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Volume 38, Issue 5

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BACK

# Upper extremity

Arthroscopy, May 2022, Volume 38, Issue 5, P 1411 – 1419

**Prospective 1-Year Outcomes Are Maintained at Short-Term Final Follow-Up After Superior Capsular Reconstruction Augmentation of Complete Rotator Cuff Repair**

Degan T.J., Hartzler R.U., et al.

DOI: https://doi.org/10.1016/j.arthro.2021.11.008

Purpose
To evaluate the outcomes of arthroscopic superior capsular reconstruction (SCR) augmentation of complete, massive rotator cuff repair (RCR).

Methods
A retrospective study of dermal allograft SCR-augmented RCRs performed by a single surgeon from June 2016 through December 2017 was performed with the following inclusion criteria: massive rotator cuff tear amenable to complete repair but with poor-quality native rotator cuff tissue. Radiographic follow-up was performed at 1 year, and clinical follow-up was performed at both 1 year and a minimum 2 years after surgery. Clinical follow-up included the American Shoulder and Elbow Surgeons score, visual analog scale score for pain, Subjective Shoulder Value score, active forward elevation, and external rotation. Radiographs and magnetic resonance imaging (MRI) scans were assessed for muscle quality using the Goutallier classification, and graft and cuff integrity was assessed according to the Sugaya classification.

Results
The inclusion criteria were met by 24 patients at 1 year and by 18 (75%) at a minimum of 2 years postoperatively. Patient-reported outcomes were improved compared with preoperative data and were maintained at minimum 2-year follow-up, with median American Shoulder and Elbow Surgeons scores of 42.5 (interquartile range [IQR], 30.8-58.7) versus 93.9 (IQR, 82.4-100) ($P < .001$); median Subjective Shoulder Value scores of 30 (IQR, 20-50) versus 90 (IQR, 86.2-97.2) ($P < .001$); and median visual analog scale pain scores of 5.5 (IQR, 1-9) versus 0 (IQR, 0-0.8) ($P = .001$). Evaluation of graft and tendon healing on postoperative MRI revealed poor interobserver agreement and showed 10 completely healed grafts (42%), 9 partially healed grafts (38%), and 5 completely disrupted grafts (21%), with 42% of supraspinatus tendons and 54% of infraspinatus tendons healed.

Conclusions
SCR with dermal allograft augmentation of complete RCR with poor-quality tissue shows very good clinical outcomes at minimum 2-year follow-up. Poor interobserver agreement regarding postoperative graft and rotator cuff integrity by MRI was found. The healing rate for the SCR grafts was 79%. The rates of healing of the native supraspinatus and infraspinatus tendons were 42% and 54%, respectively.

Level of Evidence
Level IV, retrospective case series.

BACK

Arthroscopy, May 2022, Volume 38, Issue 5, P 1411 – 1419

**Functional Outcomes Are Similar After Arthroscopic Capsular Repair of Triangular Fibrocartilage Complex Tears Between Outside-In Technique and All-Inside Technique Using Pre-Tied Suture Device**

A.C. Chen, Y Cheng, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.12.010

Purpose
To compare outcomes of arthroscopic triangular fibrocartilage complex capsular repair at 2-year follow-up between outside-in and all-inside techniques.

Methods
In total, 58 consecutive patients (wrists) with a Palmer 1B triangular fibrocartilage complex tear without symptomatic distal radioulnar joint instability underwent arthroscopic suture repair from 2011 to 2019 including 31 patients via the outside-in technique (group A) and 27 via the all-inside technique using a pre-tied needle device (group B). Two-year follow-up included visual analog scale (VAS) pain score, motion range, grip strength, Mayo Modified Wrist Score (MMWS), the Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) score, and complication rate. Correlation between functional result and patient satisfaction was analyzed.

Results
Score changes in VAS, wrist flexion–tension, supination–pronation, grip strength, MMWS, and QuickDASH at 2-year follow-up were not significantly different between group A (3.4 ± 0.8, 18.4 ± 17.5, 12.9 ± 13.3, 30.7 ± 11.2, 26.6 ± 7.9 and 19.4 ± 9.9 and group B (3.4 ± 1.0, 18.5 ± 18.3, 15.6 ± 13.7, 30.8 ± 11.4, 28.1 ± 8.6, and 7.6 ± 7.2) with P values of .400, .489, .223, .486, .240, and .223 respectively. Surgical time averaged 105 minutes (78 to 136) in group A and 94 minutes (61-126) in group B with significant difference (P = .012). Patient satisfaction averaged 1.1 (0-3.5) in group A and 1.0 (range 0-3.0) in group B. Satisfaction score was more strongly correlated with QuickDASH (coefficients: 0.863 in group A and 0.918 in group B) than with MMWS (–0.693 in group A and –0.465), grip strength (–0.619 in group A and –0.417 in group B) and VAS score (0.607 in group A and 0.222 in group B).

Conclusions
Both techniques achieved comparable outcomes with shorter surgical time in all-inside repair using pre-tied needle device. Patient satisfaction was strongly correlated with QuickDASH score.

Level of Evidence
Level III, retrospective therapeutic comparative investigation.

BACK

Arthroscopy, May 2022, Volume 38, Issue 5, P 1642 – 1657

# Ultrasound Guidance Is Not Superior in Subacromial Bursa and Intraarticular Injections but Superior in Bicipital Groove: A Meta-analysis of Randomized Controlled Trials

D. Fan, X. Liu, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.12.013

Purpose
To perform a meta-analysis comparing the clinical and functional outcomes of ultrasound-guided (USG) and blind injections for shoulder pain.

Method
The Embase, Cochrane Library, and PubMed databases were searched from database inception to April 7, 2021. Clinical and functional outcomes included the visual analog scale (VAS) pain score, abduction, flexion, American Shoulder and Elbow Surgeons Assessment Form (ASES) score, Constant-Murley Shoulder (CMS) score, Shoulder Pain and Disability Index (SPADI), Shoulder Disability Questionnaire (SDQ) score, and Shorted Disabilities of the Arm, Shoulder and Hand (Quick DASH) score. Dichotomous outcomes were assessed with mean differences (MDs) and 95% confidence intervals (95% CIs).

Results
Fifteen studies that compared USG and blind injections were included. No significant difference was found in the VAS score between the blind group and USG group (MD 0.41 [−0.02, 0.84]; I2 = 79%; P = .06). Subgroup analysis of the brachial bicipital groove indicated that the USG group had less pain than the blind group (MD 1.50 [0.54, 2.46]; I2 = 64; P = .002). The USG injection patients had better postoperative abduction (MD −3.08 [−5.19, −0.98], I2 = 0, P = .004) and flexion (MD −3.36 [−5.56, −1.16]; I2 = 0; P = .003) than the blind group. Additionally, the USG injection patients had better CMS scores than the blind injection patients (MD −12.95 [−25.60, −0.29]; I2 = 96; P = .04). However, subgroup analysis showed no significant difference in the subacromial bursas and glenohumeral joints of CMS score (MD −13.22 [−29.93, 3.94]; I2 = 97; P＜.0001). No significant difference was found in the SPADI, ASES score, or SDQ score between the groups.

Conclusions
Ultrasound guidance is not superior in the subacromial bursa and glenohumeral joint injections in pain or function. However, injection in the brachial bicipital groove, is still superior to blind injection of pain relief.

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

BACK

Arthroscopy, May 2022, Volume 38, Issue 5, P 1627 – 1641

**Peripheral Nerve Blocks Outperform General Anesthesia for Pain Control in Arthroscopic Rotator Cuff Repair: A Systematic Review and Meta-analysis**

A. Kalthoff, M. Sanda, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.11.054

Purpose
The purpose of this review is to compare the effectiveness of different peripheral nerve blocks and general anesthesia (GA) in controlling postoperative pain after arthroscopic rotator cuff repair (ARCR).

Methods
A Preferred Reporting Items for Systematic Reviews and Meta-Analyses-compliant systematic review was conducted for the period of January 1, 2005, to February 16, 2021, by searching the following databases: PubMed, Cochrane, Embase, and Arthroscopyjournal.org. The primary outcomes of interest included 1-hour, 24-hour, and 48-hour pain scores on a numeric rating scale or visual analog scale (VAS). Inclusion criteria were English language studies reporting on adults (≥18 years) undergoing ARCR with peripheral nerve blockade. To synthesize subjective pain score data at each evaluation time point across studies, we performed random-effects network meta-regression analyses accounting for baseline pain score as a covariate.

Results
A total of 14 randomized controlled trials with 851 patients were included in the meta-analysis. Data from six different nerve block interventions, single-shot interscalene brachial plexus nerve block (s-ISB; 37.8% [322/851]), single-shot suprascapular nerve block (s-SSNB; 9.9% [84/851]), continuous ISB (c-ISB; 17.5% [149/851]), continuous SSNB (c-SSNB; 6.9% [59/851]), s-ISB combined with SSNB (s-ISB+SSNB; 5.8% [49/851]), s-SSNB combined with axillary nerve block (s-SSNB+ANB; 4.8% [41/851]), as well as GA (17.3% [147/851]) were included. Our meta-analysis demonstrated that c-ISB block had a significant reduction in pain score relative to GA at 1-hour postoperation (mean difference [MD]: −1.8; 95% credible interval [CrI] = −3.4, −.08). There were no significant differences in VAS pain scores relative to GA at 24 and 48 hours postoperatively. However, s-ISB+SSNB had a significant reduction in 48-hour pain score compared to s-ISB (MD = −1.07; 95% CrI = −1.92, −.22).

Conclusions
It remains unclear which peripheral nerve block strategy is optimal for ARCR. However, peripheral nerve blocks are highly effective at attenuating postoperative ARCR pain and should be more widely considered as an alternative over general anesthesia alone.

Level of Evidence
Level II Systematic review and meta-analysis of Level I and II studies.

BACK

Journal of Shoulder and elbow surgery, May 2022, volume 31, issue 5, pages 978-983

# Patients without re-dislocation in the short term after arthroscopic knotless Bankart repair for anterior shoulder instability may show residual apprehension and recurrence in the long term after 5 years

Eren, I., Büyükdogan, K., Yürük, B. et al.

**DOI:** https://doi.org/10.1016/j.jse.2021.10.042

**Hypothesis**
The aim of this study was to report the long-term results, residual instability, and recurrence rate of arthroscopic Bankart repair surgery without a re-dislocation event in the first 5 years.

**Methods**
We performed a retrospective analysis of Bankart repairs performed in a single center, by a single surgeon, with a minimum of 5 years' follow-up. Patients without a re-dislocation in the first 5 years of surgery were included. Patients who underwent open repair, those who underwent revision surgery, and those with critical glenoid bone loss were excluded. A total of 68 shoulders in 66 patients (51 male and 15 female patients) were included. Patients were analyzed in 2 domains: (1) failures defined as re-dislocation and (2) failures defined as apprehension and re-dislocation combined (residual instability). Clinical outcomes were assessed using shoulder range of motion, the American Shoulder and Elbow Surgeons score, and the Western Ontario Shoulder Instability Index (WOSI) score. Pain, residual apprehension, re-dislocations, and additional surgical procedures were recorded.

**Results**
The mean age of patients was 31.16 (range, 16-60 years), and the mean follow-up duration was 8.42 ± 2.1 years. The median number of dislocations was 3 (range, 1-20), and the median time from first dislocation to surgery was 16 months (interquartile range, 3-100.5 months). Five patients reported re-dislocations (7.4%) with a mean period of 6.54 ± 2.5 years (range, 5-10.8 years). Seven patients without re-dislocations and 2 patients with re-dislocations reported residual apprehension. Mean shoulder elevation and mean external rotation were 161.3° ± 12.4° and 39.2° ± 11°, respectively. The mean visual analog scale, American Shoulder and Elbow Surgeons, and WOSI scores were 0.5 ± 1.4, 91 ± 11.9, and 88 ± 12.1, respectively. Age was similar in patients with stable shoulders and those with shoulders with re-dislocation or residual instability. The WOSI score was lower in patients with re-dislocation and residual instability (P = .030 and P = .049, respectively).

**Conclusions**
Arthroscopic Bankart repair is a successful surgical option for anterior shoulder instability. The 7.4% re-dislocation rate after 5 years indicates there may be a deterioration of capsulolabral repair in certain patients. The long-term failure pattern may be underestimated in short- to mid-term projections.

**Level of evidence**
Level IV, Case series, treatment study

BACK

**Arthroscopic surgery versus open surgery for lateral epicondylitis in an active work population: a comparative study**

López-Alameda, S., Varillas-Delgado, D., De Felipe-Gallego, J. et al.

**DOI:** https://doi.org/10.1016/j.jse.2021.11.017

**Background**

Lateral epicondylitis is common in workers who perform repetitive movements of the entire upper limb. Approximately 85%-90% of patients respond satisfactorily to conservative treatment, but in resistant patients, surgical treatment is considered. Classic open surgery is successful in between 70% and 97% of patients, similarly to more modern techniques such as arthroscopy. We sought to demonstrate the superiority of the Wolff technique in terms of clinical results. The goals of this study were to compare the functional and pain outcomes of arthroscopic surgery with open surgery using fasciotomy via the Wolff technique in the treatment of lateral epicondylitis.

**Methods**

This was a retrospective study of 47 working-age patients with resistant lateral epicondylitis: 27 underwent arthroscopic surgery and 20 underwent open surgery. Visual analog scale scores for pain and function, as well as the QuickDASH (short version of Disabilities of the Arm, Shoulder and Hand questionnaire) score, Mayo Elbow Performance Score, and Broberg and Morrey Rating System score, were collected preoperatively and postoperatively; return to patients' previous work and surgical time were also recorded.

**Results**

No statistically significant differences were observed between the groups in the reduction in the visual analog scale score (5.26 in arthroscopy group vs. 5.75 in fasciotomy group, $P = .5$), QuickDASH (short version of Disabilities of the Arm, Shoulder and Hand questionnaire) score (19 vs. 19.4, $P = .9$), Mayo Elbow Performance Score (82 vs. 81.5, $P = .8$), or Broberg and Morrey Rating System score (81.9 vs. 82.6, $P = .9$). The differences in terms of time off were also not statistically significant. The period of work leave corresponded, on average, to 83.78 days in the arthroscopy group and 89.95 days in the Wolff group. The mean surgical time was 44.2 minutes in the group undergoing arthroscopic intervention and 27.5 minutes in the fasciotomy group, showing a statistically significant difference ($P < .001$).

**Conclusions**

Arthroscopic surgery and open surgery provide similar functional results and pain reduction in the treatment of lateral epicondylitis.

**Level of evidence**

Level III, Retrospective Cohort Comparison, Treatment Study

BACK

**Macroscopic aspects of glenohumeral synovitis are related to rotator cuff tear severity**
Candela, V., Aimino, R., Mezzaqui, L. et al.

**DOI:** https://doi.org/10.1016/j.jse.2021.10.041

**Background**
The microscopic pattern of inflammatory mediators associated with rotator cuff pathology is well documented; however, little is known regarding the contemporary presence of macroscopic inflammatory joint involvement. Our aim was to investigate shoulder synovitis in a large group of patients with different sized rotator cuff tears (RCTs) and to correlate the degree of macroscopic inflammatory changes of the glenohumeral joint with RCT severity.

**Materials and methods**
A total of 296 consecutive patients (169 F, 127 M; mean age ± standard deviation: 60.75 ± 7.91) submitted to arthroscopic RCT repair were enrolled. RCT was classified intraoperatively. Glenohumeral synovitis was investigated according to 4 parameters (Davis classification 2017: capsule color, villous projections, capillaries, and axillary recess). A total score was calculated, and a 3-grade severity scale was introduced. Statistics was performed.

**Results**
Intraclass correlation coefficient (ICC) results show good to excellent reliability: capsule color (ICC: 0.95; 95% confidence interval [CI]: 0.89-0.99), villous projections (ICC: 0.90; 95% CI: 0.85-0.95), capillaries (ICC: 0.91; 95% CI: 0.86-0.95), and axillary recess (ICC: 0.55; 95% CI: 0.80-0.89).The synovitis total score was found to be 1.47 ± 1.16, 2.86 ± 1.84, and 3.99 ± 1.64 in patients with type I, II, and III RCTs, respectively. A significant difference was found between groups ($P < .001$). The prevalence of all the examined parameters was found to be significantly different between the different sized RCT groups (capsule color: $P < .001$; villous projections: $P < .001$; capillaries: $P < .001$; and axillary recess: $P < .001$). According to a 3-grade severity scale, the prevalence of absent, mild, and severe glenohumeral synovitis significantly differed between the RCT severity groups ($P < .001$).

**Conclusions**
The present study demonstrated that synovitis is a constant finding of rotator cuff pathology; it is present in 75% of patients with RCTs and correlates with tear severity. Whether synovitis is the cause or effect of RCT is still questionable. Further studies are also needed to better understand its role as a pain generator, as documented in other diseases.

**Level of evidence**
Basic Science Study, Histology

BACK

**Different expectations of patients and surgeons with regard to rotator cuff repair**

Karpinski, K., Plachel, F., Gerhardt, C. et al.

**DOI:** https://doi.org/10.1016/j.jse.2021.12.043

**Background**

Rotator cuff lesions are a common shoulder pathology mainly affecting patients aged >50 years. This condition is accompanied by not only pain and loss of function but also impaired quality of life and psychological stress. A frequently employed treatment option is arthroscopic repair. But expectations regarding the outcome after surgery might differ between patients and surgeons and therefore lead to dissatisfaction on both sides. The aim of this study was to document patient expectations of a planned arthroscopic rotator cuff repair and compare the results with the assessment of shoulder surgeons.

**Materials and methods**

A total of 303 patients and 25 surgeons were involved in this study. Patients with partial- or full-thickness tear of the rotator cuff scheduled for arthroscopic repair were included in this study. Preoperatively, they were asked to fill out questionnaires inquiring sociodemographic data, scores of the underlying pathology, as well as expectations regarding the operation with regard to pain relief, gain of range of motion and strength, as well as the effect on activities of daily life, work, and sports. Furthermore, 25 surgeons were surveyed on what they think their patients expected using the same standardized questions.

**Results**

Among the patients, 43.9% considered gain of range of motion to be the most important goal after rotator cuff repair, followed by pain relief (30.6%) and gain of force (13.7%). Among the surgeons, 72% believed pain relief to be the most important for their patient followed by movement (20%) and strength (8%). When asked which parameter was the most important to achieve after operation, for patients, movement was on first place, pain second, and strength third. For shoulder specialists, the ranking was pain, movement, and strength. Surgeons significantly overrated pain relief when ranking against movement compared with their patients.

**Conclusion**

The expectations of patients regarding their operation differ from the surgeon's assessment. Whereas gaining range of motion was more important for patients, surgeons clearly voted for pain relief. Different expectations should therefore be discussed within the pretreatment interview and taken into account when planning the right therapy. This might lead to better satisfaction on both sides.

**Level of evidence**

Survey Study, Patients and Experts

BACK

**Factors correlated with the optimal tension for arthroscopic rotator cuff repair using Grasper Tensioning Attachment**

Uno, T., Mura, N., Yuki, I. et al.

**DOI:** https://doi.org/10.1016/j.jse.2021.10.004

**Background**

Little is known about the optimal tension in arthroscopic rotator cuff repair (ARCR). This study aimed to identify preoperative, intraoperative, and postoperative factors that correlate with the tension in ARCR and to determine the optimal intraoperative tension using Grasper Tensioning Attachment, a tension meter attached to the common arthroscopic surgical grasper.

**Methods**

This study included 63 patients with a mean age at surgery of 65.3 years (range, 45-83 years) who underwent ARCR. The mean follow-up period was 24.1 months (range, 24-28 months). We investigated the patients' demographic data, Japanese Orthopaedic Association score, DeOrio and Cofield classification, and Goutallier stage of the supraspinatus and infraspinatus muscles. We also evaluated cuff integrity based on the Sugaya classification via magnetic resonance imaging. The free edge of the torn retracted tendon was grasped, and the passive tension to the footprint was then measured with Grasper Tensioning Attachment with the arm at the side. The anteroposterior (AP) and mediolateral (ML) diameters were also measured.

**Results**

The preoperative Goutallier stage of the supraspinatus muscle was stage 0 in 7 cases, stage 1 in 34, stage 2 in 20, and stage 3 in 2. The mean intraoperative rotator repair tension was 10.0 ± 2.5 N (range, 7.5-17 N). The mean AP diameter of the rotator cuff tear was 22 ± 10 mm (range, 8-50 mm), and the mean ML diameter was 24 ± 10 mm (range, 10-50 mm). Age, DeOrio and Cofield classification, Goutallier stage, AP diameter, and ML diameter correlated with rotator repair tension. The rotator repair tension in Sugaya classification type III or IV cases (n = 12, 11.4 ± 2.4 N) was significantly larger than that in type I or II cases (n = 51, 9.7 ± 2.4 N; P = .03). Tension ≥ 10 N as a cutoff value from receiver operating characteristic curve analysis was a risk factor for poor cuff integrity (95% confidence interval, 0.53-0.88).

**Conclusions**

Rotator repair tension ≥ 10 N was a risk factor for poor cuff integrity. Thus, care should be taken when performing intraoperative procedures and administering postoperative regimens.

**Level of evidence**

Level III, Retrospective Cohort Comparison, Prognosis Study

BACK

American Journal of Sports Medicine (AJSM), Volume 50, Issue 6

# No Difference in Clinical Outcomes for Arthroscopic Suprapectoral Versus Open Subpectoral Biceps Tenodesis at Midterm Follow-up: A Randomized Prospective Analysis

Brian Forsythe, MD*, Elyse J. Berlinberg, BS, Connor C. Diaz, BA, Avinaash Korrapati, BS, Avinesh Agarwalla, MD, Harsh H. Patel, BA, Brian J. Cole, MD, Gregory L. Cvetanovich, MD, Adam B. Yanke, MD, PhD, Anthony A. Romeo, MD, Nikhil N. Verma, MD

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**Background:** We have previously reported the 1-year outcomes of arthroscopic suprapectoral biceps tenodesis (ASPBT) versus open subpectoral biceps tenodesis (OSPBT) for the management of long head of the biceps tendon (LHBT) pathology. While patients had similar 1-year biceps muscle strength and pain, longer-term functional outcomes are unknown.

**Purpose:** To directly compare clinical outcomes of ASPBT versus OSPBT with interference screw fixation, distal to the bony bicipital groove, at a minimum of 2 years' follow-up.

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

**Methods:** A total of 85 patients undergoing biceps tenodesis (BT) for LHBT disease were randomized into the ASPBT or OSPBT group. Both techniques utilized polyether ether ketone inference screws for tenodesis fixation. Patients completed American Shoulder and Elbow Surgeons (ASES), Constant subjective, and Single Assessment Numeric Evaluation (SANE) questionnaires preoperatively and again at 6 months, 12 months, and at the final follow-up at a minimum of 24 months.

**Results:** A total of 73 patients (37/42 randomized to ASPBT [88%]; 36/42 randomized to OSPBT [86%]) with a mean age of 50.4 ± 10.3 years and a mean body mass index of 29 ± 7.9 were included in clinical outcome analyses. The mean final follow-up was 2.9 years (ASPBT, 3 years; OSPBT, 2.8 years [range 2-5.2 years]). Comparison of demographic characteristics and intraoperative findings showed no significant differences in age, sex, concomitant procedures, and rotator cuff disease. No statistically significant differences in the ASES (P = .25), Constant subjective (P = .52), and SANE scores (P = .61) were found at the final follow-up. Clinical outcomes scores showed no significant improvement from a mean of 12.6 months to the final follow-up at 34.5 months (ASPBT: ASES, P = .43; Constant, P = .25; SANE, P = .45 vs OSPBT: ASES, P = .65; Constant, P = .78; SANE, P = .70). No patients required revision of BT in either group.

**Conclusion:** This study reported a minimum of 2-year follow-up of patients undergoing ASPBT or OSPBT, utilizing the same interference screw technique, for the management of LHBT pathology in the setting of concomitant shoulder procedures. There were no significant differences in patient-reported outcomes and complication rates found at any time point.

BACK

**Outcomes of Arthroscopic Anterior Labroligamentous Periosteal Sleeve Avulsion Lesions: A Minimum 2-Year Follow-up**

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**Background:** Anterior labroligamentous periosteal sleeve avulsion (ALPSA) lesions can occur in recurrent anterior shoulder instability, which may lead to the labrum scarring medially to the glenoid. ALPSA lesions have also been associated with greater preoperative dislocations, larger Hill-Sachs lesions, and greater degrees of glenoid bone loss. Therefore, patients with these lesions have historically had a higher failure rate after repair, with nearly double the recurrent instability rate compared with those undergoing standard arthroscopic Bankart repair.

**Purpose:** To compare minimum 2-year outcomes of arthroscopic mobilization and anatomic repair of ALPSA lesions with those after standard arthroscopic Bankart repair.

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

**Methods:** Consecutive patients who underwent arthroscopic repair of ALPSA lesions were matched in a 1-to-3 fashion to patients who underwent standard Bankart repair by age, sex, number of previous ipsilateral shoulder instability surgical procedures, and number of anchors used. Patient-reported outcome (PRO) scores were compared preoperatively and postoperatively (American Shoulder and Elbow Surgeons [ASES]; 12-Item Short Form Health Survey [SF-12] Physical Component Summary [PCS]; Single Assessment Numeric Evaluation [SANE]; shortened version of Disabilities of the Arm, Shoulder and Hand; and satisfaction). Recurrent instability, on- versus off-track Hill-Sachs lesion, and reoperation rates were analyzed.

**Results:** A total of 100 shoulders (25 ALPSA and 75 Bankart) with an overall mean age of 25.7 years were evaluated. Patients in the ALPSA group demonstrated significant improvements in the ASES (preoperative, 74.8; postoperative, 89.7; P = .041) and SF-12 PCS (preoperative, 46.9; postoperative, 53.4; P = .021) scores but not the SANE score (preoperative, 65.2; postoperative, 75.3; P = .311). Patients in the Bankart group had significant improvements in all outcome scores at final follow-up: ASES (preoperative, 67.1; postoperative, 90.3), SANE (preoperative, 58.0; postoperative, 85.7), and SF-12 PCS (preoperative, 45.3; postoperative, 52.9) (all P < .001). There were no significant differences in PRO scores between the groups preoperatively or postoperatively (P > .05). The median satisfaction for the ALPSA group was 10 of 10 and for the Bankart group it was 9 of 10 (P = .094). There was a significantly higher rate of recurrent dislocation in the ALPSA group (8/25 [32.0%]) compared with the Bankart group (10/75 [13.3%]) (P = .040). Additionally, 5 patients (20.0%) in the ALPSA group underwent revision surgery at a mean of 5.6 years, and 8 patients (10.7%) in the Bankart group underwent revision surgery at a mean of 4.4 years (P = .311).

**Conclusion:** Despite improvements in the recognition of and surgical techniques for ALPSA lesions, they still lead to significantly higher postoperative dislocation rates; however, no differences in PRO scores were found. These findings highlight the importance of early surgical interventions in anterior shoulder instability with the hope of lessening recurrent instability and the risk of developing an ALPSA lesion, as well as careful assessment of the quality of soft tissues and other risk factors for recurrence when considering what type of shoulder stabilization procedure to perform.

BACK

# Lower Extremity

Arthroscopy, May 2022, Volume 38, Issue 5, P 1444 – 1453

**Defining Clinically Significant Outcomes Following Superior Capsular Reconstruction With Acellular Dermal Allograft**

A. Evuarherhe N.B. Condran, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.11.039

Purpose
To define clinically significant outcomes (CSO) thresholds for minimal clinically important difference (MCID), substantial clinical benefit (SCB), and patient-acceptable symptomatic state (PASS) in patients undergoing superior capsular reconstruction (SCR) with an acellular dermal allograft. We also evaluated patient-specific variables predictive of achieving CSO thresholds.

Methods
The American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (ASES), Single Assessment Numeric Evaluation (SANE), and subjective Constant-Murley (Constant) scores were collected preoperatively and at the most recent follow up for patients undergoing SCR from 2010 to 2019. A distribution-based approach was used to calculate MCID, and an anchor-based approach was used to calculate SCB and PASS. Logistic regression was used to determine factors associated with CSO achievement.

Results
Fifty-eight patients were identified (n = 39 males; n = 19 females) with a mean age of 53.4 ± 14.1 years at surgery and an average follow-up of 23 months. The MCID, SCB, and PASS were 11.2, 18.02, and 68.82 for ASES, 14.5, 23.13, and 69.9 for SANE, and 3.6, 10, and 18 for Constant, respectively. Subscapularis tear, female sex, and workers compensation (WC) status reduced odds of achieving MCID. Reduced odds of achieving Constant SCB were associated with older age, female sex, and WC status, while concomitant distal clavicle excision during SCR and lower preoperative ASES increased odds of achieving ASES SCB. Reduced odds for achieving ASES PASS were associated with female sex and WC status, while reduced odds for achieving SANE PASS were associated with subscapularis tearing preoperatively.

Conclusion
On the basis of calculated values for MCID, SCB, and PASS, subscapularis tearing, WC status, age, and sex are associated with failure to achieve clinically significant outcomes following SCR. Concomitant distal clavicle excision during SCR and lower preoperative ASES was predictive for achievement of MCID and SCB. By defining the thresholds and variables predictive of achieving CSOs following SCR, surgeons may better counsel patients prior to SCR.

Level of Evidence
Level IV, case series.

BACK

Arthroscopy, May 2022, Volume 38, Issue 5, P 1466 – 1477

**Previous Arthroscopic Hip Surgery Increases Axial Distractibility Compared to the Native Contralateral Hip and May Suggest Instability**

A.J. Mortensen, K.M. Tomasevich, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.09.021

Purpose
To compare intraoperative hip joint distractibility between hips that previously underwent arthroscopic surgery and the contralateral hip with no history of surgical manipulation.

Methods
Patients undergoing revision hip arthroscopy between April 2019 and December 2020, who previously underwent arthroscopic hip surgery for femoroacetabular impingement syndrome, were prospectively enrolled. Exclusion criteria were any contralateral hip surgery. Before instrumentation, fluoroscopic images of both hips were obtained at 25 lbs traction intervals up to 100 lbs. Total joint space was measured at each traction interval. Distraction was calculated as the difference between the baseline joint space and the total joint space at each subsequent traction interval. Wilcoxon signed ranks tests and McNemar tests were used to compare distraction between revision and native contralateral hips.

Results
Forty-seven patients were included. Mean distraction of operative hips was significantly greater than mean distraction of nonoperative hips at traction intervals of 50 lbs (2.13 vs 1.04 mm, P = .002), 75 lbs (6.39 vs 3.70 mm, P < .001), and 100 lbs (8.24 vs 5.39, P < .001). Mean total joint space of operative hips was significantly greater than mean total joint space of nonoperative hips at traction intervals of 50 lbs (6.60 vs 5.39 mm, P < .001), 75 lbs (10.86 vs 8.05 mm, P < .001), and 100 lbs (12.73 vs 9.73, P < .001). A greater percentage of operative hips achieved all distraction thresholds, in 2-mm intervals up to 10-mm, at each traction interval.

Conclusions
In the majority of patients undergoing revision hip arthroscopy, previous arthroscopic hip surgery increases axial distractibility of the hip joint compared with the native contralateral hip at axial traction forces of 50-100 lbs. Increased axial distractibility following hip arthroscopy may be suggestive of hip instability and can be assessed on a stress examination with the patient under anesthesia.

Level of Evidence
III, case–control study.

BACK

Arthroscopy, May 2022, Volume 38, Issue 5, P 1480 – 1485

**Lower Center Edge Angle and Bioipolar Cartilage Lesions Are Associated With Conversion to Hip Arthroplasty Within 2 Years Following Hip Arthroscopy: A Matched Cohort Analysis**

J.J. Ruzbarsky, M.N. Seiter, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.09.025

Purpose
The purpose of this study was to determine whether radiographic parameters, intraoperative findings, patient-reported outcome measures, or intraoperative interventions that were performed differentiate those patients with >2 mm of joint space who convert under two years to total hip arthroplasty (THA) after undergoing hip arthroscopy for femoroacetabular impingement (FAI) when compared to those converting after 2 years.

Methods
Included in this study were patients who underwent conversion to THA within 2 years of primary hip arthroscopy from a prospectively collected patient registry from 2007 to 2017. Patients who underwent early conversions to arthroplasty were matched 1:1 with patients who converted after 2 years, based upon age and gender. Preoperative outcome scores were collected, including Short Form-12, modified Harris Hip Score, and Hip Outcome Score. Additionally, variables from the preoperative radiographic evaluation, surgical findings, and procedures performed were also compared.

Results
Forty-nine patients were included in the early conversion group and were matched with 49 patients in the later conversion group. Patients with lateral center edge angles of less than 25° were more likely to be in the early failure group [OR: 3.9; 95% CI: 1.01 to 15]. Patients with unipolar chondral defects on either the femoral (P = .128) or acetabular side (P = .656) were not at increased odds for early conversion compared to later conversion; however, those with bipolar chondral lesions at the time of surgery had increased odds of early conversions [OR: 3.3; 95% CI: 1.4 to 8] (P = .01). Neither surgical treatment nor preoperative patient-reported outcome measures were associated with early conversion.

Conclusions
In patient with >2 mm of joint space, lateral center edge angles of less than 25° and those with bipolar articular cartilage lesions seen at the time of hip arthroscopy are at increased risk for conversion to total hip arthroplasty within two years.

Level of Evidence
Level III, retrospective comparison study.

BACK

Arthroscopy, May 2022, Volume 38, Issue 5, P 1488 – 1495

**Automated Text-Messaging After Hip Arthroscopy: A Randomized-Controlled Trial of "Post-Op Buddy"**

E.J. Scott, C.A. Anthony, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.09.030

Purpose
To assess an automated text-messaging system for patients after hip arthroscopy and its impact at 90 days on the Hip Disability Osteoarthritis Outcome Score Physical Function Short form (HOOS-PS, HOOS-Pain), compliance with rehabilitation guidelines, and patient satisfaction.

Methods
One hundred twenty-one participants (average age 29 ± 8.7 years, 52% female) undergoing hip arthroscopy at 2 academic institutions were prospectively enrolled and randomized to receive (1) standard perioperative communication or (2) additional automated mobile phone text messages. Inclusion criteria included ability to communicate in written English and access to a mobile phone with text-messaging capability. Patients undergoing revision surgery or simultaneous femoral or acetabular osteotomy were excluded. HOOS-PS and HOOS-Pain were collected preoperatively, and after surgery an automated mobile phone robot sent participants in the therapeutic arm intermittent text messages for 90 days. At 90 days all participants again completed HOOS-PS, HOOS-Pain, and additional survey questions on satisfaction with their experience (10-point scale), communication from the surgical team (10-point scale) and adherence to physical therapy exercises, weight-bearing guidelines, and brace use, The primary outcome assessed was a statistically significant change in HOOS-PS and HOOS-Pain; secondary outcomes included change in satisfaction, communication, and adherence to physical therapy exercises, weightbearing guidelines, or brace use. Wilcoxon rank sum was used to compare HOOS-PS and HOOS-Pain scores at 0 and 90 days. Demographic characteristics and survey variables were compared using Students t test for continuous variables and $\chi 2$ or Fisher exact test for categorical variables as appropriate.

Results
There were statistically significant and clinically relevant improvements in HOOS-PS and HOOS-Pain in both groups ($P < .05$). Subjective feedback was strongly positive, with 96% of text message participants reporting they would choose automated messages if it was offered to them again in the future.

Conclusions
Ninety days of automated text messaging after hip arthroscopy failed to show a significant difference in HOOS-PS ($P = .09$), HOOS-Pain ($P = .13$), patient-reported compliance with postoperative guidelines, or satisfaction with support and communication from the surgical team.

Level of Evidence
I, randomized control trial (RCT).

BACK

Arthroscopy, May 2022, Volume 38, Issue 5, P 1496 – 1505

**Hip Gluteus Medius Tears Are Associated With Lower Femoral Neck-Shaft Angles and Higher Acetabular Center-Edge Angles**

H. Sun, H. Huang, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.10.006

Purpose
1) To assess the possible relationship between the morphology of femur or acetabulum and the gluteus medius pathology. 2) To analyze the outcome of isolated arthroscopic treatment of femoroacetabular impingement (FAI) for patients with radiographic gluteus medius tear.

Methods
We performed a retrospective study of FAI patients who underwent arthroscopy between January 2016 to December 2019. Demographic data, such as sex, age, body mass index (BMI), symptom duration, were collected. Radiographic parameters, including alpha angle, lateral center-edge angle (LCEa), femur neck-shaft angle (NSa), gluteus medius pathology, were also collected. Exclusion criteria were previous hip conditions, such as osteoarthritis (Tönnis grade > 1), rheumatoid arthritis, ankylosing spondylitis, snapping hip, previous surgery on the ipsilateral hip, or incomplete data. We followed up these patients with radiographic gluteus medius tear. No surgical procedure for gluteus medius was performed. The minimum follow-up period was 13 months. Patient-reported outcomes, such as modified Harris Hip score (mHHS), visual analog scale (VAS), and patient acceptable symptom state (PASS), as well as physical examination data, including tenderness at the greater trochanter, abductor weakness, limping gait, and positive Trendelenburg sign or test, were gathered preoperatively and postoperatively.

Results
A total of 569 hips (314, 55.2% male) were collected eventually, with a mean age of 36.5 ± 10.4 years (range: 13.0 to ~65.0). Gluteus medius pathology was found in 209 (36.7%) hips, including 41 (7.2%) partial-thickness tears and 10 (1.8%) complete tears. The NSa of the normal, tendinosis, partial tear, and complete tear groups was 133.8 ± 4.7°, 130.6 ± 3.8°, 129.4 ± 3.9°, and 129.6 ± 3.4°, respectively ($P < .001$). The LCEa of each group was 31.7 ± 35.7°, 33.3 ± 6.5°, 34.9 ± 6.8°, and 33.7 ± 8.1°, respectively ($P = .004$). On multivariable logistic regression analysis, lower NSa and higher LCEa were identified as risk factors for developing gluteus medius pathology ($P < .001$). For patients with gluteus medius tear, two cases were lost to follow-up and two cases had incomplete data. The mean follow-up period of the remaining 47 hips was 29.5 ± 12.9 (range: 13 to 59) months. The mHHS improved from 54.8 ± 19.1 to 90.1 ± 6.7 points ($P < .001$), and VAS decreased from 6.8 ± 1.6 to 3.0 ± 1.6 points ($P < .001$). Forty-two cases met the threshold of PASS, with a rate of 89%. The abductor strength increased from 4.1 ± 1.00 to 4.6 ± .7 grades ($P = .002$). However, for patients with a completely torn gluteus medius, improvement of abductor strength was not significant statistically (3.4 ± .9 to 3.9 ± .9, $P = .234$).

Conclusion
There was a correlation between lower NSa/higher LCEa and gluteus medius pathology. Isolated arthroscopic treatment of FAI for patients with radiographic gluteus medius tear can gain satisfactory patient-reported outcomes.

Level of evidence
Therapeutic case series, IV.

BACK

Arthroscopy, May 2022, Volume 38, Issue 5, P 1509 – 1515

**Patients With a High Femoroepiphyseal Roof With Concomitant Borderline Hip Dysplasia and Femoroacetabular Impingement Syndrome Do Not Demonstrate Inferior Outcomes Following Arthroscopic Hip Surgery**

S.E. Wong, A.C. Newhouse, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.10.012

Purpose
The purpose of this study was to compare outcomes after hip arthroscopy for femoroacetabular impingement syndrome (FAIS) in patients with borderline hip dysplasia and hip instability defined radiographically using the femoroepiphyseal acetabular roof (FEAR) index and in patients without radiographic evidence of hip instability.

Methods
Data from consecutive patients with borderline hip dysplasia (lateral center edge angle between 18˚-25˚) who underwent primary hip arthroscopy between April 2012 and June 2017 for the treatment of FAIS were analyzed. Baseline demographic data, radiographic parameters, preoperative, and 2-year postoperative patient-reported outcome measures were collected. The FEAR index was measured by 3 different observers. Patients with an average FEAR index ≥2˚ were categorized as having radiographic evidence of instability as previously published. The analysis was powered to detect a minimal clinically important difference (MCID) for each outcome score. Statistical analysis was performed as appropriate to compare patients with FEAR index ≥2 and <2°.

Results
A total of 140 patients met the inclusion criteria. The average age and body mass index of included patients was 31.7 ± 13.2 (P < .325) years and 25.1 ± 5.6 kg/m2 (P < .862). There were no statistically significant demographic differences between the groups. Nineteen (13.0%) patients were found to have a FEAR index of over 2˚. The FEAR index <2° and FEAR index ≥2° groups had a mean preoperative FEAR index (standard deviation, range) of −7.0 (5.2, −26.8 to 1.9) and 4.8 (2.5, 2.0-11.8), respectively. The interrater intraclass correlation coefficient was 0.96. Postoperative patient-reported outcomes and rates of MCID and patient-acceptable symptomatic state achievement were not statistically different between the radiographically stable and unstable groups. (p>0.05 for all).

Conclusion
Patients with borderline hip dysplasia and radiographic evidence of hip instability, as measured by the FEAR index (≥2°), achieve similar improvement in 2-year outcomes compared to those with radiographically stable hips after arthroscopic treatment of FAIS.

Clinical Relevance
Retrospective Level III cohort study

BACK

Arthroscopy, May 2022, Volume 38, Issue 5, P 1528 – 1534

**Vancomycin Presoaking of Hamstring Autografts in Anterior Cruciate Ligament Reconstruction Is Associated With Higher Magnetic Resonance Imaging Graft Signal Without Influencing Clinical Outcome**

F. Figueroa, D. Figueroa, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.09.023

Purpose
To present the clinical and imaging results of a series of patients undergoing anterior cruciate ligament reconstruction with vancomycin presoaking of the hamstring autograft compared with patients in the immediate period prior, when no vancomycin was used.

Methods
This was a retrospective sequential series of patients with anterior cruciate ligament reconstruction using either a graft protocol with no vancomycin presoaking (group 1, January 2013 to October 2015) or a graft protocol with vancomycin presoaking (group 2, November 2015 to December 2018). Lysholm and International Knee Documentation Committee scores were obtained at a minimum 24-month follow-up. Graft ruptures were recorded. Between 6 and 12 months' follow-up, magnetic resonance imaging (MRI) was obtained to evaluate graft healing and integration.

Results
There were 102 patients (72% male patients), with 40 in group 1 (mean age, 32.2 years) and 62 in group 2 (mean age, 32.3 years). A graft rupture occurred in 5 patients (13%) in group 1 and 6 patients (10%) in group 2 (P = .65). The median Lysholm score was 95 points (interquartile range [IQR], 86-100 points) in group 1 and 95 points (IQR, 90-100 points) in group 2 (P = .37). The median International Knee Documentation Committee score was 93 points (IQR, 82-99 points) in group 1 and 94 points (IQR, 86-99 points) in group 2 (P = .22). MRI evaluation of integration showed that 87 patients (90%) had no synovial fluid at the tunnel-graft interface, without a difference between groups (P = .24). On the basis of graft signal appearance, hyperintense grafts were found in 45 patients (46%); isointense, 45 (46%); and hypointense, 7 (7%). Group 1 had a higher prevalence of hypointense grafts, whereas group 2 had a higher prevalence of hyperintense and isointense grafts (P = .003).

Conclusions
Vancomycin presoaking of hamstring grafts increased the number of hyperintense and isointense grafts on MRI. Additionally, more hypointense grafts were noted when vancomycin was not used, suggesting the presence of more mature grafts in the non-vancomycin group.

Level of Evidence
Level III, retrospective comparative study.

BACK

Arthroscopy, May 2022, Volume 38, Issue 5, P 1537 – 1543

**The Majority of Patients Aged 40 and Older Having Allograft Anterior Cruciate Ligament Reconstruction Achieve a Patient Acceptable Symptomatic State**

S.M. Sylvia, G.S. Peronne, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.09.024

Purpose
To evaluate patient satisfaction, retear rates, and patient-reported outcomes (PROs) in patients aged 40 and older undergoing allograft anterior cruciate ligament reconstruction (ACLR). The secondary goal was to compare these parameters between groups of patients with intact versus failed grafts, and to evaluate these in relation to a historically reported International Knee Documentation Committee (IKDC) patient-acceptable symptoms state (PASS) score.

Methods
Records of patients aged 40 and older who underwent ACLR between 2005 and 2016 at a single institution with a minimum 2-year follow-up were retrospectively reviewed. Patient-reported satisfaction, outcome scores, and failure rates were analyzed. The rate of achieving a previously defined IKDC PASS score based on younger cohorts was reported, and an updated PASS threshold for older patients was calculated.

Results
201 patients were included with a mean age of 48.6 years (range: 40-68) and mean follow-up of 6.2 years (range: 2.8-11.2). 182 (90.5%) patients reported satisfaction following surgery. 16 (8.0%) patients experienced failure of their ACLR, 10 of which underwent revision ACLR. The median IKDC score in the intact ACLR group was 86.2, compared to 66.7 in the failure group ($P < .001$). In total, 134 (72.4%) patients in the intact group achieved the historical PASS score of 75.9 on IKDC compared to only 4 (25%) in the failure group ($\chi 2 = 15.396$, $P < .001$). An updated IKDC PASS threshold for older cohorts was calculated to be 66.7.

Conclusion
Patients aged 40 and older who underwent allograft ACLR had an 8.0% failure rate at a mean follow-up of 6 years. Graft failure in patients aged 40 and older was associated with worse PROs. The majority of patients achieved the historically reported IKDC PASS threshold. Additionally, an updated age-appropriate IKDC PASS score of 66.7 was calculated to aid in future ACLR studies assessing older patients.

Study Design
Level IV.

BACK

Arthroscopy, May 2022, Volume 38, Issue 5, P 1547 – 1554

**Insufficient Correction and Preoperative Medial Tightness Increases the Risk of Varus Recurrence in Open-Wedge High Tibial Osteotomy**

J. Song, S. Bin et al.

DOI: https://doi.org/10.1016/j.arthro.2021.09.028

Purpose
To assess serial changes of limb alignment after open wedge high tibial osteotomy (HTO) using the weightbearing line (WBL) ratio in the midterm, with a focus on varus recurrence.

Methods
Patients undergoing open wedge HTO from January 2010 to December 2016 were retrospectively reviewed. Those without serial postoperative weightbearing long-leg alignment films, those who showed remained varus alignment after osteotomy, and those who had <2 years of follow-up were excluded. In terms of immediate postoperative limb alignment (≤3 months) measured using WBL ratio, cases were categorized into 4 groups: <50%, undercorrection; 50% to 57%, insufficient correction; 57% to 67%, planned correction; and >67%, overcorrection. To determine risk factors for varus recurrence (WBL ratio <50%), immediate postoperative WBL ratio category and preoperative valgus and varus stress angles (which represent medial and lateral tightness of the joint, respectively) were investigated using logistic regression analysis, taking other related factors into account. Clinical outcomes according to varus recurrence were measured using Hospital for Special Surgery (HSS) scores.

Results
A total of 148 cases were included. Varus recurrence was noted in 40 cases (27.0%), with a mean follow-up of 49.7 ± 21.8 months (range 24 to 102 months). The incidence of varus recurrence was different according to WBL ratio category: 10/10 (100.0%) in undercorrection; 16/33 (48.5%) in insufficient correction; 13/58 (22.4%) in planned correction; and 1/47 (2.1%) in overcorrection. Based on logistic regression analysis, insufficient correction and preoperative valgus stress angle were found to be significant risk factors (P = .038, and .008, respectively). With valgus stress angle <2°, 7 of 10 insufficient correction cases showed varus recurrence (P = .005). However, HSS scores did not differ according to varus recurrence (P = .363).

Conclusion
Insufficient correction and preoperative medial tightness increased the risk of varus recurrence. Especially in cases where preoperative valgus stress angle was <2°, insufficient correction was strongly associated with varus recurrence. However, no significant differences in clinical outcomes were observed according to varus recurrence in the midterm.

Level of Evidence
III, retrospective cohort study.

BACK

Arthroscopy, May 2022, Volume 38, Issue 5, P 1571 – 1580

**Dynamic Mediolateral Patellar Translation Is a Sex- and Size-Independent Parameter of Adult Proximal Patellar Tracking Using Dynamic 3 Tesla Magnetic Resonance Imaging**

J. Frings, T. Dust, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.10.014

Purpose
To provide normal values for physiological patellofemoral tracking in a representative group of healthy individuals, as well as sex differences, using real-time 3T-magnetic resonance imaging (MRI) and to test for the reliability of the presented technique.

Methods
One hundred knees of healthy individuals with no history of patellofemoral symptoms were scanned with dynamic MRI sequences, during repetitive cycles of flexion (40°) and full extension. Within a 30-seconds time-frame, three simultaneous, transverse slices were acquired. Dynamic mediolateral patellar translation (dMPT) and dynamic patellar tilt (dPT) were measured on two occasions by two independent examiners. Common radiological parameters were measured using static MRI, and correlations were calculated.

Results
100 knees (53 right, 47 left; age: 26.7 ± 4.4 years; BMI: 22.5 ± 3.1) of 57 individuals (27 females, 30 males) were included. Mean height was 170.1 ± 7.7 cm in women and 181.8 ± 6.4 cm in men. Average patella diameter was 37.9 ± 2.7 (95% CI 37.1-38.7) mm in women and 42.4 ± 3.2 (95% CI 41.5-43.3) mm in men. In females, the patellar diameters and intercondylar distances were significantly smaller than in males ($P < .001$). Radiological parameters for patellar maltracking were within the normal range. During the range of motion, mean dMPT was 1.7 ± 2.4 (95% CI .9-2.5) mm in females and 1.8 ± 2.7 (95% CI 1.1-2.6) mm in males ($P = .766$). Mean dPT was 1.3 ± 2.9° (95% CI .4-2.1°) in females and −0.2 ± 3.8° (95% CI −1.2-.9°) in males ($P = .036$). Neither dMPT nor dPT was correlated with height, BMI, or patellar diameter. Intercondylar distance correlated weakly with dPT ($r = −.241$; $P = .041$). Intra- and interrater reliability were excellent for dMPT and dPT.

Conclusion
Dynamic mediolateral patellar translation is a size- and sex-independent parameter for proximal patellar tracking. In healthy individuals without patellofemoral abnormalities normal dMPT proximal to the trochlea groove was 1.7 ± 2.5 (1.2-2.2) mm, independent of size or sex. Normal dPT showed a dependency on sex and was 1.3 ± 2.9 (.4-2.1)° in women and −0.2 ± 3.8 (−1.2-0.9)° in men.

Level of Evidence
Level II, diagnostic study.

BACK

Arthroscopy, May 2022, Volume 38, Issue 5, P 1571 – 1580

# An Increased Lateral Femoral Condyle Ratio in Addition to Increased Posterior Tibial Slope and Narrower Notch Index Is a Risk Factor for Female Anterior Cruciate Ligament Injury

N. Jeon, N. Choi, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.10.022

Purpose
To investigate the relationship between the lateral femoral condyle ratio (LFCR) among osseous morphologic characteristics of the knee and anterior cruciate ligament (ACL) injury in female patients.

Methods
Inclusion criteria were female patients (ACL group, n = 59) undergoing primary ACL reconstruction from 2012 to 2018. Control female patients (control group, n = 58) were matched by age, height, and body mass index to ACL group. They had no meniscal or ligament tear, and no trochlear dysplasia on magnetic resonance imaging. The LFCR, notch width index (NWI), and posterior tibial slope (PTS) were measured and compared between the ACL and control groups. For each risk factor, the receiver operating characteristic curve and the area under the curve and its 95% confidence interval (CI) was calculated to determine the cutoff for detecting increased risk of ACL injury.

Results
The LFCR was significantly larger in the knees in the ACL group than in the control group (P = .001). The NWI was significantly smaller and the PTS was significantly larger in the knees in the ACL group than in the control group (P = .000, P = .000, respectively). The NWI (odds ratio [OR] 1.41; P = .000) was the most significant factor, followed by the PTS (OR 1.29; P = .003) and the LFCR (OR 1.26; P = .001). The area under the curve (0.67, 95% CI 0.58-0.77) for the LFCR had a sensitivity of 66% and specificity of 66% to predict an ACL injury. The cutoff of 63.9 was associated with an increased risk for ACL injury (OR 3.71; 95% CI 1.73-7.95).

Conclusions
An increased LFCR was associated with female ACL injury. The LFCR, NWI, and PTS are predictive risk factors for an ACL injury. These findings need to be considered for clinician in identifying female patients at risk for an ACL injury.

Level of Evidence
III, retrospective comparative prognostic trial.

BACK

Arthroscopy, May 2022, Volume 38, Issue 5, P 1608 – 1614

**The Tibial Tubercle-Trochlear Groove Distance/Trochlear Dysplasia Index Quotient Is the Most Accurate Indicator for Determining Patellofemoral Instability Risk**

J. Moya-Angeler, G. L. Vairo, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.08.018

Purpose
The primary aim of our study was to evaluate diagnostic accuracy of the tibial tubercle-trochlear groove (TT-TG) distance relative to associated quotients produced from trochlear width (TT-TG distance/TW) and trochlear dysplasia index (TT-TG distance/TDI) for detecting patellofemoral instability. Secondary aims included identifying thresholds for risk and comparing differences between cases and controls.

Methods
Consecutive sampling of electronic medical records produced 48 (21 males, 27 females) patellofemoral instability cases (19 ± 7 years old) and 79 (61 males, 18 females) controls (23 ± 4 years old) who had a history of isolated meniscal lesion, as evaluated by magnetic resonance imaging. Standardized methods were employed with measurements executed in a blinded and randomized manner. A receiver operating characteristic curve assessed accuracy by area under the curve (AUC). The index of union (IU) was employed to identify a threshold for risk. Two-sample t-tests examined group differences. $P < .05$ denoted statistical significance.

Results
The AUC values were .69 (.60, .79) for TT-TG distance, .81 (.73, .88) for TT-TG distance/TW, and .85 (.78, .91) for TT-TG distance/TDI. Thresholds were 14.7 mm for TT-TG distance, .36 for TT-TG distance/TW, and 1.88 for TT-TG distance/TDI. Cases demonstrated statistically significant ($P < .001$) greater values for each measure compared with controls: TT-TG distance (15.8 ± 4.2 mm vs 12.9 ± 3.6 mm, [1.4, 4.3]); TT-TG distance/TW (.51 ± .24 vs .31 ± .09, [.13, .27]); TT-TG distance/TDI (3.07 ± 1.55 vs 1.7 ± .7, [.9, 1.84]).

Conclusion
The TT-TG distance, TT-TG distance/TW, and TT-TG distance/TDI measures were 69%, 81%, and 85%, respectively, accurate for determining patellofemoral instability risk. Thresholds for risk were 14.7 mm for TT-TG distance, .36 for TT-TG distance/TW, and 1.88 for TT-TG distance/TDI. The thresholds reported in this study may help in advancing clinical decision-making.

Level of Evidence
Level III, diagnostic retrospective comparative observatory trial

BACK

Arthroscopy, May 2022, Volume 38, Issue 5, P 1658 – 1663

**Post-Related Complications in Hip Arthroscopy Are Reported Significantly Greater in Prospective Versus Retrospective Literature: A Systematic Review**

A.E. Wininger, O. Mei-Dan, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.11.045

Purpose
To determine whether there are differences in (1) the incidence of post-related complications following hip arthroscopy between prospective and retrospective publications; and (2) between post-assisted and postless techniques.

Methods
A systematic review was performed using PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines to characterize post-related complications following hip arthroscopy for central or peripheral compartment hip pathology, including femoroacetabular impingement syndrome and chondrolabral injury. Inclusion criteria were prospective and retrospective Level I-IV evidence investigations that reported results of hip arthroscopy performed in the supine position. Exclusion criteria included open or extra-articular endoscopic hip surgery. Post-related complications included pudendal nerve injury (sexual dysfunction, dyspareunia, perineal pain or numbness) or perineum/external genitalia soft-tissue injury.

Results
Ninety-four studies (12,212 hips; 49% male, 51% female; 52% Level IV evidence) were analyzed. Prospective studies (3,032 hips) report a greater incidence of post-related complications compared with retrospective (8,116 hips) studies (7.1% vs 1.4%, $P < .001$). Three studies (1,064 hips) used a postless technique and all reported a 0% incidence of pudendal neurapraxia or perineal soft tissue injury. Most pudendal nerve complications were transient, resolving by 3 months, but permanent nerve injury was reported in 4 cases. Only 19%, 22%, 7%, and 4% of studies reported a total surgery time, traction time, traction force, and bed Trendelenburg angle for their study samples, respectively.

Conclusions
The incidence of post-related complications is 5 times greater in prospective (versus retrospective) hip arthroscopy literature. Postless distraction resulted in a 0% incidence of post-related injuries.

Level of Evidence
IV, systematic review of Level I-IV evidence.

BACK

Arthroscopy, May 2022, Volume 38, Issue 5, P 1658 – 1663

**Posterior Tibial Slope, Notch Width, Condylar Morphology, Trochlear Inclination, and Tibiofemoral Mismatch Predict Outcomes Following Anterior Cruciate Ligament Reconstruction**

D. N. Bongbong, J.F. Oeding, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.11.055

Purpose
To provide a comprehensive summary of the available literature on the influence of bone morphology on outcomes after anterior cruciate ligament reconstruction (ACLR).

Methods
Our protocol was prospectively registered with PROSPERO (International Prospective Register of Systematic Reviews) and followed PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines. The PubMed, Embase, and MEDLINE databases were searched for studies investigating knee morphologic features and outcomes after ACLR. Articles were screened and references lists were reviewed to identify relevant studies, after which methodologic quality was assessed for each study included in this review. Because of significant variability in terminology and methodology between studies, no meta-analyses were conducted.

Results
Systematically screening a total of 19,647 studies identified from the search revealed 24 studies that met the inclusion and exclusion criteria. Among tibial shape features identified as predictors of poor outcomes after ACLR, increased posterior tibial slope was most common (16 studies). Other features such as increased tibial plateau area (1 study), decreased medial plateau width (1 study), and increased medial plateau height (1 study) were also associated with poor outcomes. For the femur, features related to notch width and condylar morphology were most common (4 studies and 7 studies, respectively). An increased condylar offset ratio, increased lateral femoral condylar ratio, and larger notch width were each found to be associated with negative ACLR outcomes, including increased cartilage degeneration, worse patient-reported outcomes, and graft failure.

Conclusions
Posterior tibial slope, notch width, condylar morphology, trochlear inclination, and tibiofemoral mismatch are associated with and predictive of outcomes after ACLR.

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

BACK

Knee Surgery, Sports Traumatology, Arthroscopy, May 2021, volume 30, issue 5, pages: 1520 – 1526

**Autologous semitendinosus tendon graft could function as a meniscal transplant**
Rönnblad, E., Rotzius, P., Eriksson, K.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06606-8

**Purpose**
Meniscectomy results in poor knee function and increased risk for osteoarthritis. Meniscal allograft transplantation is not widely used due to costs and availability. The semitendinosus tendon (ST) has the potential to remodel and revascularize in an intraarticular environment, such as ACL reconstruction. The objective for this pilot study was to investigate whether the ST graft could function as a meniscal transplant.

**Methods**
The ST was doubled and sutured with running sutures and pull-out sutures in each end. Bone tunnels were used for root anchorage and the graft was sutured with allinside, inside-out and outside-in technique. The pull-out sutures were fixed over a button. Partial weight bearing was allowed with limited range of motion in a brace for the first 6 weeks. Evaluation was assessed using clinical examination, radiology and patient reported outcome.

**Results**
A total of seven patients have been included between January 2018 and June 2020. Six medial transplants and one lateral transplant were performed. Mean age was 29 years. Four patients had completed the 12-month follow-up. Improvements were noted for IKDC Global Score, KOOS pain subscale and Lysholm. MRI indicated that the transplant become more wedge-like with visible roots and minor protrusion.

**Conclusions**
Even though this is primarily a technical report the follow-up data indicate that the transplant survives and adapts in shape and capabilities to an original meniscus. There were no adverse events and the patients seem to improve in terms of pain and quality of life.

BACK

**Good healing potential of patellar chondral defects after all-arthroscopic autologous chondrocyte implantation with spheroids: a second-look arthroscopic assessment**

Sumida, Y., Nakamura, K., Feil, S. et al.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06584-x

**Purpose**

To report second-look arthroscopic assessment after all-arthroscopic autologous chondrocyte implantation (ACI) for articular cartilage defects at the patella.

**Methods**

A second-look arthroscopy after all-arthroscopic ACI using chondrospheres® (ACT3D) was performed in 30 patients with 30 full-thickness retropatellar cartilage defects. The mean time from ACI to second-look arthroscopy was 14.9 ± 16.3 (6–71) months. The quality of cartilage regeneration was evaluated by the International Cartilage-Repair Score (ICRS)—Cartilage Repair Assessment (CRA).

**Results**

Eleven lesions (36.7%) were classified as CRA grade I (normal) and 19 lesions (63.3%) as grade II (nearly normal). Concerning the degree of defect repair, 25 lesions (83.3%) were repaired up to the height of the surrounding articular retropatellar cartilage. Five lesions (16.7%) showed 75% repair of defect depth. The border zone was completely integrated into the surrounding articular cartilage shoulder in 28 lesions (93.3%) and demarcated within 1 mm in 2 lesions (6.7%). Macroscopically and by probing, 12 lesions (40%) had intact smooth surface, 17 lesions (56.7%) had fibrillated surface and 1 lesion (3.3%) had small, scattered fissures. A negative correlation was found between the overall repair assessment score and the defect size ($r^2 = -0.430$, $p = 0.046$) and between integration into border zone and defect size ($r^2 = -0.340$, $p = 0.045$). A positive correlation was found between macroscopic appearance and age ($r^2 = +0.384$, $p = 0.036$).

**Conclusions**

All-arthroscopic ACI using chondrospheres® (ACT3D) for full-thickness retropatellar articular cartilage defects proved to be reproducible and reliable. The advantage of the procedure is that it is minimal invasive. Arthroscopic second-look demonstrated a high grade of normal or nearly normal cartilage regeneration. Although statistically significant differences were not observed, larger defect size and younger age may compromise the result of overall repair.

**Level of evidence**

III.

BACK

**Remnant preserving ACL reconstruction with a functional remnant is related to improved laxity but not to improved clinical outcomes in comparison to a nonfunctional remnant**

Franciozi, C.E., Minami F.K., Ambra, L.F. et al.

**DOI**: https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06572-1

**Purpose**

The Anterior cruciate ligament (ACL) remnant has been pointed out as a ligamentization enhancer. Nonetheless, the remaining tissue can be functional if it still provides some stability or nonfunctional. This study intends to compare the clinical results and knee stability of functional vs. nonfunctional remnant preservation ACL reconstruction (ACLR).

**Methods**

One hundred and seventy-five patients with ACL injuries were included and underwent remnant preservation ACLR. They were divided into two groups accordingly to remnant tissue functionality: functional (Group F) and nonfunctional (Group NF). Primary outcome was defined as patient reported outcomes measured with Lysholm, IKDC and Tegner continuous scales and improvements. Secondary outcomes comprised of Lachman test, anterior drawer test, pivot shift test, extension and flexion deficit, graft coverage by remnant preserved tissue and failure rate (persistent instability or new ACL lesion). Menisci lesions, cartilage lesions and time to surgery were also recorded for each group.

**Results**

One hundred and forty-four patients were available at a mean of 30.2 ± 10.1 months: 69 Functional and 75 Nonfunctional. Lysholm, IKDC and Tegner functional outcomes demonstrated no difference between the groups, Functional compared to Nonfunctional: 88.4 ± 10.5 vs. 92.2 ± 4.9, n.s. and 83.2 ± 11.3 vs. 87 ± 5.3, n.s. and 6 (5–10) vs. 6 (5–9), n.s., respectively. Lysholm and IKDC functional outcomes improvements demonstrated differences between the groups: Functional compared to Nonfunctional (39.3 ± 9.4 vs. 42.3 ± 7.4, $p = 0.014$ and 37.7 ± 10 vs. 41.0 ± 6.6, $p = 0.032$); however, they were not clinically significant. Functional group showed more stability on physical examination pre- and post-operatively ($p < 0.001$, $p < 0.001$). There was no difference regarding extension deficit (n.s.); however, functional group had more flexion deficit ($p = 0.02$). Nonfunctional group had better graft coverage ($p = 0.001$). There was no difference regarding failure rate: 4% vs. 9%, (n.s.).

**Conclusion**

Both remnant preservation ACLR techniques were able to achieve satisfactory functional outcomes. A functional remnant was not related to improved functional outcomes in comparison to a nonfunctional remnant; however, it was related to less laxity pre and postoperatively and inferior graft coverage.

**Level of evidence**

II.

BACK

**Incidence and risk factors for symptomatic venous thromboembolism following anterior cruciate ligament reconstruction**

Forlenza, E.M., Parvaresh, K.C., Cohn, M.R. et al.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06583-y

**Purpose**

To determine the incidence of symptomatic venous thromboembolism (VTE) following anterior cruciate ligament (ACL) reconstruction using a large national database and to identify corresponding independent risk factors.

**Methods**

The Humana administrative claims database was reviewed for patients undergoing ACL reconstruction from 2007 to 2017. Patient demographics, medical comorbidities, as well as concurrent procedures were recorded. Postoperative incidence of VTE was measured by identifying symptomatic deep vein thrombosis (DVT) and pulmonary embolism (PE) at 30 days, 90 days, and 1 year postoperatively. Univariate analysis and binary logistic regression were performed to determine independent risk factors for VTE following surgery.

**Results**

A total of 11,977 patients were included in the study. The incidence of VTE was 1.01% (n = 120) and 1.22% (n = 146) at 30 and 90 days, respectively. Analysis of VTE events within the first postoperative year revealed that 69.6% and 84.3% of VTEs occurred within 30 and 90 days of surgery, respectively. Logistic regression identified age ≥ 45 (odds ratio [OR] = 1.88; 95% confidence interval [CI] 1.32–2.68; $p < 0.001$), inpatient surgery (OR = 2.07; 95% CI 1.01–4.24; $p = 0.045$), COPD (OR = 1.51; 95% CI 1.02–2.24; $p = 0.041$), and tobacco use (OR = 1.75; 95% CI 1.17–2.62; $p = 0.007$), as well as concurrent PCL reconstruction (OR = 3.85; 95% CI 1.71–8.67; $p = 0.001$), meniscal transplant (OR = 17.68; 95% CI 3.63–85.97; $p < 0.001$) or osteochondral allograft (OR = 15.73; 95% CI 1.79–138.43; $p = 0.013$) as independent risk factors for VTE after ACL reconstruction.

**Conclusions**

The incidence of symptomatic postoperative VTE is low following ACL reconstruction, with the majority of cases occurring within 90 days of surgery. Risk factors include age ≥ 45, inpatient surgery, COPD, tobacco use and concurrent PCL reconstruction, meniscal transplant or osteochondral allograft.

**Level of evidence**

III.

BACK

**A larger side-to-side difference in anterior knee laxity increases the prevalence of medial and lateral meniscal injuries in patients with ACL injuries**

Nakamae, A., Sumen, Y., Tsukisaka, K. et al.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06601-z

**Purpose**

The objective of this study was to investigate factors that influence the prevalence of medial and lateral meniscal injuries at the time of anterior cruciate ligament (ACL) reconstruction in patients with ACL injuries.

**Methods**

Patients with ACL injuries at 9 institutions were enrolled in this multicentre study. Age, sex, duration between injury and surgery, pivot shift test grade, anterior knee laxity determined using the Kneelax 3 arthrometer, and other variables were assessed by logistic regression analysis. Meniscal conditions were evaluated via arthroscopy.

**Results**

In all, 830 patients were enrolled. The prevalence of medial and lateral meniscal tears was 32.0% (266 knees) and 26.5% (220 knees), respectively. Significant factors that influenced the prevalence of medial meniscal injuries were age [odds ratio (OR) 1.03; P = 0.000], side-to-side differences in instrumented anterior knee laxity before surgery (OR 1.12; P = 0.002), duration between injury and surgery (≥ 12 months) (OR 1.86; P = 0.023), and pivot shift test grade (OR 1.36; P = 0.014). Significant factors of lateral meniscal injury were side-to-side differences in anterior knee laxity before surgery (OR 1.12; P = 0.003) and the male sex (OR 1.50; P = 0.027).

**Conclusion**

Greater anterior knee laxity, age, a longer duration between injury and surgery, and a higher pivot shift test grade predicted medial meniscal injury. Greater anterior knee laxity and the male sex predicted lateral meniscal injury. In patients with ACL injuries, the importance of side-to-side differences in anterior knee laxity should be rediscovered from the viewpoint of meniscal conditions.

**Level of evidence**

Level III.

BACK

**Performing a knee arthroscopy among patients with degenerative knee disease: one-third is potentially low value care**

Rietbergen, T., Marang-van de Mheen, J., Diercks, R.L. et al.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06615-7

**Purpose**

The purpose of this study was to assess in which proportion of patients with degenerative knee disease aged 50+ in whom a knee arthroscopy is performed, no valid surgical indication is reported in medical records, and to explore possible explanatory factors.

**Methods**

A retrospective study was conducted using administrative data from January to December 2016 in 13 orthopedic centers in the Netherlands. Medical records were selected from a random sample of 538 patients aged 50+ with degenerative knee disease in whom arthroscopy was performed, and reviewed on reported indications for the performed knee arthroscopy. Valid surgical indications were predefined based on clinical national guidelines and expert opinion (e.g., truly locked knee). A knee arthroscopy without a reported valid indication was considered potentially low value care. Multivariate logistic regression analysis was performed to assess whether age, diagnosis ("Arthrosis" versus "Meniscal lesion"), and type of care trajectory (initial or follow-up) were associated with performing a potentially low value knee arthroscopy.

**Results**

Of 26,991 patients with degenerative knee disease, 2556 (9.5%) underwent an arthroscopy in one of the participating orthopedic centers. Of 538 patients in whom an arthroscopy was performed, 65.1% had a valid indication reported in the medical record and 34.9% without a reported valid indication. From the patients without a valid indication, a joint patient–provider decision or patient request was reported as the main reason. Neither age [OR 1.013 (95% CI 0.984–1.043)], diagnosis [OR 0.998 (95% CI 0.886–1.124)] or type of care trajectory [OR 0.989 (95% CI 0.948–1.032)] were significantly associated with performing a potentially low value knee arthroscopy.

**Conclusions**

In a random sample of knee arthroscopies performed in 13 orthopedic centers in 2016, 65% had valid indications reported in the medical records but 35% were performed without a reported valid indication and, therefore, potentially low value care. Patient and/or surgeons preference may play a large role in the decision to perform an arthroscopy without a valid indication. Therefore, interventions should be developed to increase adherence to clinical guidelines by surgeons that target invalid indications for a knee arthroscopy to improve care.

**Level of evidence**

IV.

BACK

**Low annual hospital volume of anterior cruciate ligament reconstruction is not associated with higher revision rates**

Martin, R.K., Persson, A., Moatshe, G. et al.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06655-z

**Purpose**

Surgery performed in low-volume centres has been associated with longer operating time, longer hospital stays, lower functional outcomes, and higher rates of revision surgery, complications and mortality. This has been reported consistently in the arthroplasty literature, but there is a paucity of data regarding the relationship between surgical volume and outcome following anterior cruciate ligament (ACL) reconstruction. The purpose was to compare ACL reconstruction failure rates between hospitals performing different annual surgical volumes.

**Methods**

All patients from the Norwegian Knee Ligament Register having primary autograft ACL reconstruction between 2004 and 2016 were included. Hospital volume was divided into quintiles based on the number of ACL reconstructions performed annually, defined arbitrarily as: 1–12 (V1), 13–24 (V2), 25–49 (V3), 50–99 (V4) and ≥ 100 (V5) annual procedures. Kaplan–Meier estimated survival curves and survival percentages were calculated with revision ACL reconstruction as the end point. Secondary outcome measures included (1) mean change in Knee Injury and Osteoarthritis Outcome Score (KOOS) Quality of Life (QoL) and Sport subsections from pre-operative to 5-year follow-up and (2) subjective failure defined as KOOS QoL < 44.

**Results**

Twenty thousand eight hundred and fifty patients met the inclusion criteria and 1195 (5.7%) underwent subsequent revision ACL reconstruction over the study period. Revision rates were lower in the lower volume hospitals compared with the higher volume hospitals ($p < 0.001$). There was no clinically significant difference in improvement between pre-operative and 5-year follow-up KOOS scores between hospital volume categories, but a higher proportion of patients having surgery at lower volume hospitals reported a subjective failure. Patients in the lower volume categories (V1-3) were more often male and older compared to the higher volume hospitals (V4-5). Concomitant meniscal injuries and participation in pivoting sports were most common in V5 compared with V1 ($p < 0.001$). Median operative time decreased as hospital volume increased, ranging from 90 min at V1 hospitals to 56 min at V5 hospitals ($p < 0.001$).

**Conclusion**

Patients having ACL reconstruction at lower volume hospitals had a lower rate of subsequent revision surgery relative to higher volume hospitals. However, complications occurred more frequently, operative duration was longer, and the number of patients reporting a subjective failure of ACL reconstruction was highest at these lower volume hospitals.

**Level of evidence**

Level III

BACK

**Tibial slope, remnant preservation, and graft size are the most important factors affecting graft healing after ACL reconstruction**

Okutan, A.E., Kalkışım, M., Gürün, E. et al.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06660-2

**Purpose**

The aim of this study was to determine the anatomic, operative and biological factors that influenced graft healing after single-bundle anterior cruciate ligament (ACL) reconstruction.

**Methods**

One hundred fourteen consecutive patients who underwent anatomic single-bundle ACL reconstruction with quadrupled hamstring tendon autografts between 2016 and 2019 were retrospectively analyzed. Ninety-four patients met the inclusion criteria with minimum follow-up of 12 months. Patients were evaluated with multiple clinical measurements, including International Knee Documentation Committee Subjective Knee Form (IKDC-SKF), Lyshom Scores, and Marx activity scale. To evaluate graft healing, the signal-to-noise quotient (SNQ) was measured at intra-articular graft and intra-tunnel integration were evaluated on magnetic resonance imaging (MRI) at one year after surgery. Potential factors affecting graft healing, including age, sex, body mass index, time from injury to surgery, posterior tibial slope, lateral femoral condyle ratio, notch width index, meniscal injury, remnant preservation, tunnel aperture locations, graft size, graft bending angle, graft/remaining notch volume ratio were evaluated for their association with graft SNQ value by stepwise regression analysis.

**Results**

A total of 94 patients were evaluated with mean follow-up 28.5 ± 9 months. Univariate regression analysis showed that posterior tibial slope, notch width index, remnant preserving procedure, high femoral tunnel, anterior tibial tunnel, graft bending angle, and graft/remaining notch volume ratio significantly associated with graft SNQ values. Multivariate regression analysis showed that lateral tibial slope, remnant preservation, and graft/remaining notch volume ratio were independent factors correlated with graft SNQ values. Also, the graft SNQ values was weakly correlated with femoral tunnel integration and Marx activity scale at one year. There was no correlation between graft SNQ values and IKDC-SKF and Lysholm scores. There was no correlation between graft SNQ values and International Knee Documentation Committee and Lysholm scores.

**Conclusions**

Tibial slope, remnant preservation and graft/remaining notch volume ratio were significant independent associated factors of graft SNQ value at one year. The graft SNQ values were also weakly correlated with femoral tunnel integration and the Marx activity scale. These factors should be taken into account for ensuring the ideal graft healing and for the return to sport decision-making.

**Level of evidence**

Level IV.

BACK

**Graft isometry during anatomical ACL reconstruction has little effect on surgical outcomes**

Moon, H., Choi, C., Yoo, J. et al.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06654-0

**Purpose**

To investigate the surgical outcomes of anatomical anterior cruciate ligament (ACL) reconstruction according to the graft isometry measured during surgery.

**Methods**

Electrical medical records of patients who underwent an arthroscopic ACL reconstruction through the transportal technique using hamstring tendon autograft between 2012 and 2016 were retrospectively reviewed. The patients were classified into two groups based on the graft length change throughout the knee range of motion measured just before graft fixation (Group 1, graft length change ≤ 2 mm; Group 2, graft length change > 2 mm). Comparative analyses, including a non-inferiority trial, were performed regarding the clinical scores, knee laxity, and radiographic parameters between the groups.

**Results**

A total of 67 patients were included in the study. The total change in the length of ACL graft throughout the knee range of motion was 1.4 ± 0.4 mm in Group 1 (range, 0.2–2.0 mm), and 3.0 ± 0.7 mm in Group 2 (range, 2.2–5.0 mm). Group 1 showed a relatively high (proximal) femoral tunnel and shallow (anterior) tibial tunnel compared to Group 2 ($P < 0.001$ and $P = 0.028$, respectively), but there were no apparent differences in the macroscopic view. There were no statistically significant differences in the clinical outcomes between groups at 2 years after surgery, which satisfied the non-inferiority criterion of Group 1 in terms of clinical scores and knee laxity compared to Group 2.

**Conclusion**

The surgical outcomes of anatomical ACL reconstruction in patients with non-isometric ACL graft were not inferior in terms of clinical scores and knee laxity, compared to those with nearly-isometric ACL graft. The graft tunnel placement in the isometric position during anatomical ACL reconstruction, which is technically challenging in the clinical setting, is not a crucial factor in terms of clinical outcomes.

**Level of evidence**

Level IV.

BACK

**Revision ACL reconstruction has higher incidence of 30-day hospital readmission, reoperation, and surgical complications relative to primary procedures**

Marx, J.S., Plantz, M.A., Gerlach, E.B. et al.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06646-0

**Purpose**

Although there has been substantial improvement in ACL reconstructive surgery, graft failure remains a devastating complication for some patients. Revision procedures are inherently more complex and technically challenging. The purpose of this study is to determine the incidence of short-term complications after these procedures and to compare trends in operative length, relative valuation, and reimbursement after primary versus revision ACL reconstruction.

**Methods**

Primary and revision arthroscopic ACL reconstruction cases were identified on the American College of Surgeons' NSQIP database using Current Procedural Terminology (CPT) and International Classification of Diseases (ICD) codes between January 1, 2012 and December 31, 2017. Demographics, patient variables, and surgical variables were compared between primary and revision groups using Chi-squared tests. Logistic regression was used to identify independent risk factors for revision ACL reconstruction. Various 30-day outcome measures were compared between the primary and revision ACL reconstruction groups. Various measures of valuation—including total relative value units (RVU) and reimbursement per minute—were calculated and compared between the two groups.

**Results**

A total of 8292 patients—8135 primary and 157 revision procedures—were included in the final cohort. Higher ASA scores were associated with revision ACL reconstructions. Patients undergoing revision procedures were less likely to have an ASA score of 1 ($p < 0.001$) and more likely to have an ASA score of 2 ($p = 0.004$) or 3 ($p = 0.020$). Revision ACL reconstruction was associated with higher rates of poor 30-day outcome measures, including unplanned readmission ($p = 0.029$), reoperation ($p = 0.012$), return to the OR ($p = 0.012$), and surgical complications ($p = 0.021$). The total RVUs and reimbursement for revision procedures were significantly greater than those for primary procedures ($p < 0.001$). However, when accounting for operative time, the RVU/minute and reimbursement/minute were similar between the two groups (n.s.).

**Conclusions**

Relative to primary ACL reconstruction, revision ACL procedures are associated with worse short-term outcomes—including unplanned readmission, reoperation, return to the OR, and surgical complications. A greater ASA score was independently predictive of revision ACL surgery. The current RVU system undervalues revision ACL procedures, considering the increased operative time and complexity of such procedures.

**Level of evidence**

Level III.

BACK

**Minimal graft site morbidity using autogenous semitendinosus graft from the uninjured leg: a randomised controlled trial**

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06686-6

**Purpose**
To quantify the effect on strength of semitendinosus (ST) graft harvest by comparing isokinetic and isometric muscle strength.

**Methods**
A cohort of 140 patients underwent anterior cruciate ligament (ACL) reconstruction (ACLR) and were randomized to ipsilateral or contralateral ST graft harvest. Isokinetic and isometric muscle strength testing using a dynamometer were collected for the operated and non-operated leg. Patients were assessed pre-surgery and at 6, 12 and 24 months after reconstruction.

**Results**
ST graft harvest reduced isokinetic flexion muscle strength for 6 months. At 12 months follow up there was no significant difference between the two groups and they were all stronger than pre-injury. No other significant differences were found in any primary or secondary outcome measurements.

**Conclusion**
**Solitary ST graft harvest does not appear to result in a permanent reduced isometric or isokinetic** quadriceps muscle strength on the side where the graft is harvested. A reduction in hamstring muscle strength of less than 10% can be seen at short-term follow-up with full recovery by 12 months. Most patients report little or no donor site pain. Given these findings, ST autograft is an alternative graft choice that could be used for various reconstructions in terms of donor site morbidity.

**Level of evidence**
Level II.

BACK

**Anterior cruciate ligament reconstruction with lateral plasty restores anterior–posterior laxity in the case of concurrent partial medial meniscectomy**

Di Paolo, S., Grassi, A., Pizza, N. et al.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06689-3

**Purpose**

To evaluate the in vivo knee laxity in the presence of a partial medial meniscectomy before and after a single-bundle ACL reconstruction with a lateral plasty (SBLP) and to compare it with the knee laxity after a single-bundle ACL reconstruction (SB).

**Methods**

One-hundred and one patients with ACL tear were enrolled in the study and grouped according to the surgical technique and the meniscus treatment: regarding the SBLP technique (n = 55), 31 patients underwent isolated ACL reconstruction ("SBLP Isolated ACL Group"), while 24 patients underwent combined ACL reconstruction and partial medial meniscectomy ("SBLP ACL + MM Group"); regarding the SB technique (n = 46), 33 patients underwent isolated ACL reconstruction ("SB Isolated ACL Group"), while 13 patients underwent combined ACL reconstruction and partial medial meniscectomy ("SB ACL + MM Group"). Anterior–posterior clinical laxity at 30° (AP30) and 90° (AP90) of knee flexion was quantified before and after surgery through a surgical navigation system dedicated to kinematic assessment.

**Results**

In the ACL-deficient status, the antero-posterior laxity was significantly higher in the presence of a combined MM in both the AP30 and the AP90, with no differences between the two surgical techniques. After the ACL reconstruction, both AP30 and AP90 translations decreased significantly ($p < 0.0001$) compared to the ACL-deficient status. No differences were found for AP30 and AP90 between SBLP Isolated ACL and SBLP + MM groups, while a significantly higher AP90 translation was found for the SB + MM group compared to the SB Isolated ACL group. Moreover, the AP90 translation in the SB ACL + MM group was significantly higher than the one of the other three groups, i.e., SBLP ACL + MM, SB, and SBLP Isolated ACL group.

**Conclusion**

The ACL reconstruction with lateral plasty reduced the AP knee laxity caused by the medial meniscectomy in the context of an ACL surgery.

**Level of evidence**

Level II.

BACK

**Bone-patellar tendon–bone autograft maturation is superior to double-bundle hamstring tendon autograft maturation following anatomical anterior cruciate ligament reconstruction**

Fukuda, H., Ogura, T., Asai, S. et al.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06653-1

**Purpose**

The primary purpose of this study was to evaluate the second-look arthroscopic findings 1 year postoperatively and magnetic resonance imaging (MRI) findings 2 years after anterior cruciate ligament reconstruction (ACLR) using bone-patellar tendon–bone autograft (BTB) or hamstring tendon autograft (HT). Secondary purpose included clinical results from physical examination, including range of motion, Lachman test, pivot shift test, and knee anterior laxity evaluation, and the clinical score for subjective evaluations at 2 years after surgery.

**Methods**

Between 2015 and 2018, 75 patients with primary ACL injuries were divided into either the BTB group (n = 30) or HT group (n = 45). When using HT, an anatomical double-bundle ACLR was performed. BTB was indicated for athletes with sufficient motivation to return to sporting activity. Graft maturation on second-look arthroscopy was scored in terms of synovial coverage and revascularization. All participants underwent postoperative MRI evaluation 2 years postoperatively. The signal intensity (SI) characteristics of the reconstructed graft were evaluated using oblique axial proton density-weighted MR imaging (PDWI) perpendicular to the grafts. The signal/noise quotient (SNQ) was calculated to quantitatively determine the normalized SI. For clinical evaluation, the Lachman test, pivot shift test, KT-2000 evaluation, Lysholm score, and Knee injury and Osteoarthritis Outcome Score (KOOS) were used.

**Results**

Arthroscopic findings showed that the graft maturation score in the BTB group (3.6 ± 0.7) was significantly greater than that in the anteromedial bundle (AMB; 2.9 ± 0.2, p = 0.02) and posterolateral bundle (PLB; 2.0 ± 0.9, p = 0.001) in the HT group. The mean MRI-SNQs were as follows: BTB, 2.3 ± 0.5; AMB, 2.9 ± 0.9; and PLB, 4.1 ± 1.1. There were significant differences between BTB, AMB, and PLB (BTB and AMB: p = 0.04, BTB and PLB: p = 0.003, AMB and PLB: p = 0.03). Second-look arthroscopic maturation score and MRI-SNQ value significantly correlated for BTB, AMB, and PLB. No significant differences were detected in clinical scores. There was a significant difference (p = 0.02) in the knee laxity evaluation (BTB: 0.9 ± 1.1 mm; HT: 2.0 ± 1.9 mm).

**Conclusion**

BTB maturation is superior to that of double-bundle HT based on morphological and MRI evaluations following anatomical ACLR, although no significant differences were found in clinical scores. Regarding clinical relevance, the advantages of BTB may help clinicians decide on using the autograft option for athletes with higher motivation to return to sporting activity because significant differences were observed in morphological evaluation, MRI assessment, and knee anterior laxity evaluation between BTB and double-bundle HT.

**Level of evidence**

Level I

BACK

**Iliotibial band autograft is a suitable alternative graft for anterior cruciate ligament reconstruction: a systematic review and meta-analysis of outcomes**

Lucena, T., Cavaignac, M., Marot, V. et al.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06701-w

**Purpose**

Despite encouraging clinical, biomechanical and histological results, ACL reconstruction using the ITB was slowly abandoned. The hypothesis was that the current literature supports the use of ITB as the graft of choice for ACL reconstruction because of its good outcomes.

**Methods**

A systematic search of the literature was performed in the PubMed, MEDLINE, Cochrane, and Ovid databases to identify published clinical studies relevant to ACL reconstruction with ITB autograft and studies comparing ITB autograft with bone–patellar tendon–bone (BPTB) and hamstring (HT) autografts (none were found). The results of the eligible studies were analyzed in terms of graft failure, instrumented knee laxity measurements, Lachman test, pivot-shift test, Lysholm score, objective and subjective International Knee Documentation committee (IKDC) scores, Tegner activity score, return to sports rate, return to sports at pre-injury level and complications.

**Results**

Nineteen clinical studies including 1,210 patients with ACL reconstruction met the inclusion criteria. Graft failure occurred after ITB autograft in 4.2% of patients. Postoperative mean side-to-side laxity was 1.41 mm with 21% of patients having greater than 3 mm side-to-side difference. Lachman test and pivot-shift test were negative (grade 0) in 57% and 85%, respectively, and were grade 0 or 1 in 95% and 97%, respectively. Functional outcomes were satisfactory in 84% of patients with good to excellent results (Lysholm score > 84). Mean postoperative Lysholm score was 93.3 and 84% of patients had an objective IKDC grade of A or B. Mean postoperative Tegner score was 6.8. The return to sports rate was 89% and 61% of patients returned to their pre-injury level. A comparison of 89 ITB versus 80 BPTB autografts revealed no significant differences in graft failure (n.s.), instrumented mean side-to-side knee laxity difference (n.s.) or Tegner score (n.s.).

**Conclusion**

The graft survival rate and clinical and functional outcomes for ITB autograft are satisfactory. By allowing ACL reconstruction and lateral tenodesis to be done with a single, continuous, pedicled graft through an outside-in femoral tunnel, this technique may become the preferred alternative for primary or secondary ACL surgery.

**Level of evidence**

Level IV

BACK

**Meniscal allograft transplantation shows a mismatch between anatomic and clinical failures**

Song, J., Bin, S., Kim, J. et al.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06713-6

**Purpose**

Clinical results of meniscal allograft transplantation (MAT) are not always consistent with graft status. This study aimed to investigate (1) the degree and pattern of mismatch between anatomic and clinical failures in MAT and (2) preoperative factors associated with the mismatch.

**Methods**

Two hundred and ninety-eight consecutive patients who underwent primary medial or lateral MAT during 2004–2015 were reviewed. Anatomic failure was defined as an allograft showing meniscal tear involving > 50% of the graft or unstable peripheral rim. Clinical failure included poor Lysholm score of < 65 and any requirement for re-operations such as arthroplasty, realignment osteotomy, revision MAT, and meniscectomy (more than 50% of the graft or to the zone of meniscocapsular junction). Failure cases were categorised according to the type of failure as follows: (1) type 1, anatomic failure followed by clinical failure; (2) type 2, anatomic failure did not lead to clinical failure; and (3) type 3, clinical failure without anatomic failure. Preoperative factors including age, sex, body mass index, MAT compartment, time from previous meniscectomy, alignment, cartilage status, and accompanying procedures were analysed according to the failure type.

**Results**

Forty (13.4%) patients showed anatomical or clinical failure during the median (25th–75th percentile) follow-up duration of 47 (30–72) months (range 24–178 months). Eleven (3.7%) patients showed both anatomical and clinical failure (type 1 failure). Seventeen (5.7%) patients showed anatomic failure that did not lead to clinical failure (type 2 failure). Twelve (4.0%) patients failed clinically without meniscal tear (> 50% of graft) or unstable peripheral rim (type 3 failure). Comparative analyses among failure types found a significant difference in MAT compartment ($p = 0.01$). In particular, the incidence of type 3 failure was higher in medial than in lateral MAT ($p = 0.003$).

**Conclusion**

A notable number of failure cases of MAT showed a mismatch between anatomic and clinical failures. Even with anatomic failure, MAT did not always lead to poor clinical scores or re-operations, whereas MAT could have poor results without substantial allograft problems. Therefore, both anatomic and clinical aspects should be considered when evaluating MAT. In particular, type 3 failure occurred more frequently in medial than in lateral MAT.

**Level of evidence**

III.

BACK

**Stress on the posteromedial region of the proximal tibia increased over time after anterior cruciate ligament injury**

Miura, S., Iwasaki, K., Kondo, E. et al.

**DOI**: https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06731-4

**Purpose**

Anterior cruciate ligament (ACL) injury induces anterior and rotatory instability of the knee. However, the effect of this instability on the stress distribution in the knee joint in living participants is not clear. The aim of this study was to compare the distribution pattern of subchondral bone density across the proximal tibia in the knees with and without ACL injury, and to investigate the correlation between the distribution patterns of the subchondral bone density and the duration of ACL-deficiency.

**Methods**

Radiographic and computed tomography (CT) data pertaining to 20 patients with unilateral ACL injury without combined injury (ACL-deficient group) and 19 nontraumatic subjects (control group) were collected retrospectively. Subchondral bone density of the proximal tibia was assessed using CT-osteoabsorptiometry. Both the medial and lateral compartments of the proximal tibia were divided into three subregions of equal width in the sagittal direction. The percentage of high subchondral bone density areas (HDA%) in each subregion was quantitatively analyzed.

**Results**

HDA% of the posteromedial region was significantly higher in the ACL-deficient group (mean: 21.6%) than in the control group (14.7%) ($p = 0.002$). In contrast, HDA% of the anteromedial region was significantly lower in the ACL-deficient group (9.4%) than in the control group (15.3%) ($p = 0.048$). The logarithm of the time elapsed from ACL injury to CT examination showed a significant correlation with HDA% in the posteromedial region ($p = 0.032$).

**Conclusions**

Subchondral bone density in the posteromedial region significantly increased after ACL injury and correlated with the duration of ACL-deficiency in semi-log manner in meniscus intact knees. The increase in stress on the posteromedial region after ACL injury, which induces a change in the subchondral bone density, justifies early ACL reconstruction after ACL injury.

BACK

**Double bundle ACL reconstruction leads to better restoration of knee laxity and subjective outcomes than single bundle ACL reconstruction**

Seppänen, A., Suomalainen, P., Huhtala, H. et al.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06744-z

**Purpose**

The purpose of this meta-analysis is to compare arthroscopic single bundle (SB) and double bundle (DB) anterior cruciate ligament (ACL) reconstructions in the light of all available randomised controlled trials (RCTs). A meta-analysis of this well-researched topic was performed and subgroup analyses of the medial portal (MP) technique and the transtibial technique (TT) were added as a new idea. The hypothesis was that the DB technique is superior to the SB technique also in subgroup analyses of the MP and TT techniques.

**Methods**

Instructions of the PRISMA checklist were followed. Systematic literature search from electronic databases, including PubMed, Cochrane library and Scopus was performed to find RCTs that compared the SB and DB techniques. Nine outcomes were used to compare these two techniques. Each study was assessed according to the Cochrane Collaboration's risk of bias tool and three subgroup analyses (minimum 2-years' follow-up, TT technique and MP technique) were performed.

**Results**

A total of 40 studies were included in this meta-analysis. When analysing all the included studies, the DB technique was superior to the SB technique in KT-1000/2000 evaluation ($p < 0.01$), IKDC subjective evaluation ($p < 0.05$), Lysholm scores ($p = 0.02$), pivot shift ($p < 0.01$) and IKDC objective evaluation ($p = 0.02$). Similar results were also found in the subgroup analyses of minimum 2-years' follow-up and the TT technique. However, there were no differences between the two techniques in a subgroup analysis of the MP technique.

**Conclusion**

Generally, DB ACL reconstruction leads to better restoration of knee laxity and subjective outcomes than SB ACL reconstruction. The subgroup analysis of the MP technique revealed that surgeons can achieve equally as good results with both techniques when femoral tunnels are drilled through the medial portal.

**Level of evidence**

II.

BACK

**The importance of continuous remnant preservation in anterior cruciate ligament reconstruction**

Van Keulen, L.Z., Hoogeslag, R.A.G., Brouwer, R.W. et al.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06746-x

**Purpose**

Selective anteromedial or posterolateral bundle reconstruction is recognized as a treatment modality in partial anterior cruciate ligament (ACL) reconstruction (ACLR) with a biomechanically sufficient ACL remnant. However, there is paucity in literature investigating clinical outcomes of standard ACLR with preservation of residual continuous but biomechanically insufficient ACL tissue. The aim of this study was to investigate the influence of preservation of residual continuous but biomechanical insufficient ACL tissue in standard ACLR on complication and repeat surgery rate, and patient reported and clinical outcome.

**Methods**

The retrospective cohort comprised 134 patients (age 23 ± 7 years; Tegner 6 ± 3) with an isolated acute ACL tear. In 67 patients, residual continuous but biomechanically insufficient ACL tissue was present and preserved based on visual inspection, probing of the ACL tissue and Lachman test under arthroscopic view (standard reconstruction with tissue preservation; SRTP). These patients were matched to 67 patients that underwent ACLR where no residual ACL tissue could be preserved (standard reconstruction; SR) based on gender, age and chondral and/or meniscal status. Clinical failure (recurrent instability, pathological ACL graft laxity and/or ACL graft discontinuity), other complication and repeat-surgery rate within index surgery and 1-year and within index surgery and 2-year follow-up, and patient reported and clinical outcomes at 1-year and at 2-year follow-up were compared.

**Results**

A statistically significant lower clinical failure rate within index surgery and 1-year (SRTP, 3%; SR, 13%; P = 0.028) and within index surgery and 2-year follow-up (SRTP, 3%; SR, 23%; P = 0.001), and revision ACL surgery rate within index surgery and 1-year (SRTP, 2%; ST, 10%; P = 0.029) and within index surgery and 2-year follow-up (SRTP, 2%; SR, 18%; P = 0.001) was found in the SRTP group. No statistically significant differences were found for other investigated outcomes in patients that were without clinical failure.

**Conclusion**

This study shows that in ACLR surgery, preservation of residual continuous but biomechanical insufficient ACL tissue might lead to lower clinical failure rate and ACL revision surgery rate within index surgery and 1-year, and within index surgery and 2-year follow-up compared to standard ACLR where no residual continuous ACL tissue could be preserved.

**Level of evidence**

III.

BACK

**Age, time from injury to surgery and hop performance after primary ACLR affect the risk of contralateral ACLR**

Cristiani, R., Forssblad, M., Edman, G. et al.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06759-6

**Purpose**

To evaluate factors affecting the risk of contralateral anterior cruciate ligament reconstruction (ACLR) within 5 years of primary ACLR.

**Methods**

Primary ACLRs performed at Capio Artro Clinic, Stockholm, Sweden, during the period 2005–2014, were reviewed. The outcome of the study was the occurrence of contralateral ACLR within 5 years of primary ACLR. Univariable and multivariable logistic regression analyses were employed to identify preoperative [age, gender, body mass index (BMI), time from injury to surgery, pre-injury Tegner activity level], intraoperative [graft type, medial meniscus (MM) and lateral meniscus (LM) resection or repair, cartilage injury] and postoperative [limb symmetry index (LSI) for quadriceps and hamstring strength and single-leg-hop test performance at 6 months] risk factors for contralateral ACLR.

**Results**

A total of 5393 patients who underwent primary ACLR were included. The incidence of contralateral ACLR within 5 years was 4.7%. Univariable analysis revealed that age ≥ 25 years, BMI ≥ 25 kg/m2, time from injury to surgery ≥ 12 months and the presence of a cartilage injury reduced the odds, whereas female gender, pre-injury Tegner activity level ≥ 6, quadriceps and hamstring strength and a single-leg-hop test LSI of ≥ 90% increased the odds of contralateral ACLR. Multivariable analysis showed that the risk of contralateral ACLR was significantly affected only from age ≥ 25 years (OR 0.40; 95% CI 0.28–0.58; P < 0.001), time from injury to surgery ≥ 12 months (OR 0.48; 95% CI 0.30–0.75; P = 0.001) and a single-leg-hop test LSI of ≥ 90% (OR 1.56; 95% CI 1.04–2.34; P = 0.03).

**Conclusion**

Older age (≥ 25 years) and delayed primary ACLR (≥ 12 months) reduced the odds, whereas a symmetrical (LSI ≥ 90%) 6-month single-leg-hop test increased the odds of contralateral ACLR within 5 years of primary ACLR. Knowledge of the factors affecting the risk of contralateral ACLR is important when it comes to the appropriate counselling for primary ACLR. Patients should be advised regarding factors affecting the risk of contralateral ACLR.

**Level of evidence**

Level III.

BACK

**Intra-articular steroid injection at the time of knee arthroscopy increases risk of post-operative infection**

Kohls, M., Magnusen, R., Fitzpatrick, S.

**DOI:** https://doi-org.vu-nl.idm.oclc.org/10.1007/s00167-021-06763-w

**Purpose**

To evaluate the risk of post-operative infection after intra-articular steroid injection at the time of knee arthroscopy at a single institution high-volume sports medicine practice.

**Methods**

The electronic medical record at a single institution was queried for all patients who underwent knee arthroscopy from 2011 to 2019. Patients were included if they underwent more simple arthroscopic procedures: diagnostic arthroscopy, meniscectomy, loose body removal, synovectomy, or microfracture. Patients were excluded if they underwent more complex procedures, such as ligament reconstruction, meniscus repair, or any open procedures. These patients' medical records were then queried for current procedural terminology and international classification of disease codes indicating post-operative infection. Individual chart review was performed on this group of patients to determine if a true postoperative infection occurred within 6 months of the index arthroscopy. Patients were then categorized into "intra-operative steroid injection" versus "no steroid" based on each surgeon's preferred intra-operative analgesic injection cocktail.

**Results**

A total of 6889 patients were identified, including 2416 (35.1%) who were given intra-articular steroid at the time of knee arthroscopy. Post-operative infection occurred in 10 patients (0.15%) at a median of 18 days (range 9–42 days), 7 who received intra-operative steroid injection (0.29%) and 3 who did not (0.067%), $p = 0.040$. The relative risk of infection for those who received intra-operative steroid injection was 4.32 times higher than those who did not, with a number needed to harm of 448. There were no significant differences in age, body mass index, smoking status, or the prevalence of diabetes between those who got infected and those who did not.

**Conclusions**

Knee infection following arthroscopic surgery is rare. Intra-operative steroid injection during arthroscopic knee surgery is associated with a 4.3-fold increased risk of subsequent knee infection. While the overall risk remains low, the use of intra-operative steroids is expected to result in one additional knee infection for every 448 arthroscopic procedures performed.

**Level of evidence**

IV.

BACK

American Journal of Sports Medicine (AJSM), Volume 47, Issue

# Femoroacetabular Impingement in Elite Skiers and Snowboarders: Return to Sports and Outcomes After Hip Arthroscopy

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**Background:** Hip arthroscopy has been shown to be an effective treatment for femoroacetabular impingement (FAI) in high–level athletes; however, limited outcome and return–to–play data exist for hip arthroscopy in skiers and snowboarders.

**Purposes:** To determine the return–to–sports rate of elite skiers and snowboarders who have undergone hip arthroscopic surgery for FAI and to assess hip–related outcomes at a minimum 2–year follow–up.

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

**Methods:** Elite skiers and snowboarders who underwent hip arthroscopy for the treatment of FAI between 2005 and 2018 were identified via a retrospective review of prospectively collected data. Data were obtained from fis-ski.org, usskiandsnowboard.org, xgames.com, and wikipedia.org, including information on each player's career length, participation on a national team, and time between surgery and first competition after surgery. Patient-reported outcomes (PROs) were prospectively collected preoperatively and at minimum 2 years postoperatively.

**Results:** In total, 26 elite skiers and snowboarders (34 hips) were included. The mean ± standard deviation age at surgery was 24.5 ± 6.7 years (range, 18.7-46.8 years). A total of 85% (22/26) returned to elite–level competition at 8.9 months (range, 2.9-23.7 months) with an average career length of 3.6 ± 2.7 years after surgery. Four athletes (5 hips) required revision arthroscopy, with adhesions being the most frequent indication. At a mean follow–up of 7.7 ± 3.2 years, significant improvement in PROs ($P < .05$) was demonstrated for the Hip Outcome Score (HOS)–Activities of Daily Living (from 76 ± 20 to 95 ± 6), HOS–Sport Specific Subscale (from 63 ± 28 to 92 ± 14), modified Harris Hip Score (from 70 ± 19 to 89 ± 12), and 12-Item Short Form Health Survey Physical Component Summary (from 45 ± 11 to 54 ± 8). Patient satisfaction had a mean of 8 ± 2 (range, 1-10) and median of 10.

**Conclusion:** The return–to–competition rate in elite skiers and snowboarders after hip arthroscopy for FAI was 85% at an average of 8.9 months and with a career length of 3.6 years after surgery. Significant improvement in PROs was demonstrated for the HOS–Activities of Daily Living, HOS–Sport Specific Subscale, modified Harris Hip Score, and 12-Item Short Form Health Survey Physical Component Summary, with a median patient satisfaction score of 10. These findings support hip arthroscopy as an effective procedure for the treatment of FAI in elite skiers and snowboarders with symptomatic activity–limiting hip pain, allowing them to return to their previous levels of competition at a high rate.

BACK

# Revision Hip Arthroscopy With Labral Reconstruction for Irreparable Labral Tears in Athletes: Minimum 2-Year Outcomes With a Benchmark Control Group

Andrew E. Jimenez, MD, Michael S. Lee, BA, Jade S. Owens, BS, Tom George, BS, Olivia A. Paraschos, BA, David R. Maldonado, MD, Ajay C. Lall, MD, MS, Benjamin G. Domb, MD‡

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**Background:** The incidence of revision hip arthroscopy with labral reconstruction in athletes is increasing. However, the outcomes of revision hip arthroscopy with labral reconstruction in athletes have not been well established.

**Purposes:** (1) To report minimum 2–year patient–reported outcome (PRO) scores and return to sports (RTS) characteristics for high–level athletes undergoing revision hip arthroscopy with labral reconstruction and (2) to compare clinical results with those of a propensity–matched control group of high–level athletes undergoing revision hip arthroscopy with labral repair.

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

**Methods:** Data were prospectively collected and retrospectively reviewed for athletes at any level who underwent a revision hip arthroscopy and a labral reconstruction between April 2010 and March 2019. Minimum 2–year PROs were reported for the modified Harris Hip Score (mHHS), the Nonarthritic Hip Score (NAHS), the Hip Outcome Score–Sport Specific Subscale (HOS-SSS), the visual analog scale (VAS) for pain, and RTS. The percentages of athletes achieving the minimal clinically important difference (MCID) and the maximum outcome improvement satisfaction threshold (MOIST) were also recorded. These patients were propensity matched in a 1: 1 ratio to athletes undergoing revision hip arthroscopy with labral repair for comparison.

**Results:** A total of 46 athletes (N = 47 hips) were reported from 50 (n = 51 hips) athletes who underwent revision with labral reconstruction. A subanalysis of 30 propensity–matched athletes undergoing revision labral reconstruction was performed, with a mean follow–up time of 26.3 ± 2.4 months and an age of 28.5 ± 10.1 years, and compared with a revision labral repair group. Significant improvements were obtained for the mHHS, the NAHS, the HOS-SSS, and the VAS from preoperative to the latest follow–up ($P < .001$), with an achievement MCID rate of 61.5%, 72%, 62.5%, and 76.9% for the mHHS, the NAHS, the HOS-SSS, and the VAS, respectively. The rate for re–revision surgery (2 tertiary arthroscopy and 1 conversion to total hip arthroplasty) was 10%, and 14 patients (63.6%) were able to RTS. Improvements in PROs, rates of achieving MCID/MOIST, rate of re–revision surgery (re-revision hip arthroscopy, $P = .671$; conversion to total hip arthroplasty, $P > .999$), and RTS rate ($P = .337$) were similar when compared with those of the propensity–matched control labral repair group ($P > .05$).

**Conclusion:** Revision hip arthroscopy with labral reconstruction, in the context of an irreparable labral tear, seems to be a valid treatment option in the athletic population, demonstrating significant improvements in all PROs and low rates of undergoing revision surgery. Athletes experienced a similar magnitude of improvement in PROs, RTS rate, and revision surgery rate to that of a propensity–matched control group of athletes undergoing revision hip arthroscopy with labral repair.

BACK

# Minimum 2-Year Outcomes and Return to Sports of Competitive Athletes Who Undergo Subspine Decompression During Primary Hip Arthroscopy for Femoroacetabular Impingement Syndrome and Subspine Impingement: A Propensity-Matched Controlled Study

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**Background:** Patient-reported outcomes (PROs) and return to sports (RTS) have not been established in athletes undergoing primary hip arthroscopy and subspine decompression for femoroacetabular impingement syndrome (FAIS) and subspine impingement (SSI).

**Purpose:** (1) To report minimum 2-year PROs and RTS in competitive athletes undergoing primary hip arthroscopy for treatment of FAIS with subspine decompression for treatment of SSI and (2) to compare clinical results with a matched control group of athletes without SSI.

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

**Methods:** Data were reviewed for professional, collegiate, and high school athletes undergoing primary hip arthroscopy for FAIS with arthroscopic subspine decompression for SSI between February 2011 and October 2018. Inclusion criteria included preoperative and minimum 2-year follow-up scores for the modified Harris Hip Score, Nonarthritic Hip Score, Hip Outcome Score–Sport Specific Subscale, and visual analog scale for pain. Rates of achieving the minimal clinically important difference (MCID) were also calculated. For comparison, athletes in the SSI group were propensity matched according to age at the time of surgery, sex, body mass index, lateral center-edge angle, alpha angle, sport level, acetabular labrum articular disruption grade, and sport type to a control group of athletes without SSI.

**Results:** A total of 30 SSI athletes were included in the study, with a mean plus or minus standard deviation follow-up of 32.1 ± 7.1 months and age of 20.9 ± 5.7 years. The SSI cohort demonstrated significant improvement in all recorded PROs ($P < .001$), returned to sports at high rates (88.5%), and achieved the MCID for the Hip Outcome Score–Sport Specific Subscale at a high rate (80.0%). Furthermore, these patients had a low rate of undergoing revision surgery (6.7%). When compared with a propensity-matched control group of 59 athletes, the SSI group demonstrated similar rates of RTS, revision, and achieving the MCID for all PROs.

**Conclusion:** Competitive athletes with FAIS and SSI who underwent primary hip arthroscopy and subspine decompression had favorable outcomes and high RTS rates at minimum 2-year follow-up. These results were comparable with those of a control group of athletes without SSI undergoing primary hip arthroscopy.

BACK

# Competitive Athletes with Femoroacetabular Impingement and Painful Internal Snapping Treated Arthroscopically with Intrabursal Iliopsoas Fractional Lengthening: High Rate of Return to Sport and Favorable Midterm Functional Outcomes

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**Background:** Athletes with femoroacetabular impingement syndrome (FAIS) who undergo hip arthroscopy with iliopsoas fractional lengthening (IFL) in the context of painful internal snapping have demonstrated favorable patient–reported outcomes (PROs), return to sport (RTS), and resolution of internal snapping symptoms at short term follow–up. Midterm outcomes have not been established.

**Purposes:** (1) To report minimum 5–year PROs and RTS rate in competitive athletes who underwent primary hip arthroscopy for FAIS and intra–bursal IFL for painful internal snapping and (2) to compare these clinical results with those of a propensity score–matched control group of competitive athletes who underwent primary hip arthroscopy without painful internal snapping and IFL.

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

**Methods:** Data were reviewed for consecutive surgeries performed by a single surgeon between February 2010 and December 2013. Patients were considered eligible if they were professional, collegiate, or high school athletes and received a primary hip arthroscopy for FAIS and intra–bursal IFL without extended capsulotomy for painful internal snapping. Indications for IFL were painful internal snapping on preoperative physical examination. Inclusion criteria were preoperative and minimum 5–year follow–up scores for the modified Harris Hip Score, Nonarthritic Hip Score, Hip Outcome Score–Sport Specific Subscale, and visual analog scale for pain. Rates of achieving the minimal clinically important difference were also reported. For comparison, athletes in the IFL group were propensity matched by age, sex, body mass index, lateral and anterior center–edge angles, and sports level to a control group of athletes without internal snapping who underwent primary hip arthroscopy for FAIS without IFL.

**Results:** A total of 105 competitive athletes in the IFL group were included in the study with a follow–up of 66.8 ± 6.9 months (mean ± SD). The IFL cohort showed significant improvement in all recorded PROs at minimum 5–year follow–up ($P < .001$). Furthermore, they demonstrated favorable rates of achieving the minimal clinically important difference for the modified Harris Hip Score (82.0%), Nonarthritic Hip Score (85.4%), and Hip Outcome Score–Sport Specific Subscale (82.8%). Further, 89.5% of athletes in the IFL cohort successfully returned to sport. A total of 42 athletes in the IFL group were propensity matched to 54 control athletes. When groups were compared, they demonstrated similar improvement in PROs and rates of RTS, revision arthroscopy, and achieving psychometric thresholds.

**Conclusion:** Competitive athletes undergoing primary hip arthroscopy and intra–bursal IFL in the context of FAIS and painful internal snapping demonstrated favorable PROs and RTS rate at minimum 5–year follow–up. These results were comparable with those of a control group of athletes not requiring IFL.

BACK

**Opioid Use After Simple Arthroscopic Knee Surgery**

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**Background:** Evidence-based prescribing guidelines are lacking for opioids after most orthopaedic surgical procedures.

**Hypothesis:** Opioids are commonly overprescribed after simple knee arthroscopy.

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

**Methods:** A cohort of 174 patients who underwent simple arthroscopic knee surgery were prospectively evaluated using data from the Outcome Management and Evaluation database. All patients received 10 combined hydrocodone 5 mg and acetaminophen 325 mg pills postoperatively. Patients were excluded if they (1) had revision surgery, (2) had concomitant complex surgery (eg, ligament surgery, osteotomy), (3) had current opioid use, (4) had open surgery for removal of hardware, (5) or had bilateral knee surgery. Total opioid consumption was reported at the first postoperative visit, and a distribution was created based on patient response. Based on the distribution, patients were separated into low (0-2 pills) versus high (3 or more pills) opioid consumption groups for evaluating risk factors for opioid use. The risk factors included were age, body mass index, smoking status, education level, baseline pain (Knee injury and Osteoarthritis Outcome Score pain subscale [KOOS Pain]), and baseline mental health (Veterans RAND 12-Item Health Survey Mental Component Score), as well as intraoperative findings such as synovial characteristics and extent of osteoarthritis in the multivariate model.

**Results:** Total opioid consumption ranged from 0 to 19 pills. The median pill count was 2 (25th; 75th interquartile range, 0; 4). Of total patients, 59% were categorized as having low opioid consumption, and the remaining 41% were in the high opioid consumption group. Only 23 patients (13.2%) took 6 or more pills. Preoperative pain as measured by KOOS Pain score was a significant predictor of high opioid consumption postoperatively (odds ratio, 0.97; 95% CI, 0.95-0.99; P = .003).

**Conclusion:** The clinically relevant conclusion is that opioids are overprescribed after simple arthroscopic knee surgery. Based on distribution, the authors recommend that 4 pills be prescribed after simple arthroscopic knee surgery. After accounting for confounding variables, preoperative pain was associated with higher postoperative opioid consumption.

BACK

**What Is the Failure Rate After Arthroscopic Repair of Bucket-Handle Meniscal Tears? A Systematic Review and Meta-analysis**

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**Background:** Meniscal repair has become the treatment of choice for meniscal tears, especially in the subset of bucket-handle meniscal tears (BHMTs). However, a comprehensive estimate of the corresponding failure rate is not available, thus maintaining doubts about the healing potential of these tears. Furthermore, a wide range of factors to predict high failure rates have been reported but with conflicting evidence.

**Purpose:** To determine the failure rate after arthroscopic repair of BHMTs as reported in the literature, compare this with the failure rate of simple meniscal tears extracted from the same studies, and analyze the influence of factors previously reported to be predictive of meniscal repair failure.

**Study Design:** Systematic review and meta-analysis; Level of evidence, 4.

**Methods:** A systematic search was conducted by 2 independent reviewers using principal bibliographic databases (PubMed, Scopus, Cochrane Library, and EMBASE). After a stepwise exclusion process, 38 articles met the inclusion criteria. Failure rate data were analyzed with a random-effects proportional meta-analysis (weighted for individual study size), and forest plots were constructed to determine any statistically significant differences between BHMTs versus simple tears (longitudinal, radial, or horizontal), medial versus lateral BHMTs, isolated procedures versus repairs with concomitant anterior cruciate ligament reconstruction, and tears in red-red versus red-white zones. Moreover, a meta-regression analysis was conducted to evaluate the effect of patient age and sex, suture technique (in-out or all-inside), time from injury to surgery, mean number of stitches, and length of follow-up on failure rates.

**Results:** The pooled failure rate was 14.8% (95% CI, 11.3%-18.3%; I2 = 77.2%). A total of 17 studies provided failure rates of both BHMT repairs (46/311 repairs) and simple tear repairs (54/546 repairs), demonstrating a significantly higher failure rate for BHMT repairs (risk ratio [RR] = 1.50; 95% CI, 1.05-2.15; I2 = 0%; P = .03). Medial BHMT repairs (RR = 1.94; 95% CI, 1.25-3.01; I2 = 0%; P = .003) and isolated repairs (RR = 1.77; 95% CI, 1.15-2.72; I2 = 0%; P = .009) had statistically higher risk of failure, but no statistically significant difference was found between tears in red-red versus red-white zones. Among the other factors evaluated with meta-regression, only the mean number of stitches showed a statistically significant effect on failure rates.

**Conclusion:** Based on the currently available literature, this systematic review provides a reasonably comprehensive analysis of failure rate after arthroscopic BHMT repair; failure is estimated to occur in 14.8% of cases. Medial tears and isolated repairs were the 2 major predictors of failure.

BACK

Journal of Bone and Joint Surgery (JBJS), Volume 104, Issue 10

**Outcomes and Survivorship at a Median of 8.9 Years Following Hip Arthroscopy in Adolescents with Femoroacetabular Impingement: A Matched Comparative Study with Adults**

Fukase, Naomasa; Murata, Yoichi; Pierpoint, Lauren A.; Soares, Rui W.; Arner, Justin W.;Ruzbarsky, Joseph J.; Quinn, Patrick M.; Philippon, Marc J.

DOI: 10.2106/JBJS.21.00852


Background: Because of the unique theoretical surgical risks, including osteonecrosis, acute iatrogenic slipped capital femoral epiphysis, and epiphyseal injury, the optimal treatment strategy for femoroacetabular impingement (FAI) in growing adolescents has yet to be established. The aim of this study was to compare the clinical outcomes of primary arthroscopic treatment of FAI in growing adolescents with a matched adult group.

Methods: Patients with FAI who underwent arthroscopic treatment with a minimum follow-up of 2years were included. Patients with previous ipsilateral hip surgery, an Outerbridge grade of ≥3, preoperative Tönnis grade of ≥2, or evidence of dysplasia (lateral center-edge angle of <25°)were excluded. Eligible patients who were ≤19 years old and whose proximal femoral physis had not yet closed were matched to adult (20 to 40-year-old) counterparts in a 1:1 ratio by sex, body mass index, and time of surgery. For the adolescents, cam resection was performed with an aphyseal-sparing approach. Outcome scores, including the modified Harris hip score (mHHS), Hip Outcome Score-Activities of Daily Living (HOS-ADL), and HOS-Sports-Specific Subscale (HOS-SSS), were prospectively collected.

Results: Of the 196 eligible adolescents, 157 (80%) were pair-matched to adult controls, with a median postoperative follow-up of 8.9 and 6.6 years, respectively. Fourteen (9%) of the adolescents required revision hip arthroscopy compared with 18 adults (11%) ($p = 0.46$). No patient in the adolescent group had conversion to a total hip arthroplasty (THA), while 3 in the adult group had a THA ($p = 0.25$). For adolescents without subsequent hip surgery, the medianm HHS improved from 59 preoperatively to 96 postoperatively; the HOS-ADL, from 71 to 98; and the HOS-SSS, from 44 to 94 ($p < 0.001$), which were significantly higher postoperative scores than those of the matched adults ($p < 0.05$) despite similar or inferior baseline scores. No complications were found during the office visit or at the final follow-up.

Conclusions: Hip arthroscopy performed with a physeal-sparing approach for FAI in growing adolescents is safe and effective and yields superior clinical outcomes compared with those in a matched adult group.

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

BACK

Bone and Joint Journal (BJJ), Volume 101, issue

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

BACK

## Miscellaneous

Arthroscopy, May 2022, Volume 38, Issue 5, P 1519 – 1527

**Increased Combined Anteversion Is an Independent Predictor of Ischiofemoral Impingement in the Setting of Borderline Dysplasia With Coxa Profunda**

L. Xu, Y. Huang, et al.

DOI: https://doi.org/10.1016/j.arthro.2021.10.028

Purpose
To investigate the differences in radiologic parameters between borderline dysplasia hips (BDDH) +/– coxa profunda and normal hips and to evaluate the correlations between these parameters and the prevalence of ischiofemoral impingement (IFI) in borderline dysplasia.

Methods
The imaging of patients with BDDH (18° ≤ lateral center edge angle <25°) treated in our hospital from January 2018 to December 2019 was retrospective reviewed. These patients were divided into BDDH with coxa profunda (acetabular fossa touches the ilioischial line, pBDDH) and without coxa profunda (nBDDH) groups. The groups were compared with a control group with normal acetabular coverage. Neck–shaft angle, femoral offset, acetabular versions, acetabular coverage, ischial angle, femoral neck version, and combined anteversion were reviewed and analyzed using computed tomography imaging using one-way analysis of variance.

Results
There were 43 patients (36 female/7 male, 26.13 ± 4.96 years) in the pBDDH group, 22 patients (17 female/5 male, 28.60 ± 5.89 years) in the nBDDH group, and 23 patients (14 female/9 male, 27.67 ± 5.98 years) in the control group. The pBDDH group had increased femoral version, ischial angle, acetabular versions, and decreased ischiofemoral space (IFS)/quadratus femoris space (QFS) than the other 2 groups. The IFS/QFS correlated with neck–shaft angle, femoral offset, femoral neck version, acetabular versions, ischial angle, femoral neck-lesser trochanter angle, posterior acetabular coverage, and combined anteversion in patients with BDDH. Combined anteversion at the 3-o'clock level was an independent predictor of a decreased IFS (beta = –0.348, P = .007) and QFS (beta = –0.255, P = .01, R2 = .550). Binary logistic regression demonstrated that patients with BDDH with large combined anteversion at the 3-o'clock level had a greater prevalence of IFI (odds ratio 1.148; P = .001, R2 = .505).

Conclusions
In patients with borderline dysplasia, the QFS/IFS significantly correlated with combined anteversion at the 3-o'clock level on clock face of acetabulum. BDDH with coxa profunda might have a greater prevalence of IFI because of large combined anteversion.

Level of Evidence
III, retrospective comparative observation study.

BACK