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BACK

# Upper extremity

Arthroscopy, Volume 40, Issue 5

## Higher Upper Subscapularis Goutallier Grade and Coracohumeral Distance Narrowing Are Predictive of Subscapularis Tears in Patients Undergoing Arthroscopic Rotator Cuff Repair

A.I. Kilic, J. Ardebol

DOI: https://doi.org/10.1016/j.arthro.2023.10.017

**Purpose:** To evaluate the relation between subscapularis (SSC) Goutallier grade or coracohumeral distance (CHD) and SSC tears, as well as the relation between these radiographic variables and long head of the biceps tendon lesions.

**Methods:** A retrospective analysis was conducted on prospectively maintained data on patients who underwent arthroscopic rotator cuff repair of SSC tears between 2011 and 2021 with at least 6 months of follow-up. Patients with identified subscapularis tears during arthroscopy were included. A control group was established by randomly selecting patients without SSC tears from the same study period. Goutallier grading and CHD were obtained from preoperative magnetic resonance imaging (MRI) scans. Receiver operating characteristic analysis was conducted to define optimal cutoff values for these diagnostic measures.

**Results:** The study included 735 patients with SSC tears and 249 patients in the control group. Comparing subscapularis tear and intact groups' Goutallier grades revealed significant differences in infraspinatus, upper and lower SSC, and overall SSC ($P < .001$). No significant difference was detected in supraspinatus Goutallier grade ($P = .364$). An SSC tear was observed in 58.3% (n = 265) of patients with Goutallier grade 0 of the upper SSC, 77.1% (n = 195) of patients with grade 1 changes, 98.7% (n = 155) with grade 2 changes, and 100% of grade 3 or 4 changes. Goutallier grade of the upper SSC showed a significant correlation with tear size ($r_s = 0.533$; $P < .01$). CHD measurements were lower in individuals with SSC tears compared to those without tears (6.6 ± 1.7 vs 9.6 ± 1.8; $P < .001$). Upper SSC Goutallier grade >1 had an acceptable area under the curve (AUC) of 0.742. CHD of 7.96 mm or less had an excellent predictive AUC of 0.879.

**Conclusion:** Higher Goutallier grade and CHD narrowing are potential associations predictive of SSC tears. Routine MRI assessment of muscle of the upper SSC and the CHD can contribute to the diagnostic accuracy of SSC tears and offer valuable information regarding the severity of such tears.

**Level of Evidence:** Level III, diagnostic study.

BACK

**Intravenous Tranexamic Acid Improves Visual Clarity During Synovectomy in Patients Undergoing Arthroscopic Rotator Cuff Repair: A Double-Blind, Randomized Controlled Study**

H.J. Shin, H.S. You

DOI: https://doi.org/10.1016/j.arthro.2023.10.019

**Purpose:** To assess the effects of intravenous tranexamic acid (TXA) on visual clarity at various surgical stages and the correlation between the severity of synovitis and bursitis and the grade of visual clarity in patients undergoing arthroscopic shoulder surgery under an interscalene brachial plexus block.

**Methods:** This double-blind, randomized controlled study included patients undergoing arthroscopic rotator cuff repair. The TXA group underwent injection of a 100-mL mixture of 1,000 mg of TXA and normal saline solution intravenously whereas the control group was administered the same volume of normal saline solution at 10 minutes preoperatively. Visual clarity was rated according to a 3-grade visual clarity scoring system from grade 1 (clear) to grade 3 (poor) at 4 surgical stages (I, intra-articular soft-tissue procedures including synovectomy; II, acromioplasty; III, bursectomy; and IV, greater tuberoplasty). The primary outcome was arthroscopic visual clarity. The secondary outcomes were medications administered for hemodynamic stability, length of hospital stay, and thromboembolic events.

**Results:** Altogether, 63 patients were included in the study; they were divided into the TXA group, comprising 32 patients, and the control group, comprising 31 patients. The TXA group showed significantly better visual clarity than the control group (median [interquartile range], 1 [1-2] vs 2 [1-2]; $P = .027$) during stage I but not during stages II through IV. Spearman correlation analysis revealed a significant correlation between synovitis and visual clarity grade during synovectomy (correlation coefficient, 0.393; $P = .001$) but not between bursitis and visual clarity grade during bursectomy. Deep vein thrombosis and pulmonary embolism did not occur in either group.

**Conclusion:** Intravenous TXA can improve visual clarity during intra-articular soft-tissue procedures, including synovectomy. However, it does not have a significant effect during acromioplasty, bursectomy, and greater tuberoplasty. TXA can be used to improve visual clarity in patients with suspected severe synovitis.

**Level of Evidence:** Level I, randomized controlled trial.

BACK

**Arthroscopic Labral Reconstruction With a Modified Inferior Capsular Shift Allows Return to Sport and Excellent Outcomes in Contact and Noncontact Athletes With Anterior Shoulder Instability at Minimum 5-Year Follow-Up**

K.D. Plancher, K.K. Briggs

DOI: https://doi.org/10.1016/j.arthro.2023.10.020

**Purpose:** To compare return to sport, functional outcomes, recurrence of instability, and osteoarthritis (OA) between collision/contact and limited/noncontact athletes following arthroscopic labral reconstruction with a modified inferior capsular shift for anterior shoulder instability.

**Methods:** Athletes underwent an arthroscopic labral reconstruction with a modified inferior capsular shift by the senior author between 1999 and 2018. Inclusion criteria were labral stripping from 12 (just beyond the biceps anchor) to 6 o'clock, less than 20% glenoid bone loss, active sports participation, and no previous surgery. Athletes were divided into collision/contact and limited/noncontact groups. Outcome measures, physical examination, and radiographic evaluation were collected at a minimum 5-year follow-up. Reoperations or any subjective laxity were considered failures. Radiographs were analyzed for OA using the Samilson-Prieto Radiological Classification.

**Results:** Ninety-two patients underwent arthroscopic labral reconstruction with a modified inferior capsular shift. Sixty-four met the inclusion criteria. Thirty-eight (age = 26.0 ± 8.0 years) participated in at least 1 collision/contact sport, and 26 (age = 38.0 ± 9.0 years) participated in limited/noncontact sports. Two (5%) collision/contact and 3 (12%) limited/noncontact athletes had traumatic reinjury requiring revision surgery. Of the remaining athletes (59/64), minimum 5-year follow-up was obtained on 54 (92%), with a mean follow-up of 12 ± 4 years (range 5-23 years). All athletes returned to their original sport at the same level. There was no significant difference between collision/contact and limited/noncontact athletes in timing of return to sports (5.2 ± 1.9 and 6.0 ± 3.1 months, respectively; $P$ = .389). There were no significant differences between groups on any outcomes scores.

**Conclusion:** Arthroscopic labral reconstruction with a modified inferior capsular shift addressed anterior instability with return to sport for both collision/contact and limited/noncontact athletes with excellent functional and clinical outcomes, full shoulder range of motion, and a low prevalence of advanced OA at minimum 5-year follow-up. This modified technique resulted in a low failure rate in both limited/noncontact and collision/contact athletes.

**Level of Evidence:** Level III, retrospective case control study.

BACK

**Arthroscopic Repair of Retracted Large and Massive Rotator Cuff Tears With and Without Augmentation With a Bio-Inductive Collagen Implant Reveals Substantial and Comparable Clinical Improvement**

T. Zhang, A. Ajayi

DOI: https://doi.org/10.1016/j.arthro.2023.10.024

**Purpose:** To compare clinical and imaging results after repair of retracted large and massive full-thickness rotator cuff tears, including revision repairs, with and without augmentation with a bio-inductive collagen implant.

**Methods:** The study group comprised 24 patients (17 male subjects) with retracted 2 or 3 tendon rotator cuff tears undergoing arthroscopic repair followed by onlay augmentation with a bio-inductive collagen implant. The control group comprised 24 patients (19 male subjects) matched by tear size undergoing repair without augmentation. Mean patient age at repair in both groups was 61 years. Active range of motion and patient-reported outcomes were recorded before and after surgery. Noncontrast high-field magnetic resonance imaging was obtained in 20 of 24 collagen implant patients and 17 of 24 control patients at minimum 6 months' follow-up to assess tendon healing.

**Results:** American Shoulder and Elbow Surgeons and Simple Shoulder Test scores improved from 35 to 86 and 3.6 to 9.3, respectively, in the collagen implant group and from 39 to 87 and 3.9 to 9.7 in the control group. The visual analog score–pain improved from 6.0 to 0.9 and from 5.9 to 0.9 in the collagen implant and control groups, respectively ($P < .001$ for all). Overall improvements in range of motion and patient-reported outcomes were similar in both groups. Magnetic resonance imaging revealed intact repairs in 11 of 20 (55%) patients in the patch group and 9 of 17 (53%) in the control group. Two patients in each group were revised to reverse shoulder arthroplasty.

**Conclusion:** Arthroscopic repair of retracted large and massive rotator cuff tears, including revision repairs, with and without augmentation using a bio-inductive collagen implant results in substantial and comparable early clinical improvement, although predictable healing remains elusive. Further work is needed to optimize patient selection for massive rotator cuff repair and define more precisely the indications for augmentation of these repairs using the collagen implant.

**Level of Evidence:** Level III, retrospective cohort study.

BACK

**Preoperative Patient-Reported Outcomes Predict Postoperative Clinical Outcomes Following Rotator Cuff Repair**

J.R. martin, P. Castaneda

DOI: https://doi.org/10.1016/j.arthro.2023.10.008

**Purpose:** To determine whether preoperative patient-reported outcomes (PROs) predict postoperative PROs and satisfaction following rotator cuff repair.

**Methods:** We retrospectively identified patients who underwent a primary rotator cuff repair at a single institution. A receiver operating characteristics analysis was used to reach a preoperative American Shoulder and Elbow Surgeons (ASES) score threshold predictive of postoperative ASES and satisfaction scores. We evaluated patients above and below the receiver operating characteristics threshold by comparing their final ASES scores, ASES change (Δ) from baseline, percent maximum outcome improvement, and achievement of minimum clinically important differences, substantial clinical benefit (SCB), and patient-acceptable symptom state (PASS). Fischer exact tests were used to analyze categorical data, and continuous data were analyzed using *t*-test.

**Results:** A total of 348 patients who underwent rotator cuff repair were included in this study. The preoperative ASES value predictive of achieving SCB was 63 (area under the curve, 0.75; 95% confidence interval: 58-67; $P < .001$). Patients with preoperative ASES *less* than 63 were significantly more likely to achieve MCID (odds ratio [OR]: 4.7, $P < .001$) and SCB (OR:6.1, $P < .001$) and had significantly higher percent maximum outcome improvement (63% vs 41%; $P = 0.003$) and Δ ASES scores (36 vs 12; $P < .001$). However, patients with preoperative ASES scores *above* 63 had significantly higher final ASES scores (86 vs 79; $P = .003$), were more likely to achieve PASS (59% vs 48%; $P = .045$), and had higher satisfaction scores (7.4 vs 6.7; $P = .024$).

**Conclusion:** Patients with high preoperative ASES scores achieve less relative improvement; however, these patients may be more likely to achieve PASS and may have higher satisfaction scores postoperatively.

**Level of Evidence:** Level III, retrospective comparative prognostic trial.

BACK

**Bone Marrow Stimulation Does Not Lead to Lower Retear Rates, Better Functional Outcomes, or Higher Complication Rates at Short-Term Follow-Up for Arthroscopic Rotator Cuff Repair: A Meta-analysis of Randomized Controlled Trials**

L. Pang, L. Yao

DOI: https://doi.org/10.1016/j.arthro.2023.10.025

**Purpose:** To determine the effect of bone marrow stimulation (BMS) on retear rates, functional outcomes, and complication rates in patients who underwent arthroscopic rotator cuff repair (RCR) through a meta-analysis of randomized controlled trials.

**Methods:** PubMed, EMBASE, Web of Science, and The Cochrane Library were searched on March 25, 2023. Two evaluators independently screened the literature, extracted data, and assessed the methodologic quality of the enrolled studies. Meta-analysis was conducted using RevMan software, version 5.4.

**Results:** A total of 7 randomized controlled trials with 638 patients were included. The evaluation of rotator cuff tendon integrity was conducted using distinct imaging modalities. Specifically, 259 patients underwent magnetic resonance imaging whereas 208 patients underwent ultrasound. Additionally, a subset of 95 patients underwent either of these modalities; however, the precise distribution between these 2 modalities was not explicitly delineated. Compared with RCR alone, RCR combined with BMS provided similar retear rates ($P$ = .51, $I^2$ = 46%), Constant-Murley scores ($P$ = .14, $I^2$ = 0%), American Shoulder and Elbow Surgeons (standardized shoulder assessment form) scores ($P$ = .56, $I^2$ = 0%), Western Ontario Rotator Cuff Index scores ($P$ = .20, $I^2$ = 0%), visual analog scale scores ($P$ = .19, $I^2$ = 0%), forward flexion ($P$ = .18, $I^2$ = 0%), external rotation ($P$ = .62, $I^2$ = 0%), severe complication rates ($P$ = .56, $I^2$ = 0%), and mild complication rates ($P$ = .10, $I^2$ = 0%).

**Conclusion:** Compared with the outcomes observed after isolated arthroscopic RCR, arthroscopic RCR with BMS showed comparable results in terms of retear rate, functional outcomes, and incidence of complications.

**Level of Evidence:** Level II, meta-analysis of Level I and II studies.

BACK

Journal of Shoulder and Elbow Surgery (JSES), Volume 33, issue 5

**Correlation analysis of the histological degeneration in a torn supraspinatus tendon with the clinical findings in arthroscopic rotator cuff repair**

T. Tokunaga, T. Karasugi

DOI: https://doi.org/10.1016/j.jse.2024.01.008

Retear after arthroscopic rotator cuff repair (ARCR) is not rare, and prognostic factors include tear size and fatty infiltration of the rotator cuff (RC) muscle. We have previously demonstrated that severe histological degeneration of the torn supraspinatus tendon on Bonar scoring is a predictor of post-ARCR retear. However, the factors associated with the histological findings of torn supraspinatus tendons remain unclear. Herein, we aimed to identify the clinical factors that correlate with the degree of histological degeneration in the tendon stump of patients undergoing ARCR for full-thickness tears.

BACK

**Patient-reported allergies are associated with increased rate of postoperative stiffness after arthroscopic rotator cuff repair**

A.M. Morgan, Z.I. Li

DOI: https://doi.org/10.1016/j.jse.2023.09.006

**Background:** Several risk factors have been identified for the development of postoperative shoulder stiffness, and there has been increasing interest in orthopedic literature regarding patient-reported allergy (PRA) as an identifiable risk factor for adverse outcomes. The purpose of this study is to determine whether PRAs are associated with subsequent rates of diagnosis of adhesive capsulitis (AC) or return to the operating room for postoperative shoulder stiffness within 2 years after arthroscopic rotator cuff repair (ARCR).

**Methods:** Current Procedural Terminology surgical billing codes were used to retrospectively identify patients who underwent ARCR at a single urban academic institution from January 2012 to December 2020 with minimum 2-year follow-up. Lysis of adhesions (LOA), manipulation under anesthesia (MUA), and AC of the shoulder were further queried within 2 years postoperatively for the ipsilateral shoulder. Patients were excluded if they had undergone ipsilateral MUA/LOA or received a diagnosis of AC before the index procedure. Demographic characteristics and medical comorbidities (hypertension, diabetes, hyperlipidemia, and hypothyroidism) were extracted from electronic medical records. Baseline characteristics were compared between patients with and without PRAs. Multivariate logistic regression analyses were performed to determine the association of the presence of PRAs overall, as well as the presence of 1, 2, or 3 or more PRAs, with subsequent MUA/LOA or diagnosis of AC within 2 years postoperatively.

**Results:** Of 7057 patients identified in the study period, 6583 were eligible for the final analysis. The mean age was 56.6 ± 11.7 years, and the mean body mass index was 29.1 ± 5.6. Overall, 19.3% of patients (n = 1271) reported at least 1 allergy, and 7.1% (n = 469) had >1 PRA. A total of 44 patients (0.7%) underwent subsequent ipsilateral MUA/LOA within 2 years postoperatively, whereas 93 patients (1.4%) received a diagnosis of ipsilateral AC in the same time frame. PRAs were significantly associated with subsequent diagnosis of AC (odds ratio [OR]: 2.39; 95% confidence interval [CI]: 1.45-3.92; P < .001), but not MUA/LOA (OR: 1.97, 95% CI: 1.26-3.61; P = .133). Patients with 2 PRAs had greater odds of being diagnosed with AC than patients with 1 PRA (OR: 2.74; 95% CI: 1.14-5.99; P = .012). Although this association was nonsignificant for MUA/LOA, patients with 2 PRAs (OR: 2.67; 95% CI: 0.96-8.80; P = .059) demonstrated a similar statistical trend.

**Conclusion:** PRAs are associated with increased odds of receiving a diagnosis of AC within 2 years after ARCR but were not found to be associated with return to the operating room for postoperative stiffness.

**Level of evidence**: Level III, Retrospective Cohort Comparison.

BACK

**Increased patient resilience scores are related to positive postoperative outcomes in rotator cuff repairs**

K.A. Petrie, N.A. Lowenstein

DOI: https://doi.org/10.1016/j.jse.2023.09.016

**Hypothesis:** We sought to determine whether patients' preoperative resilience scores predict postoperative outcomes in arthroscopic rotator cuff repair surgery.

**Methods:** Patients were prospectively enrolled and underwent data collection preoperatively and at 3, 6, 12, and 24 months postoperatively. Data collected included demographic characteristics and the Brief Resilience Scale (BRS) score, visual analog scale score, Veterans RAND 12-Item Health Survey scores (mental component [VR-12M] and physical component [VR-12P]), American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form score, Single Assessment Numeric Evaluation score, and Simple Shoulder Test (SST) score.

**Results:** In total, 131 patients had complete 1- or 2-year postoperative outcome measures. Female patients comprised 56.5% of our sample, and the average age was 57.6 years. Between the low, normal, and high resilience groups, there were significant differences in the VR-12M scores at 0, 12, and 24 months postoperatively ($P < .01$ for all). The VR-12P scores at 12 months were 44.2, 47.4, and 49.8 in the low, normal, and high resilience groups, respectively, showing a trend upward, but this failed to reach the level of significance ($P = .08$). The SST scores of the low, normal, and high resilience groups at 12 months were 69.1, 79.9, and 85.1, respectively, again showing a trend upward, but this failed to reach the level of significance ($P = .07$). The SST scores at 0 and 24 months did not differ between groups. There were no significant differences in American Shoulder and Elbow Surgeons, visual analog scale, and Single Assessment Numeric Evaluation scores at 0, 12, or 24 months postoperatively. We found a significant positive correlation between the BRS score and SST score at 12 months ($R = 0.18$), VR-12M score at 12 months ($R = 0.38$), VR-12M score at 24 months ($R = 0.31$), and VR-12P score at 12 months ($R = 0.21$).

**Conclusion**: Our study provides evidence that BRS scores in patients undergoing arthroscopic rotator cuff repair are related to postoperative outcomes, measured through the VR-12M and SST scores at 2-year follow-up.

**Level of evidence:** Level II, Prospective Cohort Comparison, Prognosis Study.

BACK

Knee Surgery, Sports Traumatology, Arthroscopy (KSSTA), Volume 32, Issue 5

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American Journal of Sports Medicine (AJSM), Volume 52, Issue 6

# Leukocyte-Poor Platelet-Rich Plasma as an Adjuvant to Arthroscopic Rotator Cuff Repair Reduces the Retear Rate But Does Not Improve Functional Outcomes: A Double-Blind Randomized Controlled Trial

L.A. Rossi, T.D. Gorodischer

DOI: https://doi.org/10.1177/03635465241239062

**Background**: Whether the use of PRP as an adjuvant of rotator cuff repairs leads to improved tendon healing and better functional outcomes remains unclear in clinical evidence.

**Purpose**: The main purpose of this study was to assess whether the use of leukocyte-poor platelet-rich plasma (LP-PRP) as an adjuvant to arthroscopic rotator cuff repair (ARCR) decreases the rate of retears compared with a control group. The secondary objective was to analyze whether LP-PRP improves patient-reported outcomes.

**Study Design**: Randomized controlled trial; Level of evidence, 1.

**Methods**: This was a double-blind randomized controlled trial at a single center. A consecutive series of 96 patients with rotator cuff tears <3 cm were enrolled and randomly allocated to the control group (double-row suture-bridge ARCR alone [n = 48]) and the PRP group (double-row suture-bridge repair, followed by 1 LP-PRP injection during surgery [n = 48]). The visual analog scale (VAS) for pain, the American Shoulder and Elbow Surgeons (ASES) score, the Single Assessment Numeric Evaluation (SANE), and the Pittsburgh Sleep Quality Index (PSQI) were administered preoperatively and at 6- and 12-month follow-up. Magnetic resonance imaging (MRI) was performed to evaluate tendon integrity at 6-month follow-up. Both patients and assessors were blinded to the intervention received during surgery.

**Results**: The mean patient age was 56.1 ± 2.98 years. Of the 96 patients, 90 had MRI performed at 6 months after surgery (94% radiological follow-up). The retear rate in the PRP group was 15.2% (7/46 [95% CI, 6%-28%]), which was lower than that in the control group of 34.1% (15/44 [95% CI, 20%-49%]) (P = .037). Therefore, the risk ratio of ruptures in patients exposed to LP-PRP was 0.44 (95% CI, 0.2-0.9; P = .037). Overall, the ASES, VAS, SANE, and PSQI scores showed a statistical improvement after surgery (P < .001). There were no significant differences in functional scores between the groups. Most of the patients exceeded the minimal clinically important difference for the ASES, SANE, and VAS without significant differences between the groups.

**Conclusion**: In patients with rotator cuff tears <3 cm undergoing double-row suture-bridge repair, a 5-mL dose of LP-PRP injected at the tendon-bone interface significantly reduced the retear rate. However, the use of LP-PRP in terms of postoperative pain and patient-reported outcomes failed to show clinically meaningful effects.

BACK

**Are Lower Passive Anterior Elevation and External Rotation at 6 Weeks Postoperatively Associated With Healing of Isolated Arthroscopic Supraspinatus Repairs?**

P. Collin, T. Martinho

DOI: https://doi.org/10.1177/03635465241241549

**Background**: Despite advancements in surgical technique, failure of tendon healing remains a common problem after arthroscopic rotator cuff repair (ARCR).

**Purpose**: The purpose of this study was to examine the relationship between range of motion (ROM) recovery and healing after ARCR. It was hypothesized that an early loss of ROM would be associated with tendon healing.

**Study Design**: Case-control study; Level of evidence, 3.

**Methods**: This was a retrospective comparative study of primary ARCR of isolated full-thickness supraspinatus (SSN) tendon tears. Cases were retrieved from a prospective rotator cuff repair database and divided into 2 groups based on healing (healed/nonhealed). A standardized clinical evaluation was performed before and at 6 weeks, 3 months, and 6 months after surgery. Collected data included passive and active ROM, visual analog scale for pain, and Constant score. Healing was assessed by ultrasound at 6 months.

**Results**: Of 1397 eligible ARCRs, 1207 were included. The healing rate was 86.7%. Age was higher in the nonhealed group (57.8 ± 7.9 years vs 61.6 ± 8.8 years; $P < .001$). Patients with healed repairs had a larger decrease in passive anterior elevation (AE) from the preoperative to the 6-week postoperative visit (–31°± 28° vs −18°± 26°; $P < .001$), followed by a more substantial increase throughout the remaining follow-up period (32°± 23° vs 18°± 21°; $P < .001$). At 6 months postoperatively, there was no difference in AE between groups (159°± 17° vs 161°± 14°; $P > .999$). External rotation elbow at side (ER1) and internal rotation hand in the back (IR1) followed similar courses of recovery. Passive and active ROM had a strong positive correlation at each follow-up. Age (odds ratio [OR], 1.79; 95% CI, 1.45-2.23; $P < .001$) and 6-week passive AE (OR, 1.33; 95% CI, 1.20-1.48; $P < .001$) and ER1 (OR, 1.15; 95% CI, 1.03-1.29; $P = .017$) were predictors for nonhealing.

**Conclusion**: Lower passive AE and ER1 at 6 weeks postoperatively and younger age are associated with healing after ARCR of isolated SSN tendon tears. At 6 months postoperatively, there were no differences in ROM, regardless of tendon healing.

BACK

**Effect of Porcine-Derived Absorbable Patch-Type Atelocollagen for Arthroscopic Rotator Cuff Repair: A Prospective Randomized Controlled Trial**

H. Kim, Y.-S. Cho

DOI: https://doi.org/10.1177/03635465241238982

**Background**: Even though arthroscopic rotator cuff repair is recognized as a standard treatment option, the risk of postoperative retear is a major concern.

**Purpose**: To evaluate the effect of porcine-derived absorbable patch-type atelocollagen during arthroscopic rotator cuff repair.

**Study Design**: Randomized controlled trial; Level of evidence, 1.

**Methods**: A total of 64 patients with rotator cuff tears diagnosed on magnetic resonance imaging (MRI) were enrolled prospectively from November 2020 to December 2021. Both groups had repairs using the suture bridge technique. For the atelocollagen group, before securing the lateral anchors, we inserted porcine-derived absorbable patch-type atelocollagen between the footprint and the tendon. On postoperative day 2, the patients underwent MRI to confirm containment of the patch-type atelocollagen. At 6 months and 1 year postoperatively, the signal intensity of the repaired tendon was assessed using MRI. Patients were evaluated using the Constant score as the primary outcome, along with the visual analog scale for pain; range of motion; American Shoulder and Elbow Surgeons score; University of California, Los Angeles, score; and Korean Shoulder Score preoperatively and at 2, 3, 6, and 12 months postoperatively.

**Results**: No significant changes in the Constant score as primary outcome, pain or other functional scores, and range of motion were observed between the groups at 1 year postoperatively. The patch-type atelocollagen was confirmed to be contained by the time-zero MRI scan taken 2 days postoperatively. Among the 55 patients included in final analysis, 12 retear cases were recorded (21.8% retear rate). A significantly lower retear rate was found in the atelocollagen group, as 3 cases were observed in this group (10.3%) and 9 cases were observed in the conventional repair group (34.6%) (P = .048).

**Conclusion**: The Constant score was not different between the groups. The retear rate after rotator cuff repair was significantly lower in the group that received porcine-derived absorbable patch-type atelocollagen compared with in the conventional group.

BACK

**Minimum 5-Year Clinical and Return-to-Sport Outcomes After Primary Arthroscopic Scapulothoracic Bursectomy and Partial Scapulectomy for Snapping Scapula Syndrome**

M.-C. Rupp, A.R. Geissbuhler

DOI: https://doi.org/10.1177/03635465241243072

**Background**: Snapping scapula syndrome (SSS) is a rare condition that is oftentimes debilitating. For patients whose symptoms are resistant to nonoperative treatment, arthroscopic surgery may offer relief. Because of the rarity of SSS, reports of clinical outcomes after arthroscopic SSS surgery are primarily limited to small case series and short-term follow-up studies.

**Purpose**: To report minimum 5-year clinical and sport-specific outcomes after arthroscopic bursectomy and partial scapulectomy for SSS and to identify demographic and clinical factors at baseline associated with clinical outcomes at minimum 5-year follow-up.

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

**Methods**: Patients who underwent arthroscopic bursectomy and partial scapulectomy for SSS between October 2005 and February 2016 with a minimum of 5 years of postoperative follow-up were enrolled in this single-center study. Clinical outcome scores, including the 12-Item Short Form Health Survey (SF-12), American Shoulder and Elbow Surgeons (ASES) Shoulder Score, shortened version of the Disabilities of the Arm, Shoulder and Hand (QuickDASH) score, Single Assessment Numeric Evaluation (SANE), and visual analog scale (VAS) score for pain, were collected at a minimum 5-year follow-up. Additionally, it was determined which patients reached the minimal clinically important difference. Bivariate analysis was used to determine whether baseline demographic and clinical factors had any association with the outcome scores.

**Results**: Of 81 patients eligible for inclusion in the study, follow-up was obtained for 66 patients (age 33.6 ± 13.3 years; 31 female). At a mean follow-up of 8.9 ± 2.5 years (range, 5.0-15.4 years), all of the outcome scores significantly improved compared with baseline. These included the ASES (from 56.7 ± 14.5 at baseline to 87.2 ± 13.9 at follow-up; $P < .001$), QuickDASH (from 38.7 ± 17.6 to 13.1 ± 14.6; $P < .001$), SANE (from 52.4 ± 21.2 to 82.7 ± 19.9; $P < .001$), SF-12 Physical Component Summary (from 39.7 ± 8.3 to 50.3 ± 8.2; $P < .001$), SF-12 Mental Component Summary (from 48.2 ± 11.7 to 52.0 ± 9.0; $P = 0.014$) and VAS pain (from 5.2 ± 2.1 to 1.4 ± 2.0; $P < .001$). The minimal clinically important difference in the ASES score was reached by 77.6% of the patients. Median postoperative satisfaction was 8 out of 10. It was found that 90.5% of the patients returned to sport, with 73.8% of the patients able to return to their preinjury level. At the time of final follow-up, 8 (12.1%) patients had undergone revision surgery for recurrent SSS symptoms. Older age at surgery ($P = .044$), lower preoperative SF-12 Mental Component Summary score ($P = .008$), lower preoperative ASES score ($P = .019$), and increased preoperative VAS pain score ($P = .016$) were significantly associated with not achieving a Patient Acceptable Symptom State on the ASES score.

**Conclusion**: Patients undergoing arthroscopic bursectomy and partial scapulectomy for SSS experienced clinically significant improvements in functional scores, pain, and quality of life, which were sustained at a minimum of 5 years and a mean follow-up of 8.9 years postoperatively. Higher patient age, inferior mental health status, increased shoulder pain, and lower ASES scores at baseline were significantly associated with worse postoperative outcomes.

BACK

**Comparison of Return to Sports and Competition After the Arthroscopic Bristow-Latarjet Procedure Versus Arthroscopic Bankart Repair in Adolescents With Recurrent Anterior Shoulder Instability**

O. Rosello, H. Barret

DOI: https://doi.org/10.1177/03635465241245608

**Background**: The use of isolated soft tissue repair versus bone block stabilization for the treatment of recurrent anterior shoulder instability in adolescents has no scientific evidence.

**Purpose**: To compare the clinical outcomes of adolescent patients who underwent isolated arthroscopic Bankart (iB) repair with those who underwent the arthroscopic Bristow-Latarjet procedure in addition to Bankart (BLB) repair.

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

**Methods**: A total of 60 shoulders in adolescents (aged 13-18 years) were reviewed with a minimum 2 years' follow-up: iB repair (n = 36) and arthroscopic Bankart repair with an additional Bristow-Latarjet procedure (BLB; n = 24). The characteristics of the patients in each group in terms of age at the first instability episode, age at surgery, hyperlaxity, participation in at-risk sports, and Instability Severity Index Score were comparable. The mean follow-up was longer in the iB group (7.7 vs 4.1 years, respectively), whereas the rates of patients engaged in competition and those with glenoid lesions were higher in the BLB group. The primary outcome measures were failure, defined as the recurrence of instability (clinical dislocation or subluxation), and return to sports. The mean follow-up was 6.2 years (range, 2-16 years).

**Results**: At the last follow-up, the rate of recurrence was significantly higher in the iB group, with 22% (8/36) failures, than in the BLB group, with 8% (2/24) instability recurrences ($P < .05$). The rate of return to sports at the same level was significantly higher after the BLB repair than after iB repair (79% vs 47%, respectively; $P < .001$). No statistical difference was found in patient-reported outcome scores between treatment groups ($P > .05$). Although failures occurred early after the BLB repair, 88% of failures after iB repair occurred after 2 years. On multivariate analysis, adolescents in the iB group with >3 episodes of preoperative dislocation and shoulder hyperlaxity (external rotation >90°) had a 60% recurrence rate ($P < .005$).

**Conclusion**: Adolescent patients undergoing the BLB repair had a lower rate of recurrent instability and higher rates of return to sports and competition than those undergoing iB repair. Patients with shoulder hyperlaxity (external rotation >90°) and >3 dislocations had an unacceptable failure rate of 60% after iB repair.

BACK

**Clinical Outcomes and Graft Resorption After Metal-Free Bone Block Suture Tape Cerclage Fixation for Recurrent Anterior Shoulder Instability: A Computed Tomography Analysis**

A. Hachem, E. Diaz-Apablaza

DOI: https://doi.org/10.1177/03635465241236179

**Background**: Glenoid reconstruction with a bone block for anterior glenoid bone loss (GBL) has shown excellent outcomes. However, fixation techniques that require metal implants are associated with metal-related complications and bone graft resorption.

**Purpose**: Arthroscopic glenoid reconstruction using a tricortical iliac crest bone graft (ICBG) and metal-free suture tape cerclage fixation can safely and effectively restore the glenoid surface area in patients with recurrent anterior shoulder instability and anterior GBL.

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

**Methods**: Adult patients (≥18 years) of both sexes with recurrent anterior shoulder instability and anterior GBL ≥15% were enrolled. These patients underwent arthroscopic glenoid reconstruction with ICBGs and metal-free suture tape cerclage fixation. The effectiveness and clinical outcomes with this technique were evaluated at 24 months using functional scores. Resorption of the graft articular surface was assessed by computed tomography, with the graft surface divided into 6 square areas aligned in 2 columns. Descriptive analysis was conducted.

**Results**: A total of 23 consecutive patients met inclusion criteria (22 male, 1 female; mean age, 30.5 ± 7.9 years). The mean preoperative GBL was 19.7% ± 3.4%, and there were 15 allograft and 8 autograft ICBGs. All patients exhibited graft union at 3 months. The median follow-up was 38.5 months (interquartile range, 24-45 months). The Western Ontario Shoulder Instability Index, Rowe, Constant-Murley, and Subjective Shoulder Value scores improved from preoperatively (35.1%, 24.8, 83.1, and 30.9, respectively) to postoperatively (84.7%, 91.1, 96.0, and 90.9, respectively) ($P < .001$). No differences in clinical scores were observed between the graft types. One surgical wound infection was reported, and 2 patients (8.7% [95% CI, 2.4%-26.8%]) required a reoperation. The mean overall glenoid surface area increased from 80.3% ± 3.5% to 117.0% ± 8.3% immediately after surgery before subsequently reducing to 98.7% ± 6.2% and 95.0% ± 5.7% at 12 and 24 months, respectively ($P < .001$). The mean graft resorption rate was 18.1% ± 7.9% in the inner column and 80.3% ± 22.4% in the outer column. Additionally, 3 patients treated with an allograft (20.0% [95% CI, 7.1%-45.2%]), including the 2 with clinical failures, exhibited complete graft resorption at the last follow-up.

**Conclusion**: Arthroscopic glenoid reconstruction using an ICBG and metal-free suture tape cerclage fixation was safe and effective, yielding excellent clinical outcomes. Resorption of the graft articular surface predominantly affected the nonloaded areas beyond the best-fit circle perimeter.

BACK

**Outcomes After Revision Arthroscopic Rotator Cuff Repair: A Systematic Review**

E.T. Hurley, A.N. Krez

DOI: https://doi.org/10.1177/03635465231185345

**Background**: Arthroscopic rotator cuff repair (ARCR) is one of the most commonly performed orthopaedic procedures; however, it is unclear how to manage patients with symptomatic retears.

**Purpose**: To perform a systematic review to evaluate the outcomes of revision ARCR in the literature.

**Study Design**: Systematic review; Level of evidence, 4.

**Methods**: A systematic literature search based on PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines was performed utilizing the Embase, MEDLINE, and Cochrane Library databases. Eligible for inclusion were clinical studies reporting on revision rotator cuff repair. Clinical outcomes were recorded.

**Results**: The 17 included studies were composed of 888 shoulders in 885 patients. The mean age of the 885 patients was 58.6 ± 9.1 years, with a mean follow-up of 28.1 ± 22.1 months. The mean visual analog scale score was 2.1 ± 1.8, the mean American Shoulder and Elbow Surgeons score was 75.0 ± 18.3, and the mean Constant score was 67.4 ± 16.6. The overall rate of retears after revision was 25.3%, with an 8.0% reoperation rate including 2.7% undergoing reverse shoulder arthroplasty and 2.0% undergoing subsequent rotator cuff repair. Finally, the complication rate was 8.6%.

**Conclusion**: Revision ARCR improved patient-reported outcomes, with 92% of patients free from reoperations at a mean follow-up of 2 years. Overall, 78.4% of patients were satisfied at final follow-up; however, the rate of retears was found to be higher than after primary ARCR.

BACK

Journal of Bone and Joint Surgery (JBJS), Volume 106, Issue 9+10

No Upper Extremity Abstracts

BACK

Clinical Orthopaedics and Related Research (CORR), Volume 482, Issue 5

No Upper Extremity Abstracts

BACK

Bone and Joint Journal (BJJ), Volume 106-B, issue 5

No Upper Extremity Abstracts

BACK

## Lower Extremity

Arthroscopy, Volume 40, Issue 5

### Preoperative Paralabral Cysts Predict More Significant Chondral Damage but Not 2-Year Functional Outcomes Following Arthroscopic Labral Repair

M.C. Dean, N.J. Cherian

DOI: https://doi.org/10.1016/j.arthro.2023.10.009

**Purpose:** To investigate whether paralabral cysts identified incidentally on preoperative magnetic resonance imaging/arthrography predict 2-year functional outcomes after arthroscopic acetabular labral repair.

**Methods:** Prospectively collected data for patients undergoing primary hip arthroscopy by a single surgeon from 2014 to 2020 were retrospectively reviewed. Included patients were ≥18 years and completed baseline patient-reported outcome measures (PROMs) with additional follow-up at 3, 6, 12, and 24 months. Exclusion criteria were labral debridement, hip dysplasia, advanced hip osteoarthritis (Tönnis > 1), or previous ipsilateral hip surgery. Patients were stratified based on the presence of paralabral cysts identified on magnetic resonance imaging/arthrography. Primary outcomes were International Hip Outcome Tool and modified Harris Hip Score. Secondary outcomes included other PROMs and the visual analog pain scale. Outcomes were compared between cohorts using linear mixed-effects models and Fisher's exact tests. Sensitivity analyses accounted for preoperative PROMs, nonlinear improvement trajectories, and relevant baseline characteristics.

**Results:** Of the 182 included hips (47.8% female; mean ± standard deviation age, 36.9 ± 11.4), 30 (16.4%) had paralabral cysts. During the 2-year study period, there were no significant differences between patients with and without paralabral cysts in terms of International Hip Outcome Tool scores (weighted difference = 1.60; 95% confidence interval [CI], −5.09, 8.28; $P$ = .64), modified Harris Hip Scores (weighted difference = 0.56; 95% CI, −4.16, 5.28; $P$ = .82), or any secondary outcomes (except for HOS–Sports Subscale at 3 months [mean difference = −11.85; 95% CI, −22.85, −0.84; $P$ = .035]). Furthermore, there were no significant differences in clinically meaningful outcomes ($P$ > .05 for all), revision rates ($P$ > .99), or conversion to total hip arthroplasty between cohorts ($P$ > .99). These results held across all sensitivity analyses.

**Conclusion:** Although preoperative paralabral cysts were associated with worse cam impingement and more severe chondral damage observed intraoperatively, they did not predict 2-year functional outcomes or clinically meaningful improvements, suggesting that incidentally discovered paralabral cysts are not a contraindication for arthroscopic labral repair.

**Level of Evidence:** Level III, retrospective cohort study.

BACK

**Concomitant Ipsilateral Knee Pain Is Associated With Worse Preoperative Functional Status and Short-Term Outcomes After Hip Arthroscopy in Patients With Femoroacetabular Impingement Syndrome**

Y. Zhu, S. Zhang

DOI: https://doi.org/10.1016/j.arthro.2023.10.022

**Purpose:** (1) To determine the effect of concomitant ipsilateral knee pain (IKP) on short-term outcomes after hip arthroscopic treatment of femoroacetabular impingement syndrome (FAIS) and (2) to determine whether IKP would improve with surgery.

**Methods:** Data between September 2021 and May 2022 were reviewed. Patients with a diagnosis of FAIS who underwent hip arthroscopy with a minimum of 1-year follow-up were included. The exclusion criteria were prior ipsilateral hip or knee surgery, hip Tönnis grade greater than 1, knee Kellgren-Lawrence grade greater than 2, hip conditions (avascular necrosis, Legg-Calvé-Perthes disease, pigmented villonodular synovitis, osteoid osteoma, synovial chondromatosis, and developmental dysplasia of the hip), and spine diseases. All patients underwent knee magnetic resonance imaging preoperatively. Preoperative and short-term (1-year) patient-reported outcomes were collected, consisting of the Hip Sports Activity Scale score, weekly sports participation, modified Harris Hip Score (mHHS), 12-component International Hip Outcome Tool (iHOT-12) score, and visual analog pain scale (VAS) scores for the hip and the ipsilateral knee. The percentages of patients achieving the minimal clinically important difference and patient acceptable symptom state (PASS) for the mHHS and iHOT-12 score were calculated. Multivariate regression analysis was performed to determine the effect of IKP severity on postoperative outcomes. Subgroup analysis was performed between patients with IKP alleviation and those without IKP alleviation.

**Results:** Among the 107 patients included, 47 presented with preoperative IKP. Compared with patients without IKP, the IKP cohort had comparable knee structural abnormalities (all with $P > .05$). Still, the IKP cohort showed inferior preoperative values for the mHHS ($P = .003$), iHOT-12 score ($P = .016$), hip VAS score ($P = .001$), and weekly sports participation ($P = .039$). Postoperatively, the IKP cohort had a lower mHHS ($P = .046$), lower iHOT-12 score ($P = .037$), and lower hip VAS score ($P = .003$) and were less likely to achieve the PASS for the mHHS ($P = .021$) and iHOT-12 score ($P = .049$). Patients with higher knee VAS scores were less likely to achieve the PASS for the mHHS (odds ratio, 0.61; $P = .023$). Within the IKP group, the knee VAS score improved from 2.3 to 1.0 ($P < .001$). Patients with alleviated IKP showed superior postoperative iHOT-12 scores ($P = .038$) compared with patients with persistent IKP.

**Conclusion:** Concomitant IKP at baseline negatively affected preoperative status and short-term clinical outcomes after arthroscopic treatment of FAIS. Patients with IKP were less likely to meet clinical thresholds. Most patients achieved IKP alleviation postoperatively, which was associated with superior clinical outcomes.

**Level of Evidence:** Level III, retrospective cohort study.

BACK

**Similar Clinical Outcomes for Arthroscopic Labral Reconstruction in Irreparable Cases Using the Indirect Head of the Rectus Femoris Tendon With an All-Inside Technique for Small Defects and the Iliotibial Band for Large Defects**

F.D. Rocca, M. Rosolani

DOI: https://doi.org/10.1016/j.arthro.2023.10.027

**Purpose:** To evaluate the clinical outcomes and satisfaction rate of patients who underwent arthroscopic labral reconstruction for an irreparable labral tear with a minimum follow-up period of 2 years. Additionally, this study aimed to compare 2 different reconstructive techniques for small and large labral defects: the indirect head of the rectus femoris tendon (IHRFT) autograft with an all-inside technique used to repair small defects (≤3 hours) and the iliotibial band (ITB) autograft for large defects (>3 hours).

**Methods:** A total of 24 hips treated with the IHRFT were compared with 24 hips treated with the ITB. All patients underwent clinical evaluation before surgery and during the most recent follow-up (42 ± 18 months). The evaluation included patient satisfaction, the modified Harris Hip Score, the Non-Arthritic Hip Score, the Hip Outcome Score, the Hip Outcome Score-sport subscale, the 12-item International Hip Outcome Tool, and the visual analog scale pain score.

**Results:** All clinical scores were significantly improved ($P < .001$) at the latest follow-up in both groups. The final satisfaction was 7.1 ± 2.8 and 8.8 ± 1.6 for the IHRFT and ITB groups, respectively ($P = .006$). There was a significant difference in age (41.2 ± 6.0 years for the IHRFT group and 33 ± 8.5 for the ITB group; $P = .004$) and in surgery time (147.3 ± 39.4 minutes for the ITB group and 105.3 ± 25.7 for the IHRFT group; $P < .001$). One patient (4.2%) in the IHRFT group underwent total hip arthroplasty after 21.3 months ($P = .999$).

**Conclusion:** At the 2-year follow-up, treating small defects using IHRFT and larger defects using ITB resulted in good patient-reported outcome measures with a low rate of complications and failures. The ITB group reported a higher level of satisfaction at the final follow-up.

**Level of Evidence:** Level III, retrospective comparative therapeutic trial.

BACK

**Time-Driven Activity-Based Costing Analysis Identifies Use of Consumables and Operating Room Time as Factors Associated With Increased Cost of Outpatient Primary Hip Arthroscopic Labral Repair**

A. Edward Allen, M.E. Sakheim

DOI: https://doi.org/10.1016/j.arthro.2023.10.050

**Purpose:** To use time-driven, activity-based costing (TDABC) methodology to investigate drivers of cost variation and to elucidate preoperative and intraoperative factors associated with increased cost of outpatient arthroscopic hip labral repair.

**Methods:** A retrospective analysis of data from January 2020 to October 2021 was performed. Patients undergoing primary hip arthroscopy for labral repair in the outpatient setting were included. Indexed TDABC data from Avant-garde Health's analytics platform were used to represent cost-of-care breakdowns. Patients in the top decile of cost were defined as high cost, and cost category variance was determined as a percent increase between high and low cost. Analyses tested for associations between preoperative and perioperative factors with total cost. Surgical procedures performed concomitantly to labral repair were included in subanalyses.

**Results:** Data from 151 patients were analyzed. Consumables made up 61% of total outpatient cost with surgical personnel costs (30%) being the second largest category. The average total cost was 19% higher for patients in the top decile of cost compared to the remainder of the cohort. Factors contributing to this difference were implants (36% higher), surgical personnel (20% higher), and operating room (OR) consumables (15% higher). Multivariate linear regression modeling indicated that OR time (Standardized $\beta = 0.504$; $P < .001$) and anchor quantity (standardized $\beta = 0.443$; $P < .001$) were significant predictors of increased cost. Femoroplasty (Unstandardized $\beta = 15.274$; $P = .010$), chondroplasty (Unstandardized $\beta = 8.860$; $P = .009$), excision of os acetabuli (unstandardized $\beta = 13.619$; $P = .041$), and trochanteric bursectomy (Unstandardized $\beta = 21.176$; $P = .009$) were also all independently associated with increasing operating time.

**Conclusion:** TDABC analysis showed that OR consumables and implants were the largest drivers of cost for the procedure. OR time was also shown to be a significant predictor of increased costs.

**Level of Evidence:** Level IV, economic analysis.

BACK

**Lateral Meniscal Allograft Transplantation Shows a Long-Term Chondroprotective Effect on Quantitative Magnetic Resonance Imaging T2 Mapping at 7-Year Minimum Follow-Up**

H.Y. Lee, J.-M. Kim

DOI: https://doi.org/10.1016/j.arthro.2023.09.027

**Purpose:** To assess the long-term chondroprotective effect of lateral meniscal allograft transplantation (MAT) using quantitative magnetic resonance imaging (MRI) T2 mapping.

**Methods:** In patients who underwent isolated lateral MAT, quantitative MRI T2 mapping was conducted preoperatively and postoperatively with at minimum follow-up of 7 years to assess the articular cartilage status. On the sagittal section image bisecting the lateral femoral condyle, the weight-bearing portions of the femoral and tibial articular cartilage were divided into 3 segments each—6 segments in total—based on the meniscal coverage area. The regions-of-interest analyses were performed on the 6 segments to measure the mean T2 value. Then the whole layer was divided into deep and superficial layers for further zonal analysis. The longitudinal change in T2 values was statistically analyzed using paired *t*-tests. Clinical outcome was evaluated using the Lysholm score.

**Results:** A total of 31 patients were included in the study, with the MRI follow-up period of a minimum of 7 years (mean: 8.9 ± 1.3 years; range: 7.0-11.2 years). The mean T2 value of the whole layer showed significant improvement in all segments of the femoral cartilage and the posterior segment of tibial cartilage. In the zonal analysis, the mean T2 value of the tibial cartilage showed significant improvement in the superficial layer of the mid to posterior portion, while the deep layer remained stable. In contrast, the mean T2 value of the femoral cartilage showed significant improvement in the superficial and deep layers in all segments. The mean Lysholm score significantly improved from 62.6 ± 12.8 to 90.9 ± 10.5 ($P < .001$).

**Conclusion:** This study suggests that MAT appears to have a long-term chondroprotective effect on the articular cartilage as judged by quantitative T2 mapping.

**Level of Evidence:** Level Ⅳ, case series.

BACK

**Satisfactory Clinical Outcome, Complications, and Provisional Results of Meniscus Centralization with Medial Meniscus Root Repair for the Extruded Medial Meniscus at Mean 2-Year Follow-Up**

A.J. Krych, A.M. Boos

DOI: https://doi.org/10.1016/j.arthro.2023.10.003

**Purpose:** To describe the patient-reported clinical outcomes following medial meniscus root repair with meniscus centralization and to identify common complications and detail provisional results.

**Methods:** Patients undergoing medial meniscus root repair with meniscus centralization from 2020 to 2022 were identified using an institutional database. Patients were followed prospectively using postoperative Tegner Activity Scale, visual analog scale (VAS) for pain, Knee Injury and Osteoarthritis Outcome Score, Joint Replacement, International Knee Documentation Committee score, and a Likert score for improvement, surgery satisfaction, and subsequent surgeries at minimum 1-year follow-up with mean 2-year follow-up. Demographics, injury characteristics, and surgical details were also collected.

**Results:** Twenty-five patients (age: 50 ± 11 years; sex: 76% female; body mass index: 33 ± 8) were included in this study. Postoperative Tegner score was maintained at preoperative levels ($P$ = .233), and VAS at rest, VAS with use, Knee Injury and Osteoarthritis Outcome Score, Joint Replacement, and International Knee Documentation Committee improved significantly postoperatively ($P$ = .003; $P$ < .001, $P$ < .001, $P$ = .023, respectively). Eighty-eight percent of patients reported subjective improvement in their knee at final follow-up. Postoperative radiographs did not show any significant osteoarthritis progression, and no patients had undergone a revision meniscus surgery or total knee arthroplasty at the time of follow-up.

**Conclusion:** At minimum 1-year follow-up and mean 2-year follow-up, patients undergoing medial meniscus root repair with meniscus centralization demonstrated significant postoperative improvements in pain, function, and quality of life and reported high rates of surgery satisfaction. There was no evidence of significant arthritic progression on postoperative imaging, and no patients underwent revision meniscus surgery or total knee arthroplasty.

**Level of Evidence:** Level IV, case series.

BACK

**Postoperative Strength Differences at Short-Term Follow-Up Vary Based on Autograft Harvest Site After Adolescent Transphyseal Anterior Cruciate Ligament Reconstruction**

J.T. Bram, A.C. Stevens

DOI: https://doi.org/10.1016/j.arthro.2023.10.018

**Purpose:** To compare the clinical and patient-reported outcomes of adolescent patients who underwent anterior cruciate ligament reconstruction (ACLR) with quadriceps tendon (QT) versus hamstring tendon (HT) autograft.

**Methods:** This was a retrospective cohort study of adolescent patients aged 18 years or younger treated at a single tertiary care children's hospital who underwent primary transphyseal ACLR using QT or HT between January 2018 and December 2019. All patients had minimum 6-month follow-up. Outcomes included isokinetic strength testing, postoperative Patient-Reported Outcomes Measurement Information System and International Knee Documentation Committee scores, and complications; these were compared between the QT and HT cohorts.

**Results:** A total of 84 patients (44 HT and 40 QT patients) were included. The QT cohort had a higher proportion of male patients (62.5% vs 34.1%, $P = .01$). At 3 months, HT patients had a lower hamstring-quadriceps (H/Q) strength ratio (60.7 ± 11.0 vs 79.5 ± 18.6, $P < .01$) and lower Limb Symmetry Index in flexion (85.6 ± 16.1 vs 95.5 ± 15.7, $P = .01$) whereas QT patients had a lower Limb Symmetry Index in extension (67.3 ± 9.5 vs 77.4 ± 10.7, $P < .01$). The H/Q ratio at 6 months was lower in HT patients (59.4 ± 11.5 vs 66.2 ± 7.5, $P < .01$). Patient-Reported Outcomes Measurement Information System and International Knee Documentation Committee scores were not different at 3 months or latest follow-up. QT patients had more wound issues (20.0% vs 2.3%, $P = .01$). Patients receiving HT autograft had more ipsilateral knee injuries (18.2% vs 2.5%, $P = .03$), but there was no difference in graft failure for ACLR using HT versus QT (9.1% vs 2.5%, $P = .36$).

**Conclusion:** There were no differences in patient-reported outcome measures between patients receiving QT autografts and those receiving HT autografts. Patients with QT grafts had more postoperative wound issues but a lower rate of ipsilateral knee complications (graft failure or meniscal tear). Differences in quadriceps and hamstring strength postoperatively compared with the contralateral limb were observed for adolescent ACLR patients receiving QT and HT autografts, respectively. This contributed to higher H/Q ratios seen at 3 and 6 months postoperatively for patients receiving QT autografts.

**Level of Evidence:** Level III, retrospective comparative therapeutic study.

BACK

**Hip Arthroscopy in Patients With Generalized Joint Hypermobility Yields Successful Outcomes: A Systematic Review**

Z. Arshad, P. Marway

DOI: https://doi.org/10.1016/j.arthro.2023.10.047

**Purpose:** To evaluate the outcomes of hip arthroscopy in patients with generalized joint hypermobility (GJH).

**Methods:** A systematic review was performed according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses. An electronic record search was performed in PubMed, Web of Science, Cochrane Library, and Embase. A 2-stage title/abstract and full-text screening was performed using the following inclusion criteria: (1) observational studies, cohort studies, and randomized controlled trials; (2) describing more than 5 patients with a mean age over 18 years and GJH; (3) undergoing arthroscopy of the hip; (4) reporting patient-reported outcome measures (PROMs), return to sport, or complications/reoperations; and (5) published in English.

**Results:** Of the 517 articles identified, 10 studies meeting all selection criteria were included. Included studies report significant improvements in a range of different functional and pain-based PROMs. Most patients (25.0%-97.0%) in each study achieved a clinically important improvement postoperatively in at least 1 PROM. No complications were described in any of the 4 studies reporting this metric. One study each found an association between GJH and an increased risk of postoperative deep gluteal syndrome and iliopsoas tendinitis. The rate of revision arthroscopy ranged from 0% to 11.4%, and only 2 patients in a single study of 11 hips required conversion to total hip arthroplasty. No statistically significant differences were reported between patients with and without GJH with respect to any of the described outcomes.

**Conclusion:** Patients with GJH may achieve good outcomes following hip arthroscopy with respect to PROMs, perioperative complications, reoperation, and return to sport. With effective labral repair and capsular closure, outcomes achieved in patients with GJH are comparable to those reported in patients without hypermobility.

**Level of Evidence:** Level IV, systematic review of level III to IV studies.

BACK

**Outcomes of Arthroscopic Joint Preservation Techniques for Chondral Lesions in the Hip: An Updated Systematic Review**

M. Akhtar, J. Wen

DOI: https://doi.org/10.1016/j.arthro.2023.11.019

**Purpose:** To systematically review outcomes of joint preservation procedures for chondral lesions of the hip through analysis of survival rates and patient-reported outcomes (PROs).

**Methods:** A literature search from 2018 to May 2023 was performed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines in 3 databases: PubMed, Embase, and Google Scholar. Studies were included if they reported on outcomes of patients undergoing hip arthroscopy for the treatment of chondral lesions of the hip joint and if there were quantifiable postoperative outcome measures. Quality assessment was completed using the Methodological Index for Non-Randomized Studies criteria.

**Results:** Twenty-seven studies were included, with 20 noncomparative and 7 comparative studies. Microfracture (MFx) was the most common procedure, reported in 17 studies. Other procedures include autologous chondrocyte transplantation (ACT) (5 studies), autologous matrix-induced chondrogenesis (AMIC) (3 studies), and MFx in conjunction with CarGel (3 studies). Seven other novel procedures were reported in individual separate studies. Survival rates, defined by no revision surgery or conversion to total hip arthroscopy (THA) at latest follow-up, for MFx (14 studies), AMIC (3 studies), and MFx in conjunction with CarGel (3 studies) ranged from 59.1% to 100%, 92.9% to 100%, and 94.4% to 95.7%, respectively. Survival rates of ACT, biological reconstruction, debridement and abrasion, microfragmented autologous adipose tissue transplantation, and ChondroFiller gel were all reported once in separate studies with rates of 100%, 100%, 85.4%, 100%, and 92.3%, respectively. All studies included PROs, most reporting statistically significant improvements ($P < .05$) at the latest follow-up.

**Conclusion:** Isolated MFx remained the most commonly performed technique, but with lower survival and higher conversion to THA rates than in studies before 2018. Novel techniques that were performed in conjunction with MFx or that avoided MFx altogether had higher overall survival rates despite being minimally performed. Most patients across all techniques demonstrated significant improvements in PROs.

**Level of Evidence:** Level IV, systematic review of Level III and IV studies.

BACK

**Female Sex, Older Age, Earlier Surgery, Anticoagulant Use, and Meniscal Repair Are Associated With Increased Risk of Manipulation Under Anesthesia or Lysis of Adhesions for Arthrofibrosis After Anterior Cruciate Ligament Reconstruction: A Systematic Review**

H. Hopper, M. Adsit

DOI: https://doi.org/10.1016/j.arthro.2023.11.006

**Purpose:** To determine what patient or surgical factors are associated with an increased risk of arthrofibrosis requiring manipulation under anesthesia (MUA) or lysis of adhesions (LOA) after anterior cruciate ligament reconstruction (ACLR).

**Methods:** A systematic review was performed in adherence to Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Cochrane, Embase, and Medline databases were searched for studies published through February 2023. Inclusion criteria were studies that identified risk factors for MUA and/or LOA after ACLR. Studies investigating arthrofibrosis after multiligamentous knee injuries or ACL repair were excluded.

**Results:** Eleven studies including a total of 333,876 ACLRs with 4,842 subsequent MUA or LOA (1.45%) were analyzed. Increasing age was associated with an increased risk in 3 studies ($P < .001$, $P < .05$, $P < .01$) but was found to have no association another two. Other factors that were identified by multiple studies as risk factors for MUA/LOA were female sex (4 studies), earlier surgery (5 studies), use of anticoagulants other than aspirin (2 studies), and concomitant meniscal repair (4 studies).

**Conclusion:** In total, 1.45% of the patients who underwent ACLR and were included in this systematic review had to undergo a subsequent MUA/LOA to treat arthrofibrosis. Female sex, older age, earlier surgery, use of anticoagulants other than aspirin, and concomitant meniscal repair were associated with increased risk of MUA/LOA. The modifiable risks, including use of anticoagulants and time between injury and surgery, can be considered when making treatment decisions.

**Level of Evidence:** Level IV, systematic review of Level III-IV studies.

BACK

**Concomitant Treatment of High-Grade Cartilage Lesions Mitigates Risk of Meniscal Allograft Transplant Failure**

Z. Wang, K. Credille

DOI: https://doi.org/10.1016/j.arthro.2023.11.011

**Purpose:** To identify frequently studied significant preoperative risk factors for meniscal allograft transplantation (MAT) failure.

**Methods:** Preferred Reporting Items for Systematic Reviews and Meta-analysis guidelines were used to conduct this systematic review. The database analysis was performed in May 2022 and included PubMed, Embrace, and Cochrane. Studies between January 1, 2000, and January 1, 2021, were reviewed with search terms, including “meniscal,” “meniscus,” “transplantation,” “transplant,” and “allograft.” Twenty-one full-text manuscripts met inclusion criteria of studies assessing preoperative risk factors for MAT failure defined as either clinical failure (Lysholm <65) or surgical failure (revision, removal, or conversion to knee arthroplasty).

**Results:** In total, 21 studies were included, comprising 47.6% with Level of Evidence III and 52.4% with Level of Evidence IV. The analysis involved 2,533 patients, and the mean final follow-up ranged from 2.2 to 20.0 years. The presence of high-grade cartilage defects was the only factor found predictive of MAT surgical failure in the majority of studies in which it was analyzed (5/7 studies, 71.4%). Four of the 5 studies that found high-grade cartilage defects to be a predictor of MAT surgical failure did not treat all cartilage lesions, whereas the 2 studies that found high-grade cartilage defects an insignificant predictor of MAT surgical failure treated all defects at the time of MAT. For clinical failure, no risk factors were predictive of MAT failure in the majority of studies, although smoking and concomitant ligamentous or realignment procedures were significant in 1 study.

**Conclusion:** The presence of untreated high-grade cartilage appears to elevate the risk of surgical MAT failure; however, concomitant treatment of defects may mitigate their detrimental effect. There is no clear risk factor that consistently predicts clinical failure. Age, sex, body mass index, knee compartment, time from prior meniscectomy, femorotibial alignment (after correction), concomitant cartilage procedure, and laterality do not routinely influence MAT failure.

**Level of Evidence:** Level IV, systematic review of Level III and IV studies.

BACK

Journal of Shoulder and Elbow Surgery (JSES), Volume 33, issue 5

No Lower Extremity Abstracts

BACK

Knee Surgery, Sports Traumatology, Arthroscopy (KSSTA), Volume 32, Issue 5

# Satisfactory mid-term clinical outcomes of endoscopic tenotomy for iliopsoas tendinopathy following total hip arthroplasty

J. Erard, M.R. Viamont-Guerra

DOI: https://doi.org/10.1002/ksa.12103

**Purpose:** To report 5-year outcomes of endoscopic iliopsoas tenotomy in patients with iliopsoas tendinopathy following total hip arthroplasty (THA) and determine whether clinical scores are associated with cup position.

**Methods:** Patients who underwent endoscopic iliopsoas tenotomy for iliopsoas tendinopathy following THA (2014–2017) were contacted. Indications for endoscopic iliopsoas tenotomy after THA were groin pain during active hip flexion, exclusion of other causes of groin pain, and no pain relief after 6 months of conservative treatment. Pretenotomy cup inclination and anteversion were measured on radiographs; axial and sagittal cup overhang were measured on computed tomography (CT) scans. Oxford hip score (OHS), modified Harris hip score (mHHS), and groin pain were assessed.

**Results:** The initial cohort comprised 16 men (17 hips) and 31 women (32 hips), aged 60.7 ± 10.6 years. Cup inclination and anteversion were, respectively, 46.2 ± 6.2° and 14.6 ± 8.4°, while axial and sagittal cup overhang were, respectively, 4.4 ± 4.0 mm and 6.9 ± 4.5 mm. At ≥5 years follow-up, four hips underwent cup and stem revision, two underwent isolated cup revision and one underwent secondary iliopsoas tenotomy. OHS improved by 23 ± 10 and mHHS improved by 31 ± 16. Posttenotomy groin pain was slight in 20.0%, mild in 17.5% and moderate in 12.5%. Regression analyses revealed that net change in mHHS decreased with sagittal cup overhang ($\beta = -3.1$; 95% confidence interval [CI] = –4.6 to –1.7; $p < 0.001$), but that there were no associations between cup position and net change in OHS.

**Conclusions:** Endoscopic iliopsoas tenotomy provides good mid-term clinical outcomes in patients with iliopsoas tendinopathy following THA. Furthermore, improvements in mHHS were found to decrease with increasing sagittal cup overhang, in cases for which adequate preoperative imaging was available.

**Level of Evidence:** Level IV.

BACK

American Journal of Sports Medicine (AJSM), Volume 52, Issue 6

# Rates of Subjective Failure After Both Isolated and Combined Posterior Cruciate Ligament Reconstruction: A Study From the Norwegian Knee Ligament Registry 2004-2021

G. Moatshe, C.M. LaPrade

DOI: https://doi.org/10.1177/03635465241238461

**Background**: Outcomes after posterior cruciate ligament (PCL) reconstruction (PCLR) have been reported to be inferior to those of anterior cruciate ligament reconstruction. Furthermore, combined ligament injuries have been reported to have inferior outcomes compared with isolated PCLR.

**Purpose**: The purpose of this study was to report on PCLR outcomes and failure rates and compare these outcomes between isolated PCLR and multiligament knee surgery involving the PCL. The hypothesis was that combined PCL injury reconstruction would have higher rates of subjective failure and revision relative to isolated PCLR.

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

**Methods**: Patients with primary PCLR with or without concomitant ligament injuries registered in the Norwegian Knee Ligament Registry between 2004 and 2021 were included. Knee injury and Osteoarthritis Outcome Score (KOOS) totals were collected preoperatively and at 2 years and 5 years postoperatively. The primary outcome measure was failure, defined as either a revision surgery or a KOOS Quality of Life (QoL) subscale score <44.

**Results**: The sample included 631 primary PCLR procedures, with 185 (29%) isolated PCLR procedures and 446 (71%) combined reconstructions, with a median follow-up time of 7.3 and 7.9 years, respectively. The majority of patients had poor preoperative knee function as defined by a KOOS QoL score <44 (90.1% isolated PCLR, 85.7% combined PCL injuries; P = .24). Subjective outcomes improved significantly at 2- and 5-year follow-up compared with preoperative assessments in both groups (P < .001); however, at 2 years, 49.5% and 46.5% had subjective failure (KOOS QoL <44) for isolated PCLR and combined PCLR, respectively (P = .61). At 5 years, the subjective failure rates of isolated and combined PCLR were 46.7% and 34.2%, respectively (P = .04). No significant difference was found in revision rates between the groups at 5 years (1.9% and 4.6%, respectively; P = .07).

**Conclusion**: Patients who underwent PCLR had improved KOOS QoL scores relative to their preoperative state. However, the subjective failure rate was high for both isolated and multiligament PCLR. Within the first 2 years after surgery, patients who undergo isolated PCLR can be expected to have similar failure rates to patients who undergo combined ligament reconstructions.

BACK

**Outcomes of Flexibility Sport Athletes With Borderline Hip Dysplasia After Hip Arthroscopy for Femoroacetabular Impingement Syndrome: A Propensity-Matched Analysis at Minimum 2-Year Follow-up**

K. Jan, M.J. Vogel

DOI: https://doi.org/10.1177/03635465241239874

**Background**: Hip arthroscopy has proved successful in treating femoroacetabular impingement syndrome (FAIS) in patients with and without borderline hip dysplasia (BHD). Despite a high prevalence of BHD in patients who participate in sports with high flexibility requirements, a paucity of literature evaluates the efficacy of hip arthroscopy in treating FAIS in flexibility sport athletes with BHD.

**Purpose**: To compare minimum 2-year patient-reported outcomes (PROs) and achievement of clinically significant outcomes in flexibility sport athletes with BHD undergoing primary hip arthroscopy for FAIS with capsular plication with results in flexibility sport athletes without dysplasia.

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

**Methods**: Data were prospectively collected for patients undergoing primary hip arthroscopy for FAIS with BHD, defined as a lateral center-edge angle of 18° to 25°, who reported participation in a sport with a high flexibility requirement, including dance, gymnastics, figure skating, yoga, cheerleading, and martial arts, according to previous literature. These patients were matched 1:2 to flexibility sport athletes without dysplasia, controlling for age, sex, and body mass index. Preoperative and minimum 2-year postoperative PROs were collected and compared between groups. Cohort-specific minimal clinically important difference and patient acceptable symptom state achievement was compared between groups.

**Results**: In total, 52 flexibility sport athletes with BHD were matched to 104 flexibility sport athletes without BHD. Both groups showed similar sport participation ($P = .874$) and a similar level of competition ($P = .877$). Preoperative lateral center-edge angle (22.2°± 1.6° vs 31.5°± 3.9°; $P < .001$) and Tönnis angle (10.9°± 3.7° vs 5.8°± 4.4°; $P < .001$) differed between groups. Capsular plication was performed in all cases. Both groups achieved significant improvement in all PROs ($P < .001$) with no differences in postoperative PROs between groups ($P \geq .147$). High minimal clinically important difference (BHD group: 95.7%; control group: 94.8%) and patient acceptable symptom state (BHD group: 71.7%; control group: 72.2%) achievement for any PRO was observed with no differences between groups ($P \geq .835$).

**Conclusion**: Flexibility sport athletes with BHD achieved similar outcomes as those of flexibility sport athletes without BHD after hip arthroscopy for FAIS with capsular plication.

BACK

**The Everted Acetabular Labrum: Outcomes of Surgical Management**

N.G. Girardi, J.H. Lee

DOI: https://doi.org/10.1177/03635465241237252

**Background**: An everted acetabular labrum (EL) is a pathologic variant in which the labrum is flipped to the capsular side of the acetabular rim. An iatrogenic EL is a known complication of a poorly executed labral repair, and a recent study described the native acetabular EL.

**Purpose**: To analyze surgical outcomes after advancement or reconstruction of an EL in a native hip.

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

**Methods**: This was a multicenter retrospective review of prospectively collected data on primary hip arthroscopic surgeries performed between 2013 and 2023. An EL was identified arthroscopically as a labrum–femoral head gap while off traction in the native hip. All patients with EL who were analyzed in this study underwent arthroscopic labral repair and advancement or labral augmentation or reconstruction. Patients with hip dysplasia also underwent periacetabular osteotomy with or without a derotational femoral osteotomy. Patient-reported outcomes (PROs) were assessed using the 12-item International Hip Outcome Tool (iHOT-12) and the Nonarthritic Hip Score. PROs were obtained preoperatively and up to 24 months after surgery. PROs were compared with those of a case-matched control cohort in a 1:2 ratio. Only patients with PROs available at ≥1 year postoperatively were included in the outcome analysis.

**Results**: A total of 111 patients (129 hips) with EL during the study period were identified, with PROs available in 96 hips. The mean age of patients with EL was 30.5 years, and women made up 87% of the cohort. Of the 129 hips with an EL, an isolated diagnosis of an EL was present in 11.6% of hips. Deficient acetabular coverage (lateral center-edge angle <25°) was seen in 40.6% of EL hips. No difference was seen in iHOT-12 scores between EL and control groups at 12- or 24-month follow-up ($P = .18$ and .94, respectively). Patients with EL reported a significant improvement of PROs at latest follow-up ($P < .001$ for iHOT-12 and Nonarthritic Hip Score).

**Conclusion**: Surgical management of a native EL with restoration of the labral seal on the femoral head and correction of concomitant pathologies resulted in significant clinical improvement, with postoperative outcome scores comparable to those of patients without an EL. These findings provide evidence supporting surgical intervention for a native EL.

BACK

**Return to Sport After Pediatric Anterior Cruciate Ligament Reconstruction: A Systematic Review of the Criteria**

J.-P. Lorange, L. Senécal

DOI: https://doi.org/10.1177/03635465231187039

**Background**: Postoperative rehabilitation is an important component of recovery after anterior cruciate ligament (ACL) reconstruction (ACLR), facilitating successful return to sport (RTS) by reducing risk factors for repeat injury.

**Purpose**: This systematic review aimed to determine the best protocol for RTS after ACLR in children.

**Study Design**: Systematic review; Level of evidence, 4.

**Methods**: PubMed, Embase, PEDro, SPORTDiscus, and Web of Science databases were searched from October 3, 2014, to November 3, 2022. The inclusion criteria were the pediatric population (<18 years old) after ACLR with clear RTS criteria and/or mean/median time to RTS. Multiligament knee injuries were excluded from this study. The methodologic quality of the included articles was assessed using the methodological index for non-randomized studies (MINORS). The highest possible score was 24 points for comparative studies (ie, a study comparing 2 protocols or more). Noncomparative studies or studies with a single protocol could score a maximum of 16 points as assessed by the MINORS score.

**Results**: The search yielded 1816 titles, and 24 were retained based on the inclusion and exclusion criteria. Every study was published between 2015 and 2022. Among the 24 studies included, 13 were retrospective and 11 were prospective. The mean MINORS score for the noncomparative studies was 13 of 16 (n = 23) and 23 of 24 for the comparative study (n = 1). The studies were categorized into unspecified clearance (n = 10), milestone based (n = 13), and combined time and milestone (n = 1). A total of 1978 patients (57% female) were included in the review. The mean age at ACLR was 14.7 years. The most common endpoint used was graft rupture (0% to 35%). In the unspecified group, the quickest RTS was 5.8 months and the longest was 9.6 months. Statistically significant risk factors for ACL reinjury included younger age and earlier RTS. The latter was a significant contributor to graft failure for combined time-based and milestone-based RTS. In the milestone-based group, the most common criteria were ≥90% limb symmetry measured using hamstring strength, quadriceps strength, and/or hop tests. The mean RTS time was 6.8 to 13.5 months.

**Conclusion**: RTS should be delayed, when possible, especially in the younger population. A combination of quantitative tests and qualitative tests is also recommended. However, optimal RTS criteria have yet to be determined. Future prospective studies should focus on comparing the different times and milestones currently available.

BACK

Journal of Bone and Joint Surgery (JBJS), Volume 106, Issue 9+10

No Lower Extremity Abstracts

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Clinical Orthopaedics and Related Research (CORR), Volume 482, Issue 5

No Lower Extremity Abstracts

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Bone and Joint Journal (BJJ), Volume 106-B, issue 5

No Lower Extremity Abstracts

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## Miscellaneous

Arthroscopy, Volume 40, Issue 5

No Miscellaneous Abstracts

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Journal of Shoulder and Elbow Surgery (JSES), Volume 33, issue 5

No Miscellaneous Abstracts

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Knee Surgery, Sports Traumatology, Arthroscopy (KSSTA), Volume 32, Issue 5

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American Journal of Sports Medicine (AJSM), Volume 52, Issue 6

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Journal of Bone and Joint Surgery (JBJS), Volume 106, Issue 9+10

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