We sought to evaluate the functional and sports-specific results of hip arthroscopic surgery in recreational HIIT participants.

### Purpose

To evaluate patients' ability to return to HIIT after hip arthroscopic surgery for femoroacetabular impingement syndrome (FAIS).

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

### Methods

Consecutive patients with FAIS who had identified themselves as participating in HIIT and had undergone hip arthroscopic surgery for the treatment of FAIS by a single fellowship-trained surgeon between 2012 and 2015 were reviewed. Demographic data; preoperative physical examination findings; preoperative imaging results; preoperative patient-reported outcome (PRO) scores including the modified Harris Hip Score (mHHS), Hip Outcome Score–Activities of Daily Living (HOS-ADL), Hip Outcome Score–Sports-Specific Subscale (HOS-SSS), and visual analog scale (VAS) for pain; and postoperative examination and PRO scores at a minimum 2 years after surgery, including a HIIT-specific questionnaire, were assessed for all patients.

### Results

Thirty-two patients (13 male, 19 female) with a mean age of  $34.7 \pm 6.9$  years (range, 21–49 years) were identified with a minimum 24-month follow-up. Among these, 22 participated in CrossFit, 4 in Shred415, 3 in Orangetheory, and 3 in self-directed cross-training including plyometrics. Preoperatively, 14 patients had discontinued HIIT because of activity-related hip complaints, 17 patients had scaled back involvement in HIIT, and 1 patient maintained her baseline routine. Postoperatively, 28 of 32 patients (88%) returned to HIIT at a mean of  $9.8 \pm 5.7$  months after surgery (range, 3–24 months); 96% returned to HIIT at the same level as or better than before the injury. Fear of reinjury was the most common reason for cessation (3/4). Preinjury and postoperative involvement in HIIT were comparable ( $5.3$  vs  $5.1$  h/wk, respectively;  $P = .8$ ). All patients had significant improvements in the HOS-ADL score ( $69.7 \pm 17.3$  to  $94.2 \pm 8.4$ ;  $P < .001$ ), HOS-SSS score ( $49.2 \pm 21.2$  to  $83.3 \pm 21.4$ ;  $P < .001$ ), mHHS score ( $59.9 \pm 14.2$  to  $85.4 \pm 11.6$ ;  $P < .001$ ), and VAS for pain score ( $7.5 \pm 1.8$  to  $1.1 \pm 1.3$ ;  $P < .001$ ) from preoperatively to postoperatively.

**Conclusion** Arthroscopic treatment of FAIS in recreational HIIT participants resulted in significant improvements in hip function and predictably high rates of patient satisfaction. Postoperatively, 88% of patients returned to HIIT, 44% noted improvement from preinjury HIIT performance, and the mean weekly participation was comparable with before the injury.

[BACK](#)

## **Time Required to Achieve Minimal Clinically Important Difference and Substantial Clinical Benefit After Arthroscopic Treatment of Femoroacetabular Impingement**

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### **Background**

Minimal clinically important difference (MCID) defines the minimum degree of quantifiable outcome improvement that a patient perceives as the result of an intervention or in the process of healing. Substantial clinical benefit (SCB) defines the amount of quantifiable outcome improvement that is needed for a patient to feel substantially better. Little is known about when clinically significant outcome improvement is achieved.

### **Purpose**

To investigate the time-dependent nature of MCID and SCB after hip arthroscopy for femoroacetabular impingement (FAI).

**Study Design** Cohort study; Level of evidence, 2.

### **Methods**

An institutional hip preservation registry was queried. The modified Harris Hip Score, Hip Outcome Score, and 33-item International Hip Outcome Tool (iHOT-33) were administered to patients undergoing hip arthroscopy for FAI. Follow-up times for outcome measures were classified into 3 periods: 5 to 11 months (6 months), 12 to 23 months (1 year), and 24 to 35 months (2 years). Cumulative probabilities for achieving MCID and SCB were calculated with Kaplan-Meier survival curve analysis and interval censoring. A Weibull parametric regression analysis evaluated the odds of achieving earlier MCID.

### **Results**

A total of 719 patients undergoing primary hip arthroscopy were included. The mean  $\pm$  SD age was  $32.5 \pm 10.5$  years, and the majority were female ( $n = 380$ , 52.9%). Across all 4 outcome instruments, patients had the highest probability for achieving MCID and SCB by the 6-month postoperative period. The iHOT-33 demonstrated the highest probability for capturing MCID and SCB improvement at each of the 3 periods, with 76.0%, 84.8%, and 93.6% achieving MCID by 6 months, 1 year, and 2 years, respectively. Similarly, the probabilities of achieving SCB on the iHOT-33 were as follows: 57.1%, 68.0%, and 71.7%. A similar trend was demonstrated across other outcome tools. Older male patients and those with Outerbridge classification 1 to 4 (vs grade 0) had a significantly increased risk for taking a longer time to achieve MCID and SCB. Additionally, patients with higher preoperative outcome scores took a longer time to achieve MCID and SCB.

### **Conclusion**

At least half of patients treated with hip arthroscopy for FAI achieve MCID and SCB within the first 6 months after the procedure. However, clinically significant outcome improvement continues to be attained until 2 years postoperatively. Female patients, younger individuals, and those without chondral defects achieve faster clinical outcome improvement. These findings can be helpful for establishing shared decision-making aids and follow-up guidelines for arthroscopic treatment of FAI.

[BACK](#)

## **Patient-Reported Outcomes Within the First Year After Hip Arthroscopy and Rehabilitation for Femoroacetabular Impingement and/or Labral Injury: The Difference Between Getting Better and Getting Back to Normal**

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### **Background**

The Copenhagen Hip and Groin Outcome Score (HAGOS) was recently found valid, reliable, and responsive for patients undergoing hip arthroscopy. However, it is currently unknown to what degree patients undergoing hip arthroscopy improve and/or normalize their HAGOS result within the first year after surgery.

### **Purpose**

First, to use HAGOS to evaluate clinical outcomes at 3, 6, and 12 months after hip arthroscopy for femoroacetabular impingement (FAI) and/or labral injury and compare the HAGOS results with the modified Harris Hip Score (mHHS). Second, to explore how many patients would (a) improve to a degree of minimal clinical importance (MIC) and (b) obtain scores within the reference intervals of healthy controls.

**Study Design** Cohort study; Level of evidence, 2.

### **Methods**

From September 2011 to March 2014, 97 consecutive patients [56 females (mean age, 38 years; range, 17-60 years) and 41 males (mean age, 37 years; range, 19-59 years)] underwent first-time hip arthroscopy for FAI and/or labral injury. Standardized postoperative rehabilitation instructions were provided. HAGOS (0-100 points) and mHHS (0-100 points) values were obtained preoperatively and again postoperatively at 3, 6, and 12 months. Furthermore, 158 healthy controls, matched on age and sex, were included to obtain HAGOS and mHHS reference values for comparison. Minimal important change was determined by using the 0.5 SD of the baseline values for HAGOS and mHHS.

### **Results**

Improvements for all HAGOS subscales and mHHS results were seen at 3 months ( $P < .001$ ). Further improvements were seen only for HAGOS Sport and Recreation (Sport/Rec) and Participation in Physical Activities (PA) subscales between 3 and 12 months ( $P < .05$ ) but not for HAGOS Pain, Symptoms, Activities of Daily Living (ADL), or Hip-Related Quality of Life (QOL) subscales or the mHHS. Furthermore, on HAGOS Sport/Rec, PA, and QOL subscales, patients reached scores of only 54 to 70 points 1 year after surgery. At the individual level, up to 70% of the patients experienced minimal important improvements during the first year after surgery, but only up to 38% and 36% of patients reached a score within the reference interval of HAGOS and mHHS, respectively.

### **Conclusion**

Statistically and clinically relevant improvements in HAGOS and mHHS results after hip arthroscopy and rehabilitation can be seen at 3 months and up to 1 year. However, specific HAGOS subscales suggest that a patient's ability to function and participate in sport and physical activity is still markedly reduced 1 year after surgery. Furthermore, the majority of patients undergoing hip arthroscopy cannot expect to reach the level of the healthy population on self-reported pain and function within the first year after surgery.

[BACK](#)

## **Does Iliopsoas Lengthening Adversely Affect Clinical Outcomes After Hip Arthroscopy? A Multicenter Comparative Study**

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### **Background**

Iliopsoas fractional lengthening (IFL) continues to be a controversial procedure in hip arthroscopy.

### **Hypothesis**

Patients who underwent arthroscopic surgery for femoroacetabular impingement (FAI) and a labral tear either with or without IFL would experience favorable outcomes, and there would be no difference in postoperative patient-reported outcomes (PROs) between the 2 groups at minimum 2-year follow-up.

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

### **Methods**

Data from July 2009 and April 2015 were retrospectively reviewed. Patients were eligible if they had hip arthroscopy for both FAI and labral tear treatment with IFL and without IFL. IFL was indicated for painful internal snapping. Minimum postoperative follow-up was set to 2 years. The authors calculated the modified Harris Hip Score, International Hip Outcome Tool–12, Hip Outcome Score–Activity of Daily Living Score, Hip Outcome Score–Sports Specific Subscale, Non-Arthritic Hip Score, visual analog scale for pain, patient satisfaction, minimal clinically important difference (MCID), and the percentage of patients who achieved patient acceptable symptomatic state (PASS). Revision surgeries and conversions to total hip arthroplasty (THA) were documented.

### **Results**

351 hips (307 patients) met the necessary inclusion criteria in the IFL cohort, with a mean  $\pm$  SD follow-up time of  $42.5 \pm 18.1$  months. For the control cohort, 392 hips (354 patients) were included, with a mean  $\pm$  SD follow-up time of  $43.9 \pm 19.6$  months. Both groups showed significant postoperative improvement in 2-year follow-up PROs. The group with iliopsoas lengthening showed comparable results to the control group with respect to PRO improvement, MCID, PASS, and rates of revision or THA conversion.

### **Conclusion**

This comparative cohort study demonstrated that treatment of painful internal snapping syndrome with arthroscopic IFL, in the setting of FAI and a labral tear, is a safe procedure with good short- to mid-term follow-up results and associated improvement in PROs. Patients who underwent IFL showed similar outcomes compared with a control group treated for FAI and labral tear without IFL. In appropriately selected patients, arthroscopic IFL did not adversely affect clinical outcomes compared with patients who did not need IFL.

## **Comparative Outcomes of Radial and Bucket-Handle Meniscal Tear Repair: A Propensity-Matched Analysis**

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### **Background**

Full-thickness radial meniscal tears render the meniscus nonfunctional and have historically been treated with partial meniscectomy. As preservative techniques evolve for radial repair, comparisons with other tear patterns are necessary to evaluate repair efficacy and prognosis.

### **Purpose**

To assess clinical outcomes and reoperation rates of radial meniscal repair and to compare them to bucket-handle meniscal repair.

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

### **Methods**

Radial and bucket-handle meniscal tears without concurrent root injuries undergoing surgical repair at a single institution between 2007 and 2015 were analyzed, including both all-inside and inside-out suturing techniques. Propensity matching was performed on the basis of age at surgery, sex, meniscus laterality, body mass index (BMI), and concomitant anterior cruciate ligament reconstruction (ACLR) using a comparison pool of 70 bucket-handle repairs. Reoperation-free survival rates and Tegner, visual analog scale (VAS) for pain, and International Knee Documentation Committee (IKDC) scores were analyzed.

### **Results**

Twenty-four patients (18 male, 6 female; mean age,  $22.8 \pm 11.9$  years) who underwent repair of a radial meniscal tear were followed for a mean of 3.5 years (range, 2.0-6.3 years). Significant postoperative improvements in VAS scores at rest and with use and IKDC scores were noted postoperatively ( $P < .001$ ). Five patients (20.8%) required a reoperation. Subsequently, 18 patients with radial tears (mean age,  $19.1 \pm 9.1$  years; 12 male; mean BMI,  $27.0 \pm 6.2$  kg/m<sup>2</sup>; 3 medial; 11 ACLR) were propensity matched to 18 patients with bucket-handle tears (mean age,  $20.8 \pm 5.1$  years; 13 male; mean BMI,  $25.0 \pm 3.5$  kg/m<sup>2</sup>; 3 medial; 11 ACLR). The matched radial and bucket-handle groups demonstrated similar ( $P = .17$ ) reoperation-free survival rates at 2 years (88.9% and 94.4%, respectively) and 5 years (77.8% and 87.7%, respectively). VAS and IKDC scores improved significantly after surgery ( $P < .001$ ), with no difference noted between the groups ( $P \geq .17$ ). Patients with radial and bucket-handle meniscal repairs achieved mean postoperative Tegner scores (6.6 and 6.6, respectively) not significantly different from their preinjury levels (6.9 and 6.7, respectively) ( $P \geq .32$ ).

### **Conclusion**

Satisfactory clinical outcomes are achievable for radial meniscal tear repair at short-term follow-up. In a robustly matched comparison, radial and bucket-handle meniscal tears demonstrate similar improvements in VAS and IKDC scores, restoration of preoperative Tegner scores, and acceptable reoperation rates. Full-thickness radial meniscal tears should be considered for repair.

[BACK](#)

## **Evaluation of Healing After Medial Meniscal Root Repair Using Second-Look Arthroscopy, Clinical, and Radiological Criteria**

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### **Background**

Previous studies have reported various healing rates (0%-100%) as evaluated by second-look arthroscopy after repair of medial meniscal root tears (MMRTs). Such variable results might provoke suspicion of the necessity for repair. Furthermore, the effect of meniscal healing on the clinical outcomes has not been reported.

### **Purpose**

To more precisely determine the healing rate of MMRTs repaired through the transseptal portal, which could provide objective visualization of the healed meniscus, and to identify the effect of meniscal healing on the clinical and radiological outcomes.

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

### **Methods**

Between June 2010 and April 2015, 56 patients underwent pullout suture for MMRT. Lysholm score, Hospital for Special Surgery score, International Knee Documentation Committee subjective score, medial joint space height, and Kellgren-Lawrence (K-L) grade were evaluated. Thirty-three patients underwent second-look arthroscopy and were divided into a “stable healed group” and “unhealed group” according to their healing status, as evaluated through the transseptal portal. The intraoperative, clinical, and radiological outcomes of the 2 groups were compared.

### **Results**

All other clinical outcomes improved. However, medial joint space became significantly narrower ( $P < .001$ ), and 23 patients (41%) showed K-L grade progression. On the basis of second-look arthroscopy, 23 patients (69.7%) were classified into a stable healed group and 10 (30.3%) into an unhealed group. The stable healed group showed a higher Hospital for Special Surgery score ( $P = .023$ ), International Knee Documentation Committee subjective score ( $P = .031$ ), and successful microfracture rate ( $P = .023$ ), with less progression of medial joint space narrowing ( $P < .001$ ) and K-L grade ( $P < .001$ ).

### **Conclusion**

Despite degenerative change progression, clinical outcomes were improved. The successful healing rate was 69.7% after repair of MMRTs. Compared with the unhealed group, the stable healed group showed better clinical outcomes and less degenerative change progression.

# Comparative Matched-Pair Analysis of Open-Wedge High Tibial Osteotomy With Versus Without an Injection of Adipose-Derived Mesenchymal Stem Cells for Varus Knee Osteoarthritis: Clinical and Second-Look Arthroscopic Results

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## Background

High tibial osteotomy (HTO) is reported to be an effective treatment for varus knee osteoarthritis (OA) by redistributing the load line within the knee joint. The cell-based tissue engineering approach using mesenchymal stem cells (MSCs) has addressed the issue of articular cartilage repair in knee OA.

## Purpose

This study aimed to compare the clinical, radiological, and second-look arthroscopic outcomes of open-wedge HTO with versus without an MSC injection and to identify the association between cartilage regeneration and HTO outcomes.

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

## Methods

Among 271 patients treated with HTO for varus knee OA from September 2009 to April 2014, patients treated with HTO alone (conventional group;  $n = 50$ ) were pair-matched with those who underwent HTO with an MSC injection (injection group;  $n = 50$ ) based on sex, age, and lesion size. Clinical outcomes were evaluated using the International Knee Documentation Committee (IKDC) score and Lysholm score. Radiological outcomes evaluated were the femorotibial angle and posterior tibial slope. At second-look arthroscopic surgery, cartilage regeneration was evaluated using the International Cartilage Repair Society (ICRS) grade.

## Results

At the time of second-look arthroscopic surgery (mean, 12.4 months [conventional group] and 12.7 months [injection group]), the mean IKDC and Lysholm scores in each group significantly improved: conventional group, from  $38.4 \pm 9.2$  to  $55.2 \pm 15.0$  and from  $56.7 \pm 12.2$  to  $79.6 \pm 13.5$ , respectively; and injection group, from  $36.5 \pm 4.7$  to  $62.7 \pm 14.1$  and from  $55.7 \pm 11.9$  to  $80.6 \pm 15.6$ , respectively ( $P < .001$  for all). Clinical outcomes at final follow-up (mean, 38.8 months [conventional group] and 37.2 months [injection group]) further improved from  $62.7 \pm 14.1$  to  $64.8 \pm 13.4$  (IKDC) and from  $80.6 \pm 15.6$  to  $84.7 \pm 16.1$  (Lysholm) ( $P < .001$  and  $P = .034$ , respectively) only in the injection group when compared with the values at second-look arthroscopic surgery. At final follow-up, there was a significant difference in the mean IKDC and Lysholm scores between groups ( $P = .049$  and  $P = .041$ , respectively). Overall ICRS grades, which significantly correlated with clinical outcomes, were better in the injection group than in the conventional group. Radiological outcomes at final follow-up showed improved knee joint alignment relative to patients' preoperative conditions but showed no significant correlation with clinical outcomes or ICRS grade in either group ( $P > .05$  for all).

## Conclusion

The group that received an MSC injection scored better on the IKDC and Lysholm scales at final follow-up than the group that did not, although these differences were relatively small. When performing HTO for patients with varus knee OA, an MSC injection should be considered as an additional procedure for improved cartilage regeneration with better clinical outcomes.

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## **Return to Play After Hip Arthroscopy: A Systematic Review and Meta-analysis**

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### **Background**

The use of arthroscopic treatment for intra-articular hip pathology has demonstrated improved patient-reported outcomes (PROs) with a lower rate of complications, reoperation, and patient morbidity as compared with traditional methods. Although the use of this minimally invasive approach has increased in prevalence, no evidence-based return-to-play (RTP) criteria have been developed to ensure an athlete's preparedness for sporting activities.

### **Purpose**

To determine if there exists sufficient evidence in the literature to support an RTP protocol and functional assessment after hip arthroscopy, as well as to assess the mean rate and duration of RTP.

### **Study Design**

Systematic review and meta-analysis.

### **Methods**

The search terms "hip arthroscopy," "return to play," and 10 related terms were searched in PubMed, Cochrane Library, Scopus, and Web of Science, yielding 263 articles. After screening, 22 articles were included. RTP timeline, rehabilitation protocols, and conditional criteria measures were assessed with previously established criteria. Pooled estimates were calculated for RTP rate and duration, and weighted mean scores were determined for PROs.

### **Results**

A total of 1296 patients with 1442 total hips were identified. Although 54.5% (12 of 22) of studies did not provide a guideline for RTP duration after hip arthroscopy, 36.4% (8 of 22) recommended a duration of 4 months, while 9.1% (2 of 22) recommended 3 months. The most frequently described postoperative rehabilitation protocols were weightbearing guidelines (15 studies) and passive motion exercises (9 studies). Only 2 studies satisfied the criteria for a sufficient RTP protocol, and 3 provided a specific replicable test for RTP. The mean RTP duration was 7.4 months (95% CI, 6.1-8.8 months), and the return rate was 84.6% (95% CI, 80.4%-88.8%;  $P = .008$ ) at a mean  $\pm$  SD follow-up of  $25.8 \pm 2.4$  months. Mean modified Harris Hip Score (mHHS) improved from 63.1 to 84.1 postoperatively (+33.3%), while Non-arthritic Hip Score improved from 61.7 to 86.8 (+40.7%). A lower preoperative mHHS was significantly associated with a higher postoperative improvement ( $r = -0.95$ ,  $P = .0003$ ).

### **Conclusion**

Significant variability exists in RTP protocols among institutions owing to a lack of standardization. Despite a high overall rate of RTP and improvement in PROs after hip arthroscopy, the majority of rehabilitation protocols are not evidence based and rely on expert opinion. No validated functional test currently exists to assess RTP.

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