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Volume 36, issue 4

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Upper extremity

Arthroscopy, Volume 36, Issue 4

Open Versus Arthroscopic Latarjet Procedure for the Treatment of Chronic Anterior Glenohumeral Instability With Glenoid Bone Loss

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Arthroscopy, Volume 36, Issue 3, Received: January 3, 2019; Accepted: September 25, 2019

https://doi.org/10.1016/j.arthro.2019.09.042

Purpose
The purpose of this study was to compare the clinical, functional, and radiographic outcomes of open versus arthroscopic Latarjet procedures.

Methods
Between December 2009 to January 2015, all patients older than 18 years of age who were treated with a Latarjet procedure for chronic osseous anterior instability by a single surgeon were included in this retrospective cohort study. Range of motion, strength, Rowe, Western Ontario Shoulder Instability Index (WOSI) scores, and pain level according to the Visual Analog Scale (VAS) were evaluated. In addition, postoperative computed tomography scans were used to evaluate the position of the transferred coracoid, screw orientation, and degree of graft resorption.

Results
Forty-eight patients with a mean age of 29.5 years (range 19-59 years) who underwent open (n = 15; group OL) and arthroscopic (n = 33; group AL) Latarjet procedures were included in the study. The mean follow-up was 30.5 months (range 24-50 months). At final follow-up there were significant differences in the mean internal rotation loss (mean of 9° vs 14°, P = .044) favoring open surgery and WOSI (P = .017) scores favoring arthroscopic. No significant differences were detected in mean forward flexion loss (P = .918), external rotation loss (P = .883), Rowe (P = .429), and Visual Analog Scale (P = .208) scores. Mean superoinferior position of the coracoid bone graft was found between the 1:55 and 4:49 o'clock positions (2:05-4:55 for group OL; 1:51-4:47 for group AL) in en-face views. The grafts were placed laterally in 13% (group OL) and 9% (group AL) of patients. The mean α angles of the screws were 11° and 19.2°, respectively (P = .004). The mean graft resorption rates were 21% and 34% (P = .087), respectively.

Conclusion
Good functional results were obtained after both open and arthroscopic Latarjet procedures for the treatment of chronic osseous anterior shoulder instability. Comparative analysis showed small but statistically significant differences in internal rotation loss favoring open and in WOSI favoring arthroscopic techniques. All measured radiographic parameters were similar with the exception of a significant difference in alpha angle with improved screw position in open surgery. OL and AL techniques provide similar clinical and radiographic outcomes.

Level of Evidence
III; Retrospective cohort study with comparison group.

BACK

Bony Ingrowth of Coil-Type Open-Architecture Anchors Compared With Screw-Type PEEK Anchors for the Medial Row in Rotator Cuff Repair: A Randomized Controlled Trial

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Arthroscopy, Volume 36, Issue 3, Received: April 8, 2019; Accepted: November 16, 2019

https://doi.org/10.1016/j.arthro.2019.11.119

Purpose
To evaluate outcomes of screw-type and coil-type open-architecture suture anchors with respect to bony ingrowth, release of biological markers, and patient-reported outcome measures when used in rotator cuff repair (RCR).

Methods
Forty patients undergoing arthroscopic RCR for full-thickness rotator cuff tears were enrolled and prospectively randomized to receive a screw-type (19 patients) or coil-type (21 patients) suture anchor for the medial row during repair. All repairs used a transosseous-equivalent configuration with footprint anchors laterally. Marrow elements released during surgery were evaluated for 9 cytokine markers (insulin-like growth factor 1, fibroblast growth factor 2, bone morphogenetic proteins 7 and 2, platelet-derived growth factors AA and BB, epidermal growth factor, transforming growth factor beta1, and vascular endothelial growth factor). Postoperative computed tomography scans were performed at 6 months. Range of motion, strength, and validated patient-reported outcome measures (Simple Shoulder Test, Single Assessment Numeric Evaluation, visual analog scale, and American Shoulder and Elbow Surgeons scores) were gathered before the operation and at 6 months and 1 year postoperatively.

Results
Bone mineral density surrounding the coil-type anchor was significantly greater than that surrounding the screw-type anchor ($P = .005$). Bone mineral density values within the coil-type and screw-type anchors were comparable ($P = .527$); however, a larger amount of total bone mineral mass (in milligrams) was shown within the coil-type anchor owing to its larger volume ($P < .01$). Marrow elements released at the repair site were similar between groups ($P > .05$). Postoperatively, no statistically significant difference was found between groups for clinical outcome measures at 6 months or 1 year. Retear and complication rates were similar between groups ($P > .05$).

Conclusions
Both the coil-type and screw-type anchors can be reliably used for RCR and produce similar clinical outcomes. The coil-type anchor resulted in superior bony growth surrounding the anchor and a larger total bone mineral mass within the anchor owing to its larger volume.

Level of Evidence
Level II, randomized prospective comparative study.

BACK

Predicting Failure After Primary Arthroscopic Bankart Repair: Analysis of a Statistical Model Using Anatomic Risk Factors

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Purpose
The purpose of this study was to establish and analyze a simplified scoring system based on anatomic imaging measurements to predict recurrent instability after primary arthroscopic shoulder capsulolabral repair.

Methods
All patients undergoing primary arthroscopic anterior capsulolabral repair of the shoulder were reviewed. Patients were contacted and charts were reviewed for endpoint of recurrent instability and return to prior level of activity. Predictive variables for recurrent instability studied included age, sex, amount of glenoid bone loss, intact anterior articular arc (IAAA), glenohumeral tracking (off-track), contact sports and overhead sports participation.

Results
540 patients met inclusion criteria and follow-up data with magnetic resonance imaging data were available for 337 shoulders. Average follow-up was 6.2 years(range 3.4-9.3 years). Symptomatic recurrent instability occurred in 102 patients (30.3%) and 68% of contacted patients returned to pre-injury activities. In univariate analysis, age under 21 years, off-track lesions, IAAA <150°, and glenoid bone loss (GBL) of 10% or greater displayed an increased risk of recurrent instability. Multivariable analysis showed these factors remained significant: age <21 (odds ratio [ratio] 2.37), off-track glenoid (OR 2.86), IAAA <150 (OR 3.90), and GBL ≥10% (OR 7.47). A scoring system assigning 1 point each for age and off-track lesions, 2 points for IAAA <150, and 4 points for GBL >10% yielded 79% sensitivity, 75% specificity, 58% positive predictive value, and 89% negative predictive value using a probability value of 20 percent for recurrent instability.

Conclusion
At mid-term follow-up, recurrent shoulder instability following primary arthroscopic anterior capsulolabral repair was 30% in this series. Younger age, glenoid bone loss of 10% or more, IAAA <150° and off-track glenoid lesion conferred the greatest risk for postoperative instability. We propose a scoring system assigning 1 point for age, 1 point for off-track lesions, 2 points for IAAA <150, and 4 points for GBL >10%. This schema demonstrated moderate accuracy for predicting recurrent instability when using a cutoff threshold score above 2 points for failure.

Level of Evidence
Level III, Retrospective Cohort Study.

BACK

Intratendinous Injection of Mesenchymal Stem Cells for the Treatment of Rotator Cuff Disease: A 2-Year Follow-Up Study

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Arthroscopy, Volume 36, Issue 3, Received: July 12, 2019; Accepted: November 17, 2019

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Purpose
To assess the mid-term safety and efficacy of an intratendinous injection of autologous adipose tissue–derived mesenchymal stem cells (AD MSCs) for rotator cuff disease at 2-year follow-up.

Methods
The first part of the study consisted of 3 dose-escalation groups, with 3 patients each, for the evaluation of safety: low-dose (1.0 × 107 cells), mid-dose (5.0 × 107), and high-dose (1.0 × 108) groups. For the second part, we planned to include 9 patients receiving the high dose for the evaluation of exploratory efficacy. Clinical outcomes were assessed according to pain, range of motion, muscle strength, functional scores, overall satisfaction and function, and presence of failure. Structural outcomes included changes in volume of tendon defects measured using magnetic resonance imaging.

Results
This study enrolled 19 patients (9 for the first part and 10 for the second part) with partial-thickness rotator cuff tears. There were no treatment-related adverse events at minimum 2-year follow-up. Intratendinous injection of AD MSCs reduced shoulder pain by approximately 90% at 1 and 2 years in the mid- and high-dose groups. The strength of the supraspinatus, infraspinatus, and teres minor significantly increased by greater than 50% at 2 years in the high-dose group. Shoulder function measured with 6 commonly used scores improved for up to 2 years in all dose groups. Structural outcomes evaluated with magnetic resonance imaging showed that the volume of bursal-sided defects in the high-dose group nearly disappeared at 1 year and did not recur at up to 2 years. No failures—defined as the performance of any kind of shoulder surgery or return of the Shoulder Pain and Disability Index score to the preinjection level—occurred during follow-up.

Conclusions
This study showed continued safety and efficacy of an intratendinous injection of AD MSCs for the treatment of partial-thickness rotator cuff tears over a 2-year period through regeneration of tendon defects.

Level of Evidence
Level III, retrospective comparative study.

BACK

Labral Morphology and Number of Preoperative Dislocations Are Associated With Recurrent Instability After Arthroscopic Bankart Repair

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Purpose
To develop a method to measure capsule and labral volume on preoperative magnetic resonance imaging to predict surgical failure after primary Bankart repair.

Methods
A retrospective case-control study was conducted on patients undergoing primary anterior arthroscopic shoulder stabilization. Surgical failure was defined as a recurrent dislocation event. Cases were matched to controls based on age and sex in a 1:2 ratio. Preoperative magnetic resonance (MR) arthrograms were analyzed by 2 trained reviewers using Vitrea software to measure labral and capsular volume with a 3-dimensional model. Labral size was also qualitatively measured on axial images. A “diffusely small” labrum was defined as labral height less than the width of the glenoid tidemark cartilage.

Results
Of the 289 patients who had an arthroscopic Bankart repair from 2006 to 2015, 33 who had a postoperative dislocation met the inclusion criteria and were matched to 62 control patients who did not. There was no difference between groups with regard to age (P = .88), sex (P = .82), contact sport participation (P = .79), proportion of overhead athletes (P = .33), proportion of throwers (P = 1), surgical positioning in lateral decubitus (P = .18), or number of repair anchors used (P = .91). The average number of preoperative dislocations was significantly higher in the failure group (3.2 vs. 2.0, P < .0001). In patients with normal labrum morphology, the odds of having surgical failure increased by 26% for a 1-unit increase in the number of prior dislocations (odds ratio [OR] 1.26, 95% confidence interval [CI] 1.02 to 1.55). The case and control groups had similar labral and capsular volume as measured in Vitrea. The failure group had a significantly higher proportion of patients with a diffusely small labral morphology (47% vs. 17%, P = .03). Controlling for number of preoperative dislocations, the odds of having a diffusely small labral morphology was 3.2 times more likely in the case group than the control group (95% CI 1.259 to 8.188). Interrater reliability between 2 independent reviewers was excellent for measurement of capsule volume (r = 0.91) and good for measurement of labral volume (r = 0.74).

Conclusions
This study presents a novel method of measuring labral and capsule volume with high interrater reliability. An increased number of recurrent dislocations prior to primary Bankart repair was associated with increased odds of recurrent instability after surgery. The OR for failure also increased with increasing number of preoperative dislocations. Diffusely small labral morphology was associated with having a postoperative redislocation.

Level of Evidence
III (case-control study).

BACK

Calcium Phosphate Bone Void Filler Increases Threaded Suture Anchor Pullout Strength: A Biomechanical Study

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https://doi.org/10.1016/j.arthro.2019.12.003

Purpose
To compare the response to cyclical loading and ultimate pull-out strength of threaded suture anchor with and without calcium phosphate bone void filler augmentation in a polyurethane foam block model and in vitro proximal humerus cadaveric model.

Methods
This controlled biomechanical study consisted of 2 parts: (1) preliminary polyurethane foam block model, and (2) in vitro cadaveric humeri model. The preliminary foam block model intended to mimic osteoporotic bone using a 0.12 g/mL foam material. Half of the foam block models were first filled with injectable calcium phosphate bone substitute material (CP-BSM), whereas the other half were not augmented with CP-BSM. Each specimen was then instrumented with a threaded suture anchor. The same technique and process was performed in a matched cadaveric humeri model. Testing then consisted of a stepwise, increasing axial load protocol for a total of 40 cycles. If the anchor remained intact after cyclic loading, the repair was loaded to failure. The number of completed cycles, failure load, and failure modes were compared between groups.

Results
Average pull-out strength for suture anchor with CP-BSM in the osteoporotic foam block model was significantly higher at 332.68 N ± 47.61 compared with the average pull-out strength of suture anchor without CP-BSM at 144.38 N ± 14.58 ($P = .005$). In the matched cadaveric humeri model, average pull-out strength for suture anchor with CP-BSM was significantly higher at 274.07 N ± 102.07 compared with the average pull-out strength of suture anchor without CP-BSM at 138.53 N ± 109.87 ($P = .029$).

Conclusions
In this time zero, biomechanical study, augmentation of osteoporotic foam block and cadaveric bone with calcium phosphate bone substitute material significantly increases pull-out strength of threaded suture anchors.

Clinical Relevance
Considering concerns about suture anchor pull-out from osteoporotic bone, augmentation with calcium phosphate bone substitute material increases load to failure resistance.

BACK

Clinical and Imaging Outcomes After Arthroscopic Superior Capsule Reconstruction With Human Dermal Allograft for Irreparable Posterosuperior Rotator Cuff Tears: A Minimum 2-Year Follow-Up

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Arthroscopy, Volume 36, Issue 3, Received: July 25, 2019; Accepted: December 11, 2019

https://doi.org/10.1016/j.arthro.2019.12.024

Purpose
To report the clinical and structural outcomes for non-pseudoparalytic irreparable posterosuperior rotator cuff tears treated with superior capsule reconstruction (SCR) using dermal allograft (DA).

Methods
Patients who underwent SCR using DA with a mean thickness of 3 mm for irreparable posterosuperior rotator cuff tears and underwent surgery at least 2 years earlier were included. Outcomes were assessed prospectively by the American Shoulder and Elbow Surgeons (ASES), Single Assessment Numeric Evaluation, and Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) scores; patient satisfaction; and visual analog scale for pain. Structurally, acromiohumeral distances (AHDs) were assessed both preoperatively and postoperatively (standard radiographs). Graft integrity was assessed by magnetic resonance imaging. Clinical failures were reported.

Results
We included 22 patients with a mean age of 56 years (range, 41-65 years) and a mean follow-up period of 2.1 years (range, 2-3 years). The ASES score improved from 54.0 to 83.9 ($P < .001$); the Single Assessment Numeric Evaluation score improved from 44.9 to 71.4 ($P < .001$); and Quick Disabilities of the Arm, Shoulder and Hand score (QuickDASH) improved from 37.6 to 16.2 ($P = .001$). Of the patients, 85% achieved an improvement in the ASES score that exceeded the minimal clinically important difference (11.1 points). The median patient satisfaction rating was 8.5 (range, 1-10). The median preoperative visual analog scale score decreased from 4 to 0 (range, 0-3) postoperatively ($P < .001$). Complete radiographs of 19 of 22 patients (86%) were obtained at a mean of 5.2 months (range, 1.4-10 months) postoperatively and showed a significant increase in the mean AHD from 7.0 mm preoperatively to 8.3 mm postoperatively ($P = .029$). Postoperative magnetic resonance imaging scans were obtained in 95% of the patients (21 of 22) at a mean of 2.5 months (range, 0.3-10.2 months) postoperatively and showed graft integrity rates of 100% (21 of 21) on the tuberosity side, 76% (16 of 21) at the midsubstance, and 81% (17 of 21) on the glenoid side. No significant differences in clinical outcome scores ($P > 0.930$) were found in patients with intact grafts versus those with torn grafts. The number of previous shoulder surgical procedures was a negative predictor of clinical outcome. There was 1 clinical failure.

Conclusions
SCR using DA for irreparable tears improves outcomes with high satisfaction and high graft integrity at short-term follow-up. Graft integrity, although correlated with an increased AHD, had no correlation with clinical outcomes at final follow-up.

Level of Evidence
Level IV, case series

BACK

Journal of Shoulder and Elbow Surgery (JSES), Volume 29, issue 4

The arthroscopic Latarjet: a multisurgeon learning curve analysis

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DOI: https://doi.org/10.1016/j.jse.2019.10.022

Background
The open Latarjet procedure is a standard surgical treatment option for anterior shoulder instability in patients with a high risk of failure following soft tissue stabilization. The arthroscopic technique has potential advantages of minimal invasiveness, reduced postoperative stiffness, and faster rehabilitation but is regarded as technically challenging with concern over surgical risk during the learning curve. The aim of this study was to undertake a multisurgeon, large-volume learning curve analysis of the arthroscopic Latarjet procedure using continuous learning curve analysis.

Methods
Individual patient data from 12 surgeons across 5 countries were retrospectively reviewed. A total of 573 patients undergoing the arthroscopic Latarjet procedure were included. Outcome measures of learning were collected, including operative time, computed tomography (CT) bone-block positioning, complications, and patient-reported outcome measures (PROMs). A segmented linear regression modeling technique was used for learning curve analysis.

Results
High-volume surgeons converged to an operative time steady state after 30-50 cases. Surgeons completing fewer procedures demonstrated a constant reduction in operative time without reaching a plateau. Low-volume surgeons completing fewer than 14 operations did not demonstrate a reduction in operative time. Accuracy of bone-block positioning on postoperative CT demonstrated constant improvement without reaching a plateau after 53 cases. There was no change in PROMs or complications with increased operative volume.

Conclusion
Specialist shoulder surgeons require 30-50 arthroscopic Latarjet procedures to attain steady-state operative efficiency, during which there is improvement in bone-block positioning. Only surgeons expecting to undertake the arthroscopic Latarjet in high volume should consider adopting this procedure.

Level of evidence
Educational Methodology Study
Learning Curve

BACK

The clinical impact of arthroscopic vs. open osteocapsular débridement for primary osteoarthritis of the elbow: a systematic review

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DOI: https://doi.org/10.1016/j.jse.2019.11.010

Background
Primary elbow osteoarthritis (PEOA) is a debilitating disease that can be difficult to treat. Osteocapsular débridement (OD) has been described through various approaches, including arthroscopic and open approaches, with successful outcomes in treating PEOA. There is insufficient evidence in the literature to date to demonstrate the superiority of any approach. The purpose of this review was to compare the clinical results of arthroscopic vs. open OD for PEOA.

Methods
The online databases PubMed, Embase (Elsevier), and Scopus (Elsevier) were searched from inception through April 1, 2018, for clinical studies reporting on OD. Studies were stratified based on an arthroscopic vs. open approach. Weighted means were calculated for surgical and patient-reported outcomes.

Results
We included 30 studies, reporting on 871 patients and 887 elbows, with a mean follow-up period of 44.3 ± 25.5 months. Of these studies, 15 (420 elbows) reported on open OD, 14 (456 elbows) reported arthroscopic OD, and 1 reported on a cohort of each approach (open in 5 elbows and arthroscopic in 6). The Mayo Elbow Performance Score improved by 28.6 ± 4.57 in the open group vs. 26.6 ± 7.24 in the arthroscopic group. Flexion improved by 19° ± 6° in the open group and 10° ± 6° in the arthroscopic group. Extension improved by 11° ± 5° in the open group and 11° ± 6° in the arthroscopic group.

Conclusions
Open OD and arthroscopic OD are effective surgical treatment options for patients with symptomatic PEOA, reliably improving flexion, extension, and functional outcome scores with low complication rates.

Level of evidence
Level IV. Systematic Review

BACK

The role of telehealth as a platform for postoperative visits following rotator cuff repair: a prospective, randomized controlled trial

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DOI: https://doi.org/10.1016/j.jse.2019.12.004

Background
The application of telehealth for surgical follow-up has gained recent exposure in orthopedic care. Although the results following joint arthroplasty are encouraging, the role of telemedicine for postoperative care following arthroscopic rotator cuff repair still needs to be defined. The goal of this study was to evaluate the safety, efficacy, and socioeconomic benefits of telehealth as a platform for postoperative follow-up.

Methods
This was a prospective, randomized controlled trial that enrolled 66 patients who underwent follow-up in the office vs. via telemedicine for postoperative visits at 2, 6, and 12 weeks after surgery. Post-visit surveys were administered to patients and physicians via e-mail, and the Student t test and Fisher exact test were used to compare responses.

Results
In total, 58 patients (88%) completed the study (28 telehealth vs. 30 control). Patients in each group demonstrated similar pain scores at each follow-up visit ($P = .638$, $P = .124$, and $P = .951$) and similar overall satisfaction scores ($P = .304$). Patients in the telehealth group expressed a stronger preference for telehealth than their control counterparts ($P < .001$). Telehealth visits were less time-consuming from both a patient ($P < .001$) and physician ($P = .002$) perspective. Telehealth visits also required less time off work for both patients ($P = .001$) and caregivers ($P < .001$).

Conclusion
Patients undergoing arthroscopic rotator cuff surgery were able to receive safe and effective early postoperative follow-up care using telemedicine. The preference for telehealth increased for both surgeons and patients following first-hand experience. The use of a telehealth platform is a reasonable follow-up model to consider for patients seeking convenient and efficient care following arthroscopic rotator cuff repair.

Level of evidence
Level I
Randomized Controlled Trial
Treatment Study

BACK

Little benefit of surgical anchor and suture removal and of antibiotic therapy beyond 6 weeks in infected rotator cuff repair

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DOI: https://doi.org/10.1016/j.jse.2019.07.042

Background
The purpose of this study was to investigate the benefit of surgical anchor and/or suture removal and prolonged antibiotic therapy in acute and chronic infections of rotator cuff repair (RCIs).

Methods
A single-center cohort and case-control study (Cox regression) was performed. Outcome variables were remission of infection and postinfection reoperations due to failed tendon healing for mechanical causes. All analyses were performed with an emphasis on anchor and suture retention or removal.

Results
We identified 54 primary RCIs (44 men; median age 54 years) that were surgically revised (10 by open débridement and 44 by arthroscopy). Twenty-eight (52%) were not intact on revision surgery (débridement) – 10 were partially and 18 totally re-ruptured. The median number of surgical revisions was 1 (range, 1-3), and the median duration of postsurgical antibiotic therapy was 75 days. After a minimal follow-up of 2 years, 8 infections (8/54, 15%) recurred. Twenty patients needed a revision surgery; in all of those 20 patients, intraoperative samples were negative for infection. By multivariate analysis, anchor removal at the first revision influenced neither remission (hazard ratio [HR] 0.9, 95% confidence interval [CI] 0.4-2.0) nor the need for later revision surgery due to mechanical sequelae (HR 0.6, 95% CI 0.1-1.4). The corresponding HRs for suture removal were 0.9 (95% CI 0.4-1.7) and 0.4 (95% CI 0.1-1.2). Likewise, the numbers of revision surgery (HR 0.5, 95% CI 0.2-1.3) and antibiotics beyond 6 weeks failed to influence remission (HR 1.1, 95% CI 0.4-3.1).

Level of evidence
Level III, Retrospective Cohort Design, Treatment Study

BACK

Arthroscopic débridement of irreparable rotator cuff tears: predictors of failure and success

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DOI: https://doi.org/10.1016/j.jse.2019.08.010

Hypothesis/Background
Many techniques have been described to treat irreparable rotator cuff tears (RCT). Arthroscopic débridement for massive, irreparable RCT has been previously described to be a successful operation. The primary objective of our study was to analyze the mid-term outcomes and failure rates of arthroscopic débridement for irreparable RCTs and identify risk factors associated with failure and poor outcomes.

Methods
We retrospectively identified all patients between 2008 and 2013 who underwent arthroscopic débridement for an irreparable RCT. Demographics, operative reports, and preoperative imaging were collected from the medical record and outcome scores (American Shoulder and Elbow Surgeons [ASES] and visual analog scale) were collected at a minimum of 5-year follow-up.

Results
Twenty-six patients were included with a median follow-up of 98 months (range, 58-115 months). The average age at the time of surgery was 60 ± 11 years. Six patients (23%) had a reoperation at a median 11 months (range, 1-91 months), with 5 of those being revised to reverse shoulder arthroplasty. Median ASES and visual analog scale pain scores improved significantly from preoperatively to postoperatively ($P < .01$). Lower preoperative forward elevation was associated with worse postoperative ASES scores ($P = .004$) and revision to reverse shoulder arthroplasty. We found no associations between preoperative radiographic variables and reoperation or lower outcome scores.

Discussion/Conclusion
Arthroscopic débridement for irreparable RCT shows good mid-term success with improvements in patient-reported outcome scores and pain. Cost-effectiveness of more expensive procedures should be considered in the context of these successful results. Poor preoperative forward elevation appears to be a negative predictor of outcome and should be considered carefully when indicating patients for this procedure

Level of evidence
Level IV
Case Series
Treatment Study

BACK

Does anchor insertion angle or placement of the suture anchor affect glenoid rim fracture occurrence after arthroscopic Bankart repair?

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DOI: https://doi.org/10.1016/j.jse.2019.08.002

Background
The purposes were to compare the characteristics of 2 groups of patients who underwent revision Bankart repair with and without glenoid rim fractures and to examine risk factors for glenoid rim fractures.

Methods
We retrospectively analyzed 39 patients who needed revision surgery after arthroscopic Bankart repair and identified 19 patients with and 20 patients without glenoid rim fractures. The insertion angle of the suture anchor, anchor position on the glenoid, and demographic data were compared between the groups.

Results
The mean anchor insertion angles in the glenoid fracture group (group F) at the 2-, 3-, 4-, and 5-o'clock positions were 64°, 58°, 55°, and 55°, respectively; those in the no-fracture group (group R) were 60°, 63°, 60°, and 55°, respectively (P = .630, P = .207, P = .166, and P = .976, respectively). At the 5-o'clock position, anchors were fixed to the glenoid face in 13 cases in group F and in 3 cases in group R (P = .040). Although age (P = .529) and sex (P = 1.0) did not differ between the groups, elite and professional athletes had a significantly higher incidence of glenoid rim fractures (P = .009).

Conclusion
The anchor insertion angle did not affect glenoid rim fracture occurrence after arthroscopic Bankart repair. However, the placement of the suture anchor at the 5-o'clock position on the glenoid face could increase the risk of glenoid rim fracture after trauma. Athletes were more likely to have glenoid rim fractures owing to major trauma after arthroscopic Bankart repair.

Level of evidence
Level II
Retrospective Cohort Design
Treatment Study

BACK

Increased stiffness of the supraspinatus muscle at 1 month after arthroscopic rotator cuff repair causes retear

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DOI: https://doi.org/10.1016/j.jse.2020.01.011

Purpose
To investigate changes in the stiffness of the supraspinatus muscle and tendon after arthroscopic rotator cuff repair as measured using shear wave elastography (SWE), and to compare the supraspinatus muscle stiffness of patients with recurrent tears and those of patients with healed rotator cuff tears.

Methods
Sixty patients with supraspinatus tears requiring arthroscopic rotator cuff repair underwent serial SWE of the posterior deep region of their supraspinatus muscles and repaired tendons. SWE was performed before surgery (Pre-Op) and at 1 week, 1 month, 2 months, 3 months, 4 months, 5 months, and 6 months after surgery. Additionally, the repaired rotator cuffs were evaluated using magnetic resonance imaging at 6 months after surgery to classify patients into a healed rotator cuff group and a recurrent tear group. Differences in SWE values between the groups were assessed at each time point.

Results
The SWE value of the supraspinatus muscle at 1 month after arthroscopic rotator cuff repair surgery in the healed group was lower than that at Pre-Op and at 4, 5, and 6 months after surgery, and was also lower than that at 1 month after surgery in the retear group. There were no significant between-time point differences in the SWE values of the supraspinatus muscle in the retear group. The SWE value of the muscle in the retear group was greater than that in the healed group at 1 month after surgery.

Conclusion
An increased SWE value at 1 month after arthroscopic rotator cuff repair may predict recurrent rotator cuff tears after surgery.

BACK

Glenoid morphologic changes after arthroscopic Bankart repair

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Background
The glenoid morphology before and after arthroscopic surgery is rarely reported. The purpose of this study was to evaluate the glenoid morphology after arthroscopic Bankart repair.

Methods
A total of 31 cases of anterior shoulder instability (20 men, 11 women, age 27.4 years) treated with arthroscopic Bankart repair from January through December 2007 were investigated. The glenoid morphology was evaluated according to glenoid bone loss and surface area (enface view) in preoperative and postoperative three-dimensional computed tomography scans. We examined the relationship between glenoid morphologic changes and age, sex, number of preoperative dislocations, and bony fragments. The Mann-Whitney U-test and Student's t-test were used for statistical analysis. A < 5% risk ratio was considered a significant difference.

Results
The preoperative glenoid bone defect was 13.4%, and the 10-year postoperative bone defect improved to 10.0%. In addition, the postoperative glenoid surface area improved from 570.5 to 611.6 mm2 in 10 years. There was a significant difference between postoperative glenoid morphologic changes and bony fragments ($p = 0.05$).

Conclusion
Although bony fragments have been reported to be effective in improving glenoid morphologic changes, the glenoid morphology can be almost normalized during the long-term postoperative period, even in shoulders without bony fragments.

BACK

Functional and MRI outcomes of Superior Capsule Reconstruction with Acellular Dermal Matrix

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Background
Superior capsular reconstruction (SCR) is an emerging treatment option for irreparable massive rotator cuff tears (MRCT). The initial description utilized fascia lata autograft, but acellular dermal matrix (ADM) has become the graft of choice in the United States. Several reports have demonstrated excellent short-term functional improvement and patient satisfaction, but there is limited data correlating imaging studies of graft integrity to functional outcome. The purpose of this study was to determine if functional outcome after SCR is dependent on dermal allograft integrity on post-operative MRI.

Methods
Inclusion criteria were patients who underwent an SCR by one of 5 fellowship-trained surgeons at a single institution for the indication of pain attributable to irreparable MRCT that failed non-operative treatment. Exclusion criteria included arthritis, prior infection, revision SCR, and less than 6 months follow-up. Pre- operative data including age, gender, prior surgery, Hamada grade, and Goutallier stage were recorded. Intra-operative data including surgical findings and concomitant procedures were recorded. Pre- and post operative acromiohumeral distance (AHD), American Shoulder and Elbow Surgeons (ASES), Oxford, visual analogue scale (VAS) and post-operative SANE score were recorded. In 90% of cases, a 3 mm ADM was used and in 10% of cases, a 6 mm ADM was used (doubled over 3 mm graft). All grafts were fixed by a double-row, trans-osseous equivalent technique on the tuberosity and with a mean of 3 anchors on the glenoid. Patients were routinely offered to undergo an MRI postoperatively regardless of symptoms.

Results
53 patients met our inclusion criteria. Mean age was 60.1+7.9 years (range 34 to 77). 68% were male; 34% had at least one prior procedure; 58% had a concomitant procedure; 57% were Hamada 1, 38% Hamada 2, and 5% Hamada 3. Pre-op Goutallier stage was 3.7% grade 0, 17% grade 1, 40% grade 2; 26% grade 3; 13% grade 4. The mean clinical follow-up was 15+7.8 months (range 6-42 months). 81% of patients underwent an MRI post-operatively. The mean time for MRI was 14+7 months (range 6 -40). MRI revealed that 38% had a completely intact graft, 33% had a tear from the glenoid, 12% had a mid-substance tear, 14% tear from the tuberosity, and 2% had complete graft absence. There was a significant improvement in ASES (37.7 to 79.5, $P<0.0001$), Oxford (26.3 to 44, $P<0.0001$), and VAS (7 vs 2.3, $P<0.0001$). There was no difference between pre-op and post-op AHD (7.3 mm vs 6.9mm, $P=0.57$). There was no association between pre-operative AHD ($P=0.9$), Goutallier stage ($P=0.43$), Hamada grade ($P=0.49$) with post-operative ASES scores. There was a significant correlation between graft integrity with final outcome. There was no difference in post-operative ASES score when the graft was completely intact or torn from the glenoid ($P=0.39$), but graft tear from the tuberosity resulted in a significantly lower ASES score ($P=0.013$).

Conclusion
In patients who undergo SCR for MRCT, there is significant improvement in ASES, Oxford, and VAS. This improvement is seen in patients who have an intact graft, as well as those where the graft is torn from the glenoid, but not those torn from the tuberosity. This supports the concept of the graft functioning as a ”biologic tuberoplasty” preventing bone-to-bone contact between the tuberosity and acromion. Preoperative AHD, Goutallier, Hamada, gender, or age did not have an association with post-operative ASES scores.

BACK

Short Term Comparative Imaging and Clinical Analysis of Superior Capsular Reconstruction

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Background
Superior capsular reconstruction has been advocated as an effective technique for management of massive rotator cuff tears. Despite increasing popularity of the technique, few prospective series exist regarding overall outcomes of the procedure and few available studies have examined the long-term survivability of the graft. The purpose of the present study is to evaluate the short-term outcomes of ten patients treated with arthroscopic superior capsular reconstruction with dermal allograft for treatment of irreparable massive rotator cuff tears with MRI and ultrasound assessment of the graft integrity.

Methods
Between 2016-2018, patients with symptomatic irreparable rotator cuff tears were enrolled for treatment with arthroscopic superior capsular reconstruction. Informed consent and investigational review board approval was achieved for the purposes of the study. All patients were treated by a single fellowship trained shoulder surgeon. The minimum follow-up was 1 year. Range of motion and functional outcome according to visual analog scale (VAS) pain, American Shoulder and Elbow Surgeons (ASES) score, and simple shoulder test (SST) score were assessed preoperatively and at routine follow-up intervals. MRI and ultrasound was obtained at minimum of one year to assess graft integrity and to correlate clinical outcomes.

Results
Ten patients with a mean age of 58.6 years had a minimum follow-up of one year. Two patients (20%) had a prior rotator cuff repair. Forward flexion improved from 138 preoperative and 172 postoperative ($P<.007$) respectively, VAS decreased from 6 to 1 ($P<.006$), ASES improved from 43.7 to 89.6 ($P<.008$). At one year, all patients had both ultrasound and MRI to assess graft integrity. Ultrasound identified graft failure in one patient (11%), while MRI diagnosed graft failure in 4 patients (44%). Sensitivity, specificity, PPV, NPV, and accuracy of ultrasound in the detection of graft failure was 25%, 100%, 100%, 62.5%, and 66.7%, respectively. Of the four failures, two failed at the level of the glenoid and two failed mid graft. One patient with graft failure was revised to a reverse arthroplasty.
Mann-Whitney U tests and Fisher's exact tests were used to compare patient characteristics between intact and failed grafts. Wilcoxon signed-rank tests were performed to compare pre-operative and 1-year post-operative outcomes. (Table 1 and 2). Data were analyzed using SPSS version 25 (Armonk, NY: IBM Corp.). All statistical tests were two-tailed and $p < 0.05$ was used to determine significance. Due to the small numbers, significant comparisons between the two groups could not be made, however, functional outcome and VAS trended towards better scores with an intact graft.

Conclusion
While clinical outcomes are statisically improved following athroscopic SCR using a dermal allograft, the early high failure rates of the graft raise concerns about the long-term outcomes of the procedure. Furthermore, the use of ultrasound alone to validate an intact graft should be used with caution as failures can occur at the glenoid and can be missed without MRI correlation.

BACK

Evaluating the Role of Graft Integrity on Outcomes: Clinical and Imaging Results Following Superior Capsular Reconstruction

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Introduction
Massive, irreparable rotator cuff tears in young, active patients can be difficult for the orthopaedic surgeon to treat. While reverse total shoulder arthroplasty has become a viable option, there are questions regarding the long-term implications of putting an implant designed as a salvage option in a young, high-demand patient. Mihata et al proposed the superior capsular reconstruction (SCR) utilizing fascia lata graft as an alternative1. The procedure is thought to reverse proximal humeral head migration and optimize force couples across the shoulder, leading to better function and less pain2,3. While Mihata et al and others have documented promising early results, additional cohorts free of commercial and publication bias are needed to continue to understand the outcomes4. This study seeks to provide a large, retrospective evaluation of patients following SCR, to quantify their clinical outcomes, and to evaluate their graft integrity with advanced imaging.

Methods
After obtaining Institutional Review Board approval, consecutive patients undergoing SCR with debridement and partial rotator cuff repair by two surgeons at separate hospitals were identified. All patients were contacted by phone to obtain simple shoulder test (SST), American Shoulder and Elbow Surgeons (ASES) scores, visual analog score (VAS), and single assessment numeric evaluation (SANE). Comparison to pre-operative pain scores and functional outcomes was performed using a paired two-sided t-test. The integrity of each SCR graft was evaluated by magnetic resonance imaging (MRI). Functional outcomes in patients with intact grafts and failed grafts were compared using an unpaired two-sided t-test.

Results
33 shoulders in 32 patients were identified. Four patients had subsequent surgery and were excluded from statistical analysis, including three RTSA and one latissimus dorsi transfer. The average age of patients undergoing SCR was 62 ± 7 years, with follow up ranging from 24 to 41 months. Postoperative functional outcomes were obtained on 90% of shoulders (n=26 of 29) and MRIs were obtained on 51% of shoulders (n=17 of 33). For the entire cohort, the mean post-operative outcomes were SST 79.4 ± 20.2, ASES 80.8 ± 17.6, SANE 75.4 ± 18.7, and VAS 1.4 ± 2.2. Pre-operative comparison data demonstrated significant improvement in the SST (p-value < 0.05), ASES (p-value < 0.05), and VAS (p-value <0.005), with SANE approaching significance (p-value =0.058). MRI imaging revealed graft failure in 59% (n=10 of 17) of shoulders. Failure of the grafts tended to occur off the glenoid, as shown in Figure 1. Comparison of functional outcomes based upon graft integrity is shown in Table 1, with pain-based metrics (VAS and ASES) statistically superior in the group with intact grafts, but no improvement in strictly functional metrics (SST and SANE).

Conclusion
SCR is an effective procedure for young patients with massive rotator cuff tears. While the rate of SCR graft failure is high (59%) at intermediate follow-up, functional outcomes improve regardless of radiographic evidence of graft healing. This cohort suggests that while graft integrity is important for pain relief, its influence on function remains less clear. Longer follow up and prospective assessments are needed to better elucidate the determinants of outcome as well as indications for superior capsular reconstruction.

BACK

Prospective Randomized Trial of Biologic Augmentation with Mesenchymal Stem Cells in Patients Undergoing Arthroscopic Rotator Cuff Repair

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Purpose
To comparatively examine clinical outcomes (i.e. patient-reported outcomes and tendon healing) after arthroscopic rotator cuff repair (ARCR) with and without augmentation with bone marrow aspirate concentrate (BMAC).

Methods
Patients aged 18-70 undergoing ARCR for a full-thickness tear of the supraspinatus tendon were enrolled and randomized in one of two groups. The treatment group received BMAC harvested from the iliac crest injected at the RCR site after completion using the Arthrex Angel System. The control group received a sham incision at the iliac crest to maintain blinding. Patients were assessed preoperatively and at 3 months, 6 months, 1 year, and 2 years post-operatively with a physical exam and patient reported outcomes (SST, ASES, and VR/SF-12). MRI was performed at 1-year postoperatively and graded in accordance with the Sugaya classification system. Statistical analysis was conducted with Student T-Tests and chi-squared analysis.

Results
Eighty-two patients were prospectively enrolled (control: 43, BMAC: 39). There were significantly more males than females ($p<0.05$) as well as higher baseline SST scores in the injection group ($p=0.0368$) (Table 1). ASES was significantly improved in both groups at all time points post-operatively, and SST was significantly improved in both groups at 6 months, 12 months, and 24 months compared to baseline ($p<0.05$). Mean Sugaya score for the control group (3.50±1.07) was significantly higher than that of the injection group (2.60±0.88, $p=0.003$). A strong association was noted between BMAC treatment and a lower Suguya score at 1-year post-op MRI ($\chi 2=10.077$, $p=0.002$, Cramer's $V = 0.498$).

Conclusion
Bone marrow aspirate concentrate injected into the shoulder at the time of rotator cuff repair shows improved tendon quality on 1-year post-operative MRI based on Sugaya score, suggesting that BMAC application may positively impact tendon healing rates.

BACK

Two-Year Follow-Up of Randomized Controlled Trial of Arthroscopic Bankart Repair with and Without Arthroscopic Infraspinatus Remplissage in Anterior Shoulder Instability with Hill-Sachs Defect

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Purpose
To compare re-dislocation rates and subjective outcomes between arthroscopic Bankart repair with and without arthroscopic infraspinatus Remplissage in patients with anterior shoulder instability with a Hill-Sachs lesion at 2-years post-operative.

Methods
Multi-centre, double-blinded, prospective randomized controlled trial with two parallel groups. Patients were consented from June 2011 to May 2017 and were randomized intraoperatively after confirming a Hill Sach's lesion to either undergo arthroscopic infraspinatus Remplissage (REMP) or no Remplissage (No REMP) during arthroscopic Bankart repair. Participants were +14 years old with no critical glenoid bone loss (>15% of the AP glenoid diameter) or significant shoulder arthropathy, infection, medical comorbidities, or active worker's compensation claims. Western Ontario Shoulder Instability score (WOSI), Simple Shoulder Test (SST), American Shoulder and Elbow Society assessment of shoulder function (ASES), range of motion (ROM), and re-dislocation rates were assessed at pre-, 3-, 6-months, and 1- and 2-years post-operative.

Results
One hundred and two patients were randomized and included in this analysis (50 No REMP; 52 REMP) with mean (SD) age 27.6 (8.6). Nine of 50 (82% success) No REMP and three of 52 REMP (94.2% success) patients re-dislocated by 2-years, with this difference closely approaching significance (p=0.05). Taking into account time from surgery to re-dislocation, the difference in survival was also tending towards significance in favour of REMP (0.054; Figure 1). Examining those at higher risk of re-dislocation prior to surgery, those with a Hill-Sachs lesion ≥ 25 mm or bone loss ≥ 25% of the humeral head, 4 of 14 (29%) No REMP patients re-dislocated compared to 0 of 26 in REMP (p=0.004). Both groups showed significant improvement from pre-operative to 24-months post-operative in subjective scores. WOSI improved in REMP from 57.0 (17.7) to 15.6 (17.1; p<0.001) and from 56.4 (21.5) to 15.8 (15.5) in NO REMP (p<0.001). ASES and SST scores followed similar trends (p<0.001) and there were no differences between groups in subjective outcome scores at any time point.

Conclusion
Remplissage in patients with anterior shoulder instability with a Hill-Sachs lesion may lower the risk of re-dislocation up to 2-years post-operative compared to those who do not undergo Remplissage with arthroscopic Bankart repair. In those patients at higher risk based on having a larger Hill-Sachs lesion or greater humeral head bone loss, Remplissage reduced the rate of re-dislocation significantly.

BACK

Revision Athroscopic Bankart Repair: Still a Successful Option for Recurrent Anterior Instability Following Shoulder Stabilization Surgery

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DOI: https://doi.org/10.1016/j.jse.2020.01.024

Background
Primary arthroscopic Bankart repair is considered by many to be the procedure of choice for anterior shoulder instability without bone loss. However, for cases of recurrent anterior instability, the clinical outcomes of arthroscopic revision Bankart repair compared to primary arthroscopic Bankart repair are not well known. Arthroscopic revision Bankart surgery for failed Bankart repairs can provide clinical outcomes comparable to primary arthroscopic repairs, without the need for open Bankart or Latarjet approaches.

Methods
A retrospective cohort study was performed to identify subjects 18 years and older who underwent arthroscopic revision stabilization for recurrent anterior shoulder instability. This group was compared to an age-matched control group of arthroscopic primary Bankart repairs by a single fellowship trained shoulder surgeon over a 6 year period. Patients with significant glenoid bone loss, HAGL lesions, multi-directional instability, concomitant SLAP repairs or capsular ruptures were excluded from the study. Outcome measures were performed using the American Shoulder and Elbow Surgeons (ASES) score, Simple Shoulder Score (SSS), and Short Form Health Survey (SF-12).

Results
16 patients were included in the revision arthroscopic Bankart repair group, and 37 patients formed the age-matched control group of arthroscopic primary Bankart repairs. Average follow-up was 5 years (range 2-7 years). In the revision group, the average ASES score was 91±9, average SSS was 11±3, SF-12 mental was 43 and physical 45. In the primary group average ASES score 92 ±13, average SSS 11±1, SF-12 Mental score 43 and physical score 45. There was no significant difference in ASES scores (p=0.54) or SSS (p=0.69) between groups. In the isolated group the preoperative mean ROM was 167° in FF and 67° in ER compared to post-operative ROM which was 168° FF and 60°ER. In the revision group there was a mean ROM of 154°in FF and 66°ER compared to a post-operative ROM of 162°in FF and 64°ER. At final follow-up, 14/16 (88%) subjects who had revision Bankart repair and 32/37 (86%) who had primary stabilization stated they would have the surgery again.

Conclusion
Arthroscopic revision Bankart repair can have similar clinical outcomes to arthroscopic primary Bankart repair and is an effective option for recurrent anterior instability in the absence of significant bone loss.

BACK

An Arthroscopic Bone Block Procedure Is Effective in Restoring Stability, Allowing Return to Sports in Cases of Glenohumeral Instability with Glenoid Bone Deficiency

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DOI: https://doi.org/10.1016/j.jse.2020.01.026

Purpose
A group of patients affected by bone loss in the context of recurrent anterior shoulder instability were treated arthroscopically with a modified Eden-Hybinette technique since 2005. The last modification was made in 2013, consisting of fixation using a pair of specifically designed double round Endobuttons, which secure the bone graft to the glenoid rim placed through a guide. This report describes patients operated on after this last modification.
No reports have described the results of this technique, and the purpose of this study was to assess early clinical and radiological results of an arthroscopic bone block procedure with double round Endobutton fixation. We hypothesized that this technique would restore shoulder stability in patients with anteroinferior glenohumeral instability with glenoid bone deficit, with excellent clinical and radiological results.

Methods
The clinical and radiological efficacy of this procedure was retrospectively evaluated in 26 patients with an average follow-up of 29.6 months (range 24-33 months).

Results
At minimum 2-year follow-up we had no recurrent anterior dislocations, excellent clinical results (average Walch-Duplay score 93.2, (SD 7.8); average Rowe score, 96.4 (SD 6.5); average SSV, 87.4 (SD 12.1); satisfaction rate, 88.5%; average loss of external rotation, 4.4° (SD 8.7°)) optimal graft positioning, and a healing rate of 92.3% on computed tomography scan.

Conclusions
Arthroscopic bone block grafting combined with a standard Bankart repair restored shoulder stability in patients with anteroinferior glenohumeral instability with glenoid bone deficit, with excellent clinical and radiological results. This procedure did not substantially limit external rotation, allowing a high rate of return to sports even among competitive, overhead, and “at risk” athletes.

BACK

Lower Extremity

Arthroscopy, Volume 36, Issue 4

Preoperative Duration of Symptoms Is Associated With Outcomes 5 Years After Hip Arthroscopy for Femoroacetabular Impingement Syndrome

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Purpose
To determine the effect of the preoperative duration of femoroacetabular impingement syndrome (FAIS)–associated symptoms on clinical outcomes at a minimum of 5 years after hip arthroscopy.

Methods
We identified FAIS patients who underwent primary hip arthroscopy between January 2012 and January 2014 with a minimum of 5 years' follow-up. Patient demographic characteristics and clinical outcomes, comprising the Hip Outcome Score–Activities of Daily Living (HOS-ADL), Hip Outcome Score–Sports Subscale (HOS-SS), modified Harris Hip Score (mHHS), pain score, and satisfaction score, were analyzed. The minimal clinically important difference, patient acceptable symptomatic state, and substantial clinical benefit were calculated. Patients were stratified based on the preoperative duration of symptoms: less than 2 years versus 2 years or longer. Multivariate regressions were constructed to determine the association between the preoperative symptom duration and clinical outcomes at 5 years after hip arthroscopy.

Results
A total of 310 patients were included with a mean age (±standard deviation) of 34.1 ± 11.9 years and body mass index of 25.3 ± 5.1. The study group showed statistically significant improvements in the HOS-ADL, HOS-SS, mHHS, pain score, and satisfaction score ($P < .001$ for all). A preoperative duration of symptoms of 2 or more years was an independent predictor of worse HOS-ADL, HOS-SS, mHHS, and pain score ($P < .05$ for all). Furthermore, a longer duration of symptoms was associated with a lower likelihood of achieving the minimal clinically important difference for the HOS-ADL (odds ratio [OR], 0.53; $P = .037$), HOS-SS (OR, 0.38; $P = .003$), and mHHS (OR, 0.43; $P = .009$); the patient acceptable symptomatic state for the HOS-SS (OR, 0.44; $P = .006$) and mHHS (OR, 0.46; $P = .006$) but not the HOS-ADL despite trending toward significance (OR, 0.59; $P = .098$); and substantial clinical benefit for the HOS-ADL (OR, 0.50; $P = .011$), HOS-SS (OR, 0.52; $P = .020$), and mHHS (OR, 0.47; $P = .007$).

Conclusions
Patients with a preoperative duration of FAIS-associated symptoms of 2 or more years prior to hip arthroscopy experience inferior outcomes and a lower frequency of clinically significant outcome improvement than patients with a shorter duration of symptoms at medium-to long-term follow-up.

Level of Evidence
Level III, retrospective comparative trial.

BACK

Unique Substantial Clinical Benefit Values for the 12-Item International Hip Outcome Tool Based on Preoperative Level of Function

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Purpose
To define unique substantial clinical benefit (SCB) values for improvement on the 12-item International Hip Outcome Tool (iHOT-12) based on a preoperative self-rating of function in patients undergoing hip arthroscopy for intra-articular pathology.

Methods
This was a retrospective review of prospective collected data on patients having hip arthroscopy for labral and chondral pathology and femoroacetabular impingement. On preoperative assessment and 1-year (+/–1 month) follow-up, subjects completed the iHOT-12 and a self-categorical rating of function ("severely abnormal," "abnormal," "nearly normal," or "normal"). Separate receiver operator characteristic analyses were performed for each preoperative categorical self-rating of function to determine unique SCB values for improvement-based changes in self-rating of function.

Results
Of 1034 eligible patients, 733 (71%) subjects met the inclusion criteria. Subjects consisted of 537 (73%) female and 196 (27%) male subjects with a mean age of 35.3 years (standard deviation 13). At a mean of 352 (standard deviation 21) days postsurgery, changes in iHOT-12 scores of 22, 28, and 27 points were associated with acceptable accuracy in identifying those who had an improved function rating when reporting a "severely abnormal," abnormal," and "nearly normal" rating on preoperative assessment, respectively. The accuracy of these SCB values in predicting improvement was different depending on the patient's preoperative rating of function. The accuracy of the SCB values in predicting improvement in those who had a "nearly normal" rating of function was not as accurate (area under the curve = 0.73) compared with those who had a "severely abnormal" or "abnormal" rating of function on preoperative assessment (area under the curve = 0.89; 0.89).

Conclusions
This study provides surgeons with unique SCB values for the iHOT-12 based on a preoperative rating function and may allow for a more precise interpretation of score changes. SCB values of 22, 28, and 27 points on the iHOT-12 at 1-year (+/–1 month) follow-up identified those who had an improved function rating, when reporting a "severely abnormal," abnormal," and "nearly normal" rating on preoperative assessment, respectively.

Level of Evidence
III, retrospective comparative study

BACK

Should Preoperative Fascia Iliaca Block Be Used for Hip Arthroscopic Labral Repair and Femoroacetabular Impingement Treatment? A Prospective Single Blinded Randomized Study

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Purpose
To evaluate the analgesic effect of preoperative fascia iliaca block on postoperative morphine equivalent dose, pain level, and patient satisfaction for patients electing to undergo primary hip arthroscopic labral repair with osteochondroplasty.

Methods
This prospective study included 60 patients (fascia iliaca block group: n = 27; control group: n = 33) undergoing elective arthroscopic hip surgery by a single board-certified orthopedic surgeon, fellowship trained in hip arthroscopy. Participants for the study included patients older than 10 years of age and younger than 85 years of age, American Society of Anesthesiologists classifications I to III, diagnosed with symptomatic femoroacetabular impingement, and/or hip labral tear, and/or cartilage damage, and electing to undergo arthroscopic hip surgery. Patients were randomized by surgical date to receive preoperative fascia iliaca block or control (no fascia iliaca block). Preoperative fascia iliaca block was administered by 1 of 4 board certified anesthesiologists using identical anesthetic (35-40 mL ropivacaine 0.35%). Postoperative morphine equivalent dose, self-reported pain level (visual analog scale) and patient satisfaction were measure postoperatively.

Results
There were no significant differences between the control group and the fascia iliaca block group in sex, age, height, weight, or body mass index. There was a significant difference between the 2 groups in distribution of American Society of Anesthesiologists classification ($p = .031$). There were no significant differences in postoperative morphine equivalent dose for patients receiving fascia iliaca block compared with the control group. There were no significant differences in self-reported visual analog scale pain and patient satisfaction between the 2 groups at any of the measured time points following surgery.

Conclusions
Based on the results of this study, routine preoperative fascia iliaca block for elective hip arthroscopic labral repair and treatment of femoroacetabular impingement is not recommended.

Level of Evidence
Level II, prospective single blinded randomized study.

BACK

Arthroscopy Versus Open Arthrotomy for Treatment of Native Hip Septic Arthritis: An Analysis of 30-Day Complications

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Purpose
To evaluate differences in short-term complications in patients treated with open arthrotomy or arthroscopy for septic arthritis (SA) of the native hip and identify risk factors associated with return to the operating room (ROR).

Methods
Patients who underwent hip arthrotomy or arthroscopy for native hip SA between 2007 and 2017 were queried in the Humana database via the PearlDiver research tool. Patients with a previous history of total hip arthroplasty were excluded from this study. Basic demographics and various 30-day perioperative complications, including ROR, were compared between the 2 cohorts. Multivariate analysis was performed for ROR within 30 days following arthroscopy and arthrotomy.

Results
We identified 421 patients with SA of the native hip, of whom 387 (91.9%) and 34 (8.1%) were treated with open arthrotomy and arthroscopy, respectively. There were no significant differences in demographic variables between groups. On univariate analysis, the incidence of total adverse events (arthrotomy: 75.7% vs arthroscopy: 52.9%, P = .0038) was significantly greater in the open arthrotomy cohort. However, there was little difference in ROR between both cohorts (arthrotomy: 45.9% vs arthroscopy: 38.2%, P = .3836). Multivariate analysis identified preoperative septicemia or septic shock (odds ratio [OR] 1.90; 95% confidence interval [CI] 1.25-2.89, P = .0026) as a significant risk factor for ROR within 30 days after surgery. Neither arthrotomy (OR 4.93, 95% CI 0.42-115.2, P = .2174) nor arthroscopy (OR 3.55, 95% CI 0.33-78.01, P = .3077) were significant risk factors to ROR.

Conclusions
Patients with SA of the hip had similar short-term complication rates and ROR regardless of open arthrotomy or arthroscopic management. This suggests that arthroscopic management may be a safe option for the treatment of SA of the hip with potentially limited morbidity.

Level of Evidence
Level IV (treatment harms investigation).

BACK

Intra-abdominal Pressure Changes During Hip Arthroscopy: A Prospective Multicenter Study

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Purpose
To evaluate intra-abdominal pressure changes during hip arthroscopy and define its relationship with other patient related variables.

Methods
A prospective multicenter study evaluating intra-abdominal pressure (IAP) in patients undergoing arthroscopic treatment of femoroacetabular impingement was performed. The IAP was measured indirectly by a bladder catheter (AbViser Autovalve Intra-abdominal pressure monitor) and documented every 30 minutes during the entire procedure. The following risk factors were analyzed: traction time, duration surgery, previous abdominal surgery, capsule repair, psoas tenotomy, and surgical approach.

Results
One hundred and five patients with symptomatic femoroacetabular impingement that underwent hip arthroscopy met the inclusion criteria. There were significant differences in the IAP between the preoperative measurement of IAP and the IAP at different time points during surgery ($P < .01$). The IAP increased continuously from the commencement of surgery (considered as time point from portal establishment) until the first 60 minutes. After first 60 minutes of surgery, the IAP did not increase significantly. There were no significant associations between increased IAP and the risk factors analyzed.

Conclusions
IAP increases significantly during the first 60 minutes of hip arthroscopy; it then stabilizes for the duration of surgery before decreasing just after the completion of surgery. The highest recorded IAP was not associated with additional complications. No symptomatic intra-abdominal hypertension was documented. Finally, patient- and procedure-specific risk factors did not predict changes in IAP. Systemic monitoring of IAP during the hip arthroscopy procedure can easily and effectively be done, allowing the surgeon to early detect any significant change.

Level of Evidence
Level IV, therapeutic case series.

BACK

Acetabular Ossicles: Epidemiology and Correlation With Femoroacetabular Impingement

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Purpose
To investigate (1) the prevalence, size, and location of acetabular ossicles in general population; (2) differentiation between the characteristic types of acetabular ossicles: unfused ossification centers (true os acetabuli), rim fractures, labral calcifications and loose bodies; and (3) correlation between acetabular ossicles, and femoroacetabular impingement (FAI) with symptoms.

Methods
Patients aged 16 to 60 years who underwent abdominal and pelvic computed tomography (CT) with non-orthopaedic indications in 2016 and patients who underwent hip arthroscopy surgery from 2010 to 2016 in our institution were included for asymptomatic and symptomatic groups, respectively. Two investigators evaluated CT images to find the prevalence, size, location of acetabular ossicles, and relationship with symptoms and FAI. We correlated them with types of ossicles.

Results
This study included 5684 patients with 11368 hips (2790 male and 2894 female; mean age, 44.3 years) for asymptomatic group, and 264 patients with 289 hips (171 male and 93 female; mean age, 34.4 years) for symptomatic group. The prevalence of ossicles in symptomatic and asymptomatic groups was 8.65% (25/289) and 3.33% (378/11,368), respectively. The distribution of ossicles types in general population were labral calcifications (55.09%), rim fractures (35.73%), unfused ossification center (1.24%), and loose bodies (7.94%). Labral calcification had the smallest size and mostly was asymptomatic. Rim fracture was correlated with FAI in general (83.33%; $P < .001$) but not with any types of FAI. Size of ossicles was related with symptom (895.28 vs 103.64 mm3; $P < .001$).

Conclusions
The prevalence of acetabular ossicles in general population are 3.46%, with significantly higher prevalence of acetabular ossicles were found in symptomatic group (8.65% vs 3.33%). Size of acetabular ossicles was significantly associated with hip pain. Labral calcification was the most common type of acetabular ossicles. Significant relationship was found between rim fracture and FAI but not with any specific types of FAI.

Level of Evidence
Level III, Retrospective comparative study.

BACK

Inside-Out Repair of the Meniscus in Concomitant Anterior Cruciate Ligament Reconstruction: Absorbable Versus Nonabsorbable Sutures

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Purpose
To compare the clinical and magnetic resonance imaging (MRI) outcomes of meniscal repair using absorbable versus nonabsorbable sutures in patients undergoing concomitant anterior cruciate ligament reconstruction.

Methods
Data of 142 patients who underwent meniscal repair with concomitant anterior cruciate ligament reconstruction using either absorbable or nonabsorbable sutures for longitudinal meniscal tear were retrospectively reviewed. Inside-out suture technique was used for all meniscal repairs. Weight bearing and flexion (>90°) were allowed after 6 weeks postoperatively. Clinical evaluations were assessed by the International Knee Documentation Committee subjective score, Lysholm score, and Tegner activity score preoperatively and at 2-year follow-up. MRI outcomes at 1-year follow-up were compared to identify the successful healing (complete or partial healing) rate and incidence of additional meniscal tears. Subgroup analysis was performed to evaluate the results of medial or lateral meniscus.

Results
Eighty patients underwent meniscal repair using absorbable sutures (mean age, 26.3 ± 11.9 years) and 62 patients with nonabsorbable sutures (mean age, 27.2 ± 10.0 years). There were no differences in zone and length of meniscal tears and stability tests between the groups. At a 2-year follow-up, all clinical scores had improved in both groups but did not differ significantly between the groups. Successful healing rate based on 1-year postoperative MRI was not significantly different between the absorbable and nonabsorbable sutures (93.7% vs 96.8%, P = .469). However, the absorbable sutures showed a lower additional tear incidence than the nonabsorbable sutures (2.5% vs 9.6%, P = .031). Subgroup analysis showed that the successful healing rate was not significantly different between the suture materials in both the medial and lateral menisci.

Conclusions
The use of absorbable sutures leads to comparable healing rates to and lower incidence of additional tears than nonabsorbable sutures in patients undergoing meniscal repair with anterior cruciate ligament reconstruction.

Level of Evidence
Level III, retrospective comparative therapeutic trial.

BACK

Visualization of Concurrent Anterolateral and Anterior Cruciate Ligament Injury on Magnetic Resonance Imaging

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Purpose
To investigate the ability to visualize the anterolateral ligament (ALL) on magnetic resonance imaging (MRI) and identify ALL injuries in an intact- anterior cruciate ligament (ACL) and torn-ACL cohort. We also aimed to assess inter-rater reliability between 2 radiologists when it comes to the aforementioned assessment.

Methods
MRIs that met inclusion and exclusion criteria were placed into a control (ACL-intact) or study (ACL-injured) cohort. MRIs were independently analyzed by 2 radiologists for data points pertaining to demographics, ALL visualization, presence of ALL injury, and concomitant knee abnormalities. Inter-rater reliabilities for visualizing the ALL and identifying ALL injuries were assessed.

Results
The control and study groups consisted of 116 and 82 MRIs, respectively. Age varied between the 2 groups, but sex distribution was similar. With near-perfect agreement (kappa = 0.92), both radiologists visualized at least part of the ALL in more than 95% of MRIs irrespective of ACL integrity. The mean incidence of ALL injury in the ACL injured group was 53.05% with minimal inter-rater agreement (kappa = 0.38). Segond fractures were noted in a mean 13.95% of MRIs with concomitant ALL and ACL injuries.

Conclusions
The ALL was reliably visualized on MRI irrespective of whether the ACL was intact or torn. However, ALL injuries were not reliably diagnosed on MRI in the setting of an ACL tear. Poor interobserver reliability shows the potential for false-positive and -negative interpretation. These findings suggest that, in this study, ALL injuries could not be accurately diagnosed in the presence of an ACL tear using MRI. On the basis of these findings, it is recommended that physicians should not rely on MRI to diagnose an ALL injury in the presence of an ACL injury.

Level of Evidence
Level III, retrospective comparative trial

BACK

Graft Inclination Angles in Anterior Cruciate Ligament Reconstruction Vary Depending on Femoral Tunnel Reaming Method: Comparison Among Transtibial, Anteromedial Portal, and Outside-In Retrograde Drilling Techniques

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Purpose
To compare graft coronal and sagittal inclination angles in anterior cruciate ligament (ACL) reconstruction performed by different femoral tunnel drilling techniques with respect to intact native ACL.

Methods
In total, 72 patients were prospectively enrolled in the study. The inclusion criteria were complete ACL rupture and patient age between 18 and 55 years. Reconstructions were performed using 4 different femoral tunnel drilling technique: transtibial (TT), anteromedial portal with rigid (AMP-RR) or flexible (AMP-FR) reamer, and outside-in retrograde drilling (OI) techniques. Eighteen patients with intact native ACL were included as controls. Sagittal and coronal graft inclination angles were measured by magnetic resonance imaging 6 months after the procedure by 1 radiologist blinded in regards to the used technique.

Results
OI and AMP-FR techniques allowed for the maintenance of native-like ACL inclination in both the sagittal and coronal planes, whereas TT and AMP-RR increased the sagittal angle by a mean of 9.5° ($P < .001$) and 6.7° ($P = .003$), respectively, compared with native ACLs. AMP-RR and TT also showed increased sagittal graft inclination compared with AMP-FR (+6.1°, $P = .009$ and +9.0°, $P < .001$, respectively) and OI-drilling techniques (+5.5°, $P = .024$ and +8.4°, $P < .001$, respectively). No differences were observed among study groups in terms of coronal graft inclination.

Conclusions
The study hypothesis was partially confirmed, since OI and AMP-FR techniques, but not AMP-RR, using an independent portal for femoral drilling produce a more anatomic graft inclination on the sagittal plane with respect to TT.

Level of evidence
II, prospective comparative study.

BACK

Comparison of Postoperative Tunnel Widening After Hamstring Anterior Cruciate Ligament Reconstructions Between Anatomic and Nonanatomic Femoral Tunnels

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Purpose
To evaluate the effect of the location of the femoral tunnel on 3-dimensional (3D) computed tomography (CT) upon the postoperative tunnel widening after anterior cruciate ligament (ACL) reconstructions.

Methods
Inclusion criteria were patients who underwent hamstring ACL reconstructions using an adjustable-loop cortical suspension device, underwent 3D CT at the day after surgery, and were followed for a minimum of 2 years after surgery. Exclusion criteria were patients with combined ligament injury and reinjury after reconstruction. Using 3D CT, the center of the femoral tunnel aperture was located on a standardized grid system. The center of the ACL footprint was defined from the literature. The femoral tunnel location was classified as anatomic if it located within 2 standard deviations of the center position. If it was outside the 2 standard deviations, the tunnel was classified as nonanatomic. The patients were divided into either anatomic or nonanatomic groups. Femoral tunnel angles on both sagittal and coronal planes were measured. Both femoral and tibial tunnels measured on anteroposterior and lateral radiographs at immediate postoperative day and at 2 years after surgery. Postoperative knee stability and patient-reported outcomes were evaluated.

Results
There were 37 patients in anatomical group and 52 patients in nonanatomical group among enrolled 87 patients. There were no differences in demographics between the 2 groups. There were no differences in the femoral tunnel angles and postoperative tunnel widening between the 2 groups. A higher position correlated to the femoral tunnel widening at 2 years postoperatively. Postoperative knee stability and patient-reported outcomes showed no statistically significant differences between the 2 groups.

Conclusions
There was no significant difference in postoperative tunnel widening or clinical outcomes between anatomic and nonanatomic femoral tunnel location after hamstring ACL reconstructions. A higher position correlated to the femoral tunnel widening at 2 years postoperatively.

Level of Evidence
Level III, Retrospective comparative study.

BACK

Femoral Anteversion Is Related to Tibial Tubercle-Trochlear Groove Distance in Patients with Patellar Dislocation

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Purpose
To evaluate the potential relationship between the tibial tubercle–trochlear groove (TT-TG) distance and the femoral anteversion of different segments of the femur in patients with patellar dislocation.

Methods
A total of 60 patients with a diagnosis of patellar dislocation were included in our study. Patients with previous knee surgeries, previous fractures, or lack of necessary radiologic examinations were excluded from our study. The data of computed tomography scanning within a week before the surgery was used to measure the TT-TG distance, total anteversion, proximal anteversion, diaphyseal anteversion, distal anteversion, and tibial torsion. All the data were obtained from the picture archiving and communication system (PACS) workstation. The Pearson correlation analysis was performed to confirm the potential relationship between TT-TG distance and femoral anteversion of different segments. The intraclass correlation coefficient was used to assess the interobserver reliability of measurements.

Results
The TT-TG distance was significantly correlated with the diaphyseal anteversion ($r = -0.305$, $P = 0.008$) and distal anteversion ($r = 0.365$, $P = 0.004$). The total anteversion was associated with proximal anteversion ($r = 0.392$, $P = 0.02$) and diaphyseal anteversion ($r = 0.631$, $P < 0.001$). The intraclass correlation coefficient showed the measurements of included parameters were presented with excellent agreement.

Conclusion
Our study showed that patients with high diaphyseal anteversion and distal anteversion tend to had a higher TT-TG distance but the value of total and proximal femoral anteversion were independent of the value of TT-TG distance.

Level of Evidence
Level IV therapeutic case series.

BACK

Anatomic, All-Arthroscopic Reconstruction of Posterolateral Corner of the Knee: A Cadaveric Biomechanical Study

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Purpose
To assess the role of anatomic reconstruction of the posterolateral corner (PLC) of the knee arthroscopically in cadaveric knees with simulated isolated grade III posterolateral instability.

Methods
A total of 12 nonpaired, fresh-frozen cadaveric knees were biomechanically subjected to a 10-Nm varus moment, 5-Nm external and internal rotation torques, and 134-N posterior tibial load at 0°, 15°, 30°, 60°, and 90° of knee flexion (0° for varus loading only). Testing was performed with an intact and sectioned PLC and after anatomic reconstruction of the PLC by an arthroscopic technique. Kinematics of each knee under various loading conditions was determined with a robotic universal force/moment sensor testing system.

Results
After sectioning, significant increases were found in varus rotation at 0°, 15°, 30°, 60°, and 90° of knee flexion; in external rotation at 15°, 30°, 60°, and 90° of knee flexion; in internal rotation at 60° of knee flexion only; and in posterior translation at 15° and 30° of knee flexion. After reconstruction, full recovery of knee stability was observed in varus rotation, external rotation, internal rotation, and posterior translation at all selected flexion angles without any overconstraint of knee kinematics.

Conclusions
Anatomic reconstruction of the PLC can be performed arthroscopically with isolated grade III posterolateral instability of the knee, and nearly normal stability of the knee can be restored.

Clinical Relevance
PLC reconstruction by an anatomic, all-arthroscopic technique achieves optimal stability control and kinematics of the knee.

BACK

Medial Versus Lateral Meniscus Root Tears: Is There a Difference in Injury Presentation, Treatment Decisions, and Surgical Repair Outcomes?

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Purpose
To determine (1) the demographic characteristics as well as radiographic findings of medial versus lateral meniscal root tears at time of presentation, (2) treatment decisions and clinical outcomes of patients undergoing medial versus lateral root repair, and (3) risk factors for worse clinical and radiographic outcomes.

Methods
A retrospective review was performed to identify patients with symptomatic, medial, or lateral meniscus posterior root tears with a minimum 2-year follow-up. Radiographs were graded using Kellgren-Lawrence scores. Subanalysis was performed on 62 patients who underwent root repair. Tegner, Lysholm, International Knee Documentation Committee scores, and progression to arthroplasty were analyzed in the repair groups. Patient demographics, radiographic findings, and clinical outcomes were compared between medial meniscus posterior horn root tear (MMRT) and lateral meniscus root repair (LMRT).

Results
Of the 141 root tears, 109 were MMRTs, 30 were LMRTs, and 2 patients had both. At the time of injury, patients with MMRTs had a significantly higher age (MMRT = 51.4 vs LMRT=24.6, P < .0001), body mass index (MMRT = 32.1 vs LMRT 25.8, P < .0001), Kellgren-Lawrence score (MMRT = 1.3 vs LMRT=0.6, P < .0001), and higher rate of major meniscal extrusion (MMRT = 72% vs LMRT = 20%, P < .0001). Of the 30 LMRT, 30/30 (100.0%) were treated with meniscal repair. With MMRT, 52/109 (48%) were treated nonoperatively, 27/109 (25%) with partial meniscectomy, and 30/109 (27%) with meniscal repair. Sixty-two patients underwent meniscus root repair with an average 41-month follow-up. LMRT had significantly increased International Knee Documentation Committee (LMRT = 89.5, MMRT = 80.4, P = .02) and Tegner scores (LMRT = 6.5, MMRT = 5.1, P < .05) compared with MMRT.

Conclusions
Compared with MMRTs, LMRTs occur in younger male patients with lower body mass index, less cartilage degeneration, less extrusion on magnetic resonance imaging, and more commonly with a ligament injury. Although good to excellent clinical outcomes were attained in select patients for both medial and lateral meniscus root repair, LMRTs may have better results after repair, suggesting that differences in injury and patient characteristics may contribute to differences in these outcomes.

Level of Evidence
Retrospective comparative study, Level III.

BACK

Meniscus Repair Does Not Result in an Inferior Short-term Outcome Compared With Meniscus Resection: An Analysis of 5,378 Patients With Primary Anterior Cruciate Ligament Reconstruction

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https://doi.org/10.1016/j.arthro.2019.11.122

Purpose
To compare the preoperative and 1- and 2-year postoperative Knee Injury and Osteoarthritis Outcome Score (KOOS) subscale scores between isolated anterior cruciate ligament reconstruction (ACLR) and ACLR with additional medial meniscus (MM) and/or lateral meniscus (LM) resection or repair.

Methods
A total of 5,378 patients who underwent primary ACLR, with no associated ligament injuries, at our institution from January 2005 to December 2015 were included. The KOOS subscale scores were used to evaluate patients preoperatively and at 1- and 2-year postoperative follow-up assessments. Patients who underwent isolated ACLR and those who underwent ACLR with additional MM resection, MM repair, LM resection, LM repair, MM plus LM resection, or MM plus LM repair were compared by use of an analysis of covariance, with age, sex, graft, and cartilage injury as covariates.

Results
Postoperatively, at both 1- and 2-year follow-up assessments, no significant differences were found between the groups for any of the 5 KOOS subscales. Preoperatively, a significant difference between the groups was found for the KOOS Symptoms ($P < .001$), Pain ($P < .001$), Activities of Daily Living (ADL) ($P < .001$), and Sport and Recreation (Sport/Rec) ($P = .01$) subscale scores. The lowest scores were found for the group undergoing ACLR and MM plus LM repair (Symptoms, 70.1 ± 17.3; Pain, 71.4 ± 18.5; ADL, 80.6 ± 20.5; and Sport/Rec, 35.7 ± 28.1), whereas the mean scores for the other groups ranged from 71.2 ± 18.7 to 76.5 ± 17.1 for Symptoms, from 76.1 ± 17.0 to 80.1 ± 15.5 for Pain, from 84.5 ± 16.8 to 88.1 ± 14.2 for ADL, and from 44.2 ± 28.3 to 49.1 ± 28.5 for Sport/Rec.

Conclusions
Patients undergoing isolated ACLR and those undergoing ACLR with additional MM and/or LM resection or repair obtained equivalent results for each of the KOOS subscales at the 1- and 2-year postoperative follow-up assessments. Differences between the groups were only detectable preoperatively, with patients undergoing ACLR and MM plus LM repair showing the lowest scores for the KOOS Symptoms, Pain, ADL, and Sport/Rec subscales.

Level of Evidence
Level III, retrospective comparative therapeutic trial.

BACK

Surgical Outcomes in the Treatment of Concomitant Mild Acetabular Dysplasia and Femoroacetabular Impingement: A Systematic Review

Hao-Che Tang, M.D., Michael Dienst, M.D.

Arthroscopy, Volume 36, Issue 3, Received: May 8, 2019; Accepted: November 17, 2019

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Purpose
To analyze the current approaches and clinical outcomes in the surgical management of concomitant mild acetabular dysplasia and femoroacetabular impingement (FAI).

Methods
Following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) method, the PubMed and Medline databases were searched in March 2019 for studies that reported on surgical outcomes in hips with concomitant mid acetabular dysplasia and FAI. Studies published in English that focused on the surgical outcomes after hip arthroscopy, open surgery, or periacetabular osteotomy of concomitant acetabular dysplasia and FAI, in which the lateral center-edge angle of all subjects was between 15° and 25°, were included. Articles that included subjects with lateral center-edge angle <15°, with a minimum follow-up duration <1 year, had <5 subjects, or were not original articles were excluded.

Results
The initial search yielded 748 studies, and 5 studies met the inclusion criteria. All these 5 studies focused on hip arthroscopic treatment for patients with concomitant mild acetabular dysplasia and FAI. Three studies had level III evidence, whereas 2 studies had level IV evidence. The mean patient age range across the studies was 29.8 to 49.6 years, and the female-to-male ratio was 1.14. Improved patient-reported outcomes (Hip Outcome Score—Activities of Daily Living, Hip Outcome Score—Sport, modified Harris Hip Score, Short Form-12 Physical Component Summary, Western Ontario and McMaster Universities Osteoarthritis Index) at a minimum 2-year follow-up were obtained in 4 of the 5 studies. Two of these 4 studies had a comparative cohort of patients with FAI with normal acetabular coverage, and there was no significant difference in the postoperative outcomes and secondary procedure rate between patients with mild acetabular dysplasia and those with normal acetabular coverage.

Conclusions
This systematic review indicates that improved patient-reported outcomes can be obtained with hip arthroscopy in the treatment of concomitant mild acetabular dysplasia and FAI at a minimum 2-year follow-up.

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

BACK

Comparing Hamstring Autograft With Hybrid Graft for Anterior Cruciate Ligament Reconstruction: A Systematic Review

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Arthroscopy, Volume 36, Issue 3, Received: September 3, 2019; Accepted: October 7, 2019

https://doi.org/10.1016/j.arthro.2019.10.010

Purpose
To systematically review the literature in an effort to compare the demographics and clinical outcomes of patients undergoing anterior cruciate ligament reconstruction (ACLR) with a hamstring tendon autograft (HT) versus an irradiated or nonirradiated hybrid autograft-allograft.

Methods
A systematic review of the PubMed, Cochrane Library, and Embase databases was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. All English-language literature that reported general demographics and compared the clinical outcomes of patients undergoing primary ACLR with autograft versus hybrid graft (HG) with a minimum 2-year follow-up was reviewed by 2 independent reviewers. Search terms used were “anterior cruciate ligament” and “hybrid graft.” Patients were assessed based on graft failure, anteroposterior laxity, and patient-reported outcomes (Knee Injury and Osteoarthritis Outcome Score, visual analog scale, Subjective International Knee Documentation Committee score, Lysholm, and Tegner scores). Study quality was evaluated with the Modified Coleman Methodology Score and ROBINS-I risk of bias tool.

Results
Twelve studies (1 level II, 11 level III) met inclusion criteria (follow-up, 2.0-8.9 years), including 471 patients undergoing ACLR with an irradiated hybrid graft (IH), 89 patients with a nonirradiated hybrid graft, and 829 patients with HT. Graft diameter ranged from 7.5 to 10.0 mm and from 6.5 to 10.0 mm in HG and HT patients, respectively. Overall, graft failure ranged from 0% to 30.0% and from 0% to 28.3% in HG and HT patients, respectively (I^2 = 35.9%; 95% confidence interval 0%-74.8%). Among HG patients, graft failure ranged from 0%-30.0% and from 2.4%-4.2% in IH and nonirradiated hybrid graft groups, respectively (I^2 = 33.6%; 95% confidence interval, 0%-71.8%). Results for postoperative anteroposterior laxity and patient-reported outcomes were also inconsistent.

Conclusions
Patients undergoing ACLR with HT demonstrate inconsistent differences in clinical outcomes at midterm follow-up compared with IH patients.

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

BACK

Anterior Cruciate Ligament Reconstruction with Platelet-Rich Plasma: A Systematic Review of Randomized Control Trials

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https://doi.org/10.1016/j.arthro.2019.11.004

Purpose
To perform a systematic review of the randomized controlled trials (RCTs) evaluating the efficacy of platelet-rich plasma (PRP) to augment anterior cruciate ligament (ACL) reconstruction.

Methods
Two independent reviewers screened the MEDLINE, The Cochrane Library, and EMBASE databases using Preferred Reporting for Systematic Reviews and Meta-Analyses guidelines for applicable RCTs evaluating the efficacy of PRP in ACL reconstruction. A meta-analysis was performed on the papers involving bone–patellar tendon–bone (BPTB) grafting.

Results
Thirteen RCTs fulfilled the inclusion criteria involving 765 patients. There was no clinical improvement (Tegner, Lysholm, Knee Injury and Osteoarthritis Outcome Score, or International Knee Documentation Committee scores) in any of the 7 studies evaluating PRP alongside the hamstring tendon autograft ACL reconstructions versus the control. Two studies evaluating PRP for hamstring tendon autograft demonstrated significantly improved magnetic resonance imaging findings. Two studies analyzed the use of PRP with allograft ACL reconstruction showed no clinical, biochemical, or radiologic improvements in postoperative follow-up. No functional improvements were found when PRP was used alongside BPTB in 4 studies. There was no significant difference in visual analog scale score in the BPTB group (1.1 vs 1.5, P = .18), or tibial filling defects (P = .30).

Conclusions
This study found that the current level I evidence does not support the use of PRP to improve graft healing, improve donor-site morbidity, reduce postoperative pain levels, or improve functional outcomes following ACL reconstruction.

Level of Evidence
Level I; systematic review of level I evidence

BACK

Knee Surgery, Sports Traumatology, Arthroscopy (KSSTA), Volume 27, Issue 4

Vancomycin-soaking of the graft reduces the incidence of septic arthritis following ACL reconstruction: results of a systematic review and meta-analysis

Naendrup, J., Marche, B., de SA, D. et al.

DOI: https://doi.org/10.1007/s00167-019-05353-1

Purpose
(1) To compare the incidence of post-operative septic arthritis following anterior cruciate ligament reconstruction (ACLR) between patients receiving routine pre-operative intravenous (IV) prophylaxis only intravenous (IV) infection prophylaxis and patients receiving additional graft-soaking in a vancomycin solution (5 mg/ml) perioperatively. (2) To review the literature regarding effects of graft-soaking in vancomycin solutions on outcomes, complication rates and tendon properties in ACLR.

Methods
To identify studies pertaining to routine pre-operative IV prophylaxis and additional usage of intra-operative vancomycin-soaked grafts in primary ACLR, the Cochrane Library, SCOPUS and MEDLINE were searched till June 2018 for English and German language studies of all levels of evidence following the PRISMA guidelines. Additionally, all accepted abstracts at the ESSKA 2018, ISAKOS 2017, AGA 2017 and AOSSM 2017 meetings were screened. Data regarding the incidence of septic arthritis were abstracted and combined in a meta-analysis. Data including outcome scores, complication rates and in vitro analyses of tendon properties were collected and summarized descriptively.

Results
Upon screening 785 titles, 8 studies were included. These studies examined 5,075 patients following ACLR and followed from 6 to 52 weeks post-operatively. Of those 2099 patients in the routine pre-operative IV prophylaxis group, 44 (2.1%) cases of early septic arthritis were reported. In contrast, there were no reports of septic arthritis following ACLR in 2976 cases of vancomycin-soaked grafts. The meta-analysis yielded an odds ratio of 0.04 (0.01–0.16) favouring the addition of intra-operative vancomycin-soaking of grafts. Across all available studies, no differences in clinical outcome (i.e. incidence of ACL revision, IKDC score, Tegner score), biomechanical tendon properties, or cartilage integrity between patients with and without vancomycin-soaked grafts were identified.

Conclusion
The incidence of septic arthritis following ACLR can be reduced dramatically by vancomycin-soaking the grafts intra-operatively prior to graft passage and fixation. Within the limitation confines of this study, intra-operative graft-soaking in vancomycin appears to be a safe and effective method to reduce the incidence of septic arthritis following ACLR. Still, it remains debatable if the available data facilitate the recommendation for a universal application of vancomycin-soaking for all ACLR patients or if it should be reserved for patients at risk, including the use hamstring tendons, revision cases and in the presence of medical preconditions.

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

BACK

Ramp lesions of the medial meniscus are associated with a higher grade of dynamic rotatory laxity in ACL-injured patients in comparison to patients with an isolated injury

Mouton, C., Magosch, A., Pape, D. et al

DOI: https://doi.org/10.1007/s00167-019-05579-z

Purpose
The purpose of this study was to compare preoperative knee laxity between two groups of patients with primary or revision ACL reconstruction with or without an associated ramp lesion of the medial meniscus.

Methods
Two-hundred and seventy-five patients with an ACL reconstruction (243 primaries; 32 revisions) were prospectively screened using direct arthroscopic visualisation and divided into a ramp lesion group (RLG) and a control group (CG) regardless of the presence of other associated meniscal tears. All patients were clinically examined under anaesthesia before surgery by grading the Lachman and pivot shift tests.

Results
Fifty-eight patients were included in the RLG. The CG included 217 patients. With all meniscus lesions included, there were no significant differences between the two groups. After excluding all other meniscus lesions in both groups except for ramp lesions in the RLG, the prevalence of a grade III pivot shift was higher in the RLG (32 remaining patients; 47% grade III) compared to the CG (91 remaining patients; 24% grade III, $p = 0.02$). The difference of patients with a grade III pivot shift between the CG and RLG remained significant after removal of revision ACL reconstructions (CG, 85 remaining patients; 25% grade III—RLG, 27 remaining patients; 44% grade III, $p = 0.05$).

Conclusion
Patients with an isolated ramp lesion of the medial meniscus in association with an ACL injury displayed a higher amount of dynamic rotational laxity as expressed by the pivot shift test in comparison to patients with isolated ACL injury and no ramp lesion. The association between ramp lesions of the medial meniscus and increased pivot shift grading suggests that it is important to diagnose and repair them during ACL reconstruction surgery.

Level of evidence
III.

BACK

ACL reconstruction with adjustable-length loop cortical button fixation results in less tibial tunnel widening compared with interference screw fixation

Mayr, R., Smekal, V., Koidl, C. et al.

DOI: https://doi.org/10.1007/s00167-019-05642-9

Purpose
To compare tunnel widening and clinical outcome after anterior cruciate ligament reconstruction (ACLR) with interference screw fixation and all-inside reconstruction using button fixation.

Methods
Tunnel widening was assessed using tunnel volume and diameter measurements on computed tomography (CT) scans after surgery and 6 months and 2 years later, and compared between the two groups. The clinical outcome was assessed after 2 years with instrumented tibial anteroposterior translation measurements, hop testing and International Knee Documentation Committee (IKDC), Lysholm and Tegner activity scores.

Results
The study population at the final follow-up was 14 patients with screw fixation and 16 patients with button fixation. Tibial tunnels with screw fixation showed significantly larger increase in tunnel volume over time ($P = 0.021$) and larger tunnel diameters after 2 years in comparison with button fixation ($P < 0.001$). There were no significant differences in femoral tunnel volume changes over time or in tunnel diameters after 2 years. No significant differences were found in the clinical outcome scores.

Conclusions
All-inside ACLR using button fixation was associated with less tibial tunnel widening and smaller tunnels after 2 years in comparison with ACLR using screw fixation. The need for staged revision ACLRs may be greater with interference screws in comparison with button fixation at the tibial tunnel. The clinical outcomes in the two groups were comparable.

Level of evidence
II.

BACK

Varus alignment aggravates tibiofemoral contact pressure rise after sequential medial meniscus resection

Willinger, L., Lang, J.J., Berthold, D. et al

DOI https://doi.org/10.1007/s00167-019-05654-5

Purpose
Arthroscopic partial meniscectomy of medial meniscus tears and varus alignment are considered independent risk factors for increased medial compartment load, thus contributing to the development of medial osteoarthritis. The purpose of this biomechanical study was to investigate the effect of lower limb alignment on contact pressure and contact area in the knee joint following sequential medial meniscus resection. It was hypothesized that a meniscal resection of 50% would lead to a significant overload of the medial compartment in varus alignment.

Methods
Eight fresh-frozen human cadaveric knees were axially loaded with a 750 N compressive force in full extension with the mechanical axis rotated to intersect the tibia plateau at 30%, 40%, 50%, 60% and 70% of its width. Tibiofemoral mean contact pressure (MCP), peak contact pressure (PCP), and contact area (CA) of the medial and lateral compartment were measured separately using pressure-sensitive films (K-Scan 4000, Tekscan) in four different meniscal conditions, respectively, intact, 50% resection, 75% resection, and total meniscectomy.

Results
Medial MCP was significantly increased when comparing the intact meniscus to each meniscal resection in all tested alignments ($p < 0.05$). Following meniscal resection of 50%, MCP was significantly higher with greater varus alignment compared to valgus alignment ($p < 0.05$). Similarly, medial PCP was higher at varus alignment compared to valgus alignment ($p < 0.05$). Further resection to 75% and 100% of the meniscus resulted in a significantly higher medial PCP at 30% of tibia plateau width compared to all other alignments ($p < 0.05$). Medial CA of the intact meniscus decreased significantly after 50%, 75% and 100% meniscal resection in all alignments ($p < 0.05$). Lateral joint pressure was not significantly increased by greater valgus alignment.

Conclusion
Lower limb alignment and the extent of medial meniscal resection significantly affect tibiofemoral contact pressure. Combined varus alignment and medial meniscal resection increased MCP and PCP within the medial compartment, whereas valgus alignment prevented medial overload. As a clinical consequence, lower limb alignment should be considered in the treatment of patients undergoing arthroscopic partial meniscectomy with concomitant varus alignment. In patients presenting with ongoing medial joint tenderness and effusion, realignment osteotomy can be a surgical technique to unload the medial compartment.

BACK

Ongoing MRI remodeling 3–7 years after collagen meniscus implantation in stable knees

Schenk, L., Bethge, L., Hirschmann, A. et al

DOI https://doi.org/10.1007/s00167-019-05714-w

Purpose
The purpose of the present study was to evaluate the clinical and radiological 3–7 years outcomes of patients who underwent collagen meniscus implantation in stable or stabilized knees. It was the hypothesis that using the collagen meniscus (CMI) good clinical 3–7 years outcomes with low pain levels are achieved.

Methods
Thirty-nine patients (male:female = 30:9, mean age 34 ± 10 years) underwent arthroscopic CMI after subtotal medial (n = 32) or lateral meniscectomy (n = 7). A 7-mm CMI was performed due to prophylactic (n = 25) or therapeutic indication (n = 14). IKDC score, Tegner score preinjury, preoperatively and at follow-up, Lysholm score and visual analogue scale for pain and satisfaction (follow-up rate 90%) were assessed. MRI scans were analyzed according to the Genovese criteria (n = 19). Implant failure was defined as infection or mechanical failure of the device. The minimum follow-up time was 36 months (range 36–84 months).

Results
The mean VAS satisfaction preoperatively and at follow-up was 4.0 ± 0 and 1.6 ± 1.0. The mean VAS pain was 4.3 ± 3.2 preoperatively and at last follow-up 2.1 ± 1.7. The median Tegner score preinjury was 7 (range 3–10), it decreased preoperatively to median 3.5 (range 1–8) and nearly reached the preinjury level at last follow-up 6 (range 3–10). The mean Lysholm score before surgery was 66 ± 20 and 91 ± 8 at last follow-up. Seven patients (38.9%) had a normal total IKDC score (A), 10 patients were nearly normal (B) and 1 patient slightly abnormal (C). In MRI the CMI was entirely resorbed in 4 patients (21%) and partially resorbed in 15 (79%). In 4 patients (21%) the CMI was isointense, in 14 (74%) slightly hyperintense and in 1 (5%) highly hyperintense. Ten patients (53%) showed marked signs of bone marrow edema. In 13 patients (68%) an extrusion of the meniscus > 3 mm at last follow-up was found.

Conclusions
Meniscal substitution with the CMI showed good to excellent clinical 3–7 results. The CMI shows an ongoing remodelling with decreased signal intensity and decreased size. However, as meniscus extrusion remained at the same level and bone marrow edema decreased from 1 year to longer term follow-up, it appears that the remodeling comes to an end at about 5 years after CMI.

Level of evidence
IV.

BACK

Safety and efficacy of matrix-associated autologous chondrocyte implantation with spheroid technology is independent of spheroid dose after 4 years

Niemeyer, P., Laute, V., Zinser, W. et al.

DOI: https://doi.org/10.1007/s00167-019-05786-8

Purpose
The aim of this study was to investigate the effect of product dose in autologous chondrocyte implantation (ACI) for the treatment of full-thickness cartilage defects of the knee and to assess its influence on clinical and morphological mid-term outcome.

Methods
Seventy-five patients were included in this single-blind, randomised, prospective, controlled clinical trial. Patients were assigned randomly to three different dose groups [low (3–7 spheroids/cm2), medium (10–30 spheroids/cm2), or high (40–70 spheroids/cm2)] and assessed using standardised clinical and morphological scoring systems (KOOS, IKDC, MOCART) for 4 years following the intervention.

Results
The analysis population comprised 75 patients (22 women, 53 men) aged 34 ± 9 years. Defect sizes ranged from 2 to 10 cm2 following intraoperative debridement. The assessment of the primary variable 'overall KOOS' showed a statistically significant improvement, compared with baseline, for each dose group, i.e., at baseline the mean 'overall KOOS' scores were 60.4 ± 13.6, 59.6 ± 15.4, and 51.1 ± 15.4 for the low-, medium-, and high-dose groups, respectively, and 57.0 ± 15.2 for 'all patients'. After 48 months those values improved to 80.0 ± 14.7, 84.0 ± 14.9, and 66.9 ± 21.5 in the respective dose groups and 77.1 ± 18.6 for 'all patients'. Pairwise comparisons of these dose groups did not reveal any statistically significant differences. Likewise, assessment of the subjective IKDC score revealed no statistically significant differences between the three dose groups up to the 48-month visit. However, between 12 and 48 months there was a low, but steady, improvement in the low-dose group and a substantial amelioration in the medium-dose group. The mean MOCART total scores 3 months after treatment were 59.8 ± 10.9, 64.5 ± 10.3, and 64.7 ± 9.4 for the low-, medium-, and high-dose groups, and 62.9 ± 10.3 for 'all patients'; 48 months after treatment these were 73.9 ± 13.1, 78.0 ± 12.4, and 74.3 ± 14.0 for the respective dose groups and 75.5 ± 13.1 for 'all patients'.

Conclusions
Results of this study confirm the efficacy and safety of the applied "advanced therapy medicinal product"; no dose dependence was found either for the incidence or for the severity of any adverse reactions. All doses applied in the present study led to significant clinical improvement over time and can therefore be regarded as effective doses. The influence of product doses in the range investigated seems to be low and can be neglected. Thus, the authorised dose range of 10–70 spheroids/cm2 confirmed by this clinical trial offers a broad therapeutic window for the surgeon applying the product, thereby reducing the risk of over- or underdosing.

Level of evidence
I.

BACK

Soaking of autografts in vancomycin is highly effective in preventing postoperative septic arthritis after revision anterior cruciate ligament reconstruction

Schuster, P., Schlumberger, M., Mayer, P. et al

DOI: https://doi.org/10.1007/s00167-019-05820-9

Purpose
To determine and compare the incidence of postoperative septic arthritis following revision anterior cruciate ligament reconstruction (R-ACLR) with and without soaking of the graft in vancomycin solution prior to implantation in a large single-centre series.

Methods
A total of 2155 isolated R-ACLR with autologous tendons were performed from 2004 to 2019 and were reviewed with regard to the occurrence of postoperative septic arthritis. From February 2017 onwards, all grafts were wrapped in a vancomycin-soaked (5 mg/ml) gauze swab between harvest and implantation (517 patients, treatment group (2), prospectively followed). These were compared to 1638 patients before that date (control group (1), retrospectively evaluated). The technique of R-ACLR did not significantly change during the years of the study. Hamstring tendons were used in 1310 patients (60.8%) and quadriceps tendons with patellar bone block were used in 845 patients (39.2%), respectively, with no difference between the groups (n.s.). Routine follow-up examination was performed 6 weeks postoperatively (follow-up rate 96.5%), and patients with no treatment for septic arthritis until that time were classified as non-infected.

Results
There were 14 cases of postoperative septic arthritis in group 1 (incidence 0.9%), and none in group 2 (incidence 0.0%), respectively. The difference was significant ($p = 0.029$).

Conclusion
Soaking of the graft in vancomycin solution prior to implantation dramatically reduces the incidence of postoperative septic arthritis in R-ACLR.

Level of evidence
III.

BACK

ACL reconstruction combined with lateral monoloop tenodesis can restore intact knee laxity

Lagae, K.C., Robberecht, J., Athwal, K.K. et al.

DOI: https://doi.org/10.1007/s00167-019-05839-y

Purpose
An anterior cruciate ligament (ACL) injury is often combined with injury to the lateral extra-articular structures, which may cause a combined anterior and rotational laxity. It was hypothesised that addition of a 'monoloop' lateral extra-articular tenodesis (mLET) to an ACL reconstruction would restore anteroposterior, internal rotation and pivot-shift laxities better than isolated ACL reconstruction in combined injuries.

Method
Twelve cadaveric knees were tested, using an optical tracking system to record the kinematics through 0°–100° of knee flexion with no load, anterior and posterior translational forces (90 N), internal and external rotational torques (5 Nm), and a combination of an anterior translational (90 N) plus internal rotational load (5 Nm). They were tested intact, after sectioning the ACL, sectioning anterolateral ligament (ALL), iliotibial band (ITB) graft harvest, releasing deep ITB fibres, hamstrings tendon ACL reconstruction, mLET combined with ACL reconstruction, and isolated mLET. Two-way repeated-measures ANOVA compared laxity data across knee states and flexion angles. When differences were found, paired t tests with Bonferroni correction were performed.

Results
In the ACL-deficient knee, cutting the ALL significantly increased anterior laxity only at 20°–30°, and only significantly increased internal rotation at 50°. Additional deep ITB release significantly increased anterior laxity at 40°–90° and caused a large increase of internal rotation at 20°–100°. Isolated ACL reconstruction restored anterior drawer, but significant differences remained in internal rotation at 30°–100°. After adding an mLET there were no remaining differences with anterior translation or internal rotation compared to the intact knee. With the combined injury, isolated mLET allowed abnormal anterior translation and rotation to persist.

Conclusions
Cutting the deep fibres of the ITB caused large increases in tibial internal rotation laxity across the range of knee flexion, while cutting the ALL alone did not. With ACL deficiency combined with anterolateral deficiency, ACL reconstruction alone was insufficient to restore native knee rotational laxity. However, combining a 'monoloop' lateral extra-articular tenodesis with ACL reconstruction did restore native knee laxity.

BACK

The dimensions of the hip capsule can be measured using magnetic resonance imaging and may have a role in arthroscopic planning

Kay, J., Memon, M., Rubin, S. et al

DOI: https://doi.org/10.1007/s00167-018-5162-5

Purpose
The purpose of this study was to systematically evaluate the dimensions and thickness of the hip joint capsule. Secondarily, the study assessed whether there were any described correlations between capsule thickness and stability of the hip joint.

Methods
Four databases (PubMed, Ovid [MEDLINE], Cochrane Database, and EMBASE) were searched from database inception to May 2018, and two reviewers independently and in duplicate screened the resulting literature. Methodological quality of all included papers was assessed using the Methodological index for non-randomized studies (MINORS) criteria. Mean differences were combined in a meta-analysis using a random effects model when possible.

Results
A total of 14 studies (1 level I, 1 level II, 4 level III, 5 level IV) were identified including 796 patients (1013 hips) with a mean age of 39.5 years (range 2–95). Of the included patients, 55.2% were female and they were followed up for a mean of 7.6 months (range 1–12.5 months). The thickness of the capsule was measured in cadaveric specimens, ultrasound, and magnetic resonance imaging (MRI), with MRI measurements reported most consistently and with the least variation. Mean thickness of the anterior capsule in patients without hip disease on MRI ranged from 4.4 and 4.7 mm. Mean thickness of the anterior capsule in patients with FAI ranged between 4.9 and 5.0 mm. Males had significantly thicker capsules than females (mean difference = 1.92 mm, 0.35–3.49, P = 0.02). Clinical laxity of the hip joint, as well as female gender was correlated with thinner anterior joint capsules.

Conclusion
The thickness of the anterior hip capsule can be measured consistently using MRI. A thinner anterior capsule may be associated with clinical laxity of the hip joint. The relevance of capsular thickness on postoperative instability following hip arthroscopy is poorly understood and warrants further investigation. The thickness of the anterior hip capsule, as measured on MRI, has the potential to be used as part of the clinical decision-making in capsular management strategies.

Level of evidence
IV.

BACK

Survey results from an international hip course: comparison between experts and non-experts on hip arthroscopy clinical practice and post-operative rehabilitation

Bolia, I.K., Briggs, K.K., Matheny, L. et al.

DOI https://doi.org/10.1007/s00167-018-5289-4

Purpose
The purpose of this study was to compare the clinical practices between expert and non-expert arthroscopy hip surgeons.

Methods
Registered orthopedic surgeons completed anonymous surveys during a hip arthroscopy meeting. The survey included 60 questions on physician's level of expertise, surgical anesthesia, procedures performed, hospital stay, pain control, rehabilitation and socioeconomic parameters, and the results are presented. Comparisons were made between hip arthroscopy experts (> 500 cases performed) and non-experts (≤ 500 cases performed) on aspects of patient care.

Results
Forty-eight (74%) surgeons responded. Forty-four questionnaires were filled out completely. There were no significant differences in recommendations between 15 (34%) hip arthroscopy experts and 29 (66%) non-experts on hip capsular management and cartilage repair techniques, use of antithrombotic prophylaxis and opioid analgesics, time of rehabilitation initiation and patient compliance factors, use of hip brace and CPM, and patient evaluation to return to sports following surgery. Surgical expertise was significantly associated with the performance of hip labral reconstruction ($p = 0.016$), subspine decompression ($p = 0.039$) and recommendation of a longer period of restricted weight bearing following the performance of microfractures ($p = 0.011$). There were no significant differences in clinical practice between surgeons who performed hip arthroscopy exclusively versus those who did not.

Conclusions
Hip arthroscopy is a relatively new field, and clinical practice may vary among physicians based on the surgical expertise. In this study, hip arthroscopy experts agree with non-experts on most aspects of patient care. Surgical expertise was associated with performance of advanced techniques and recommendation of longer period of restricted weight bearing following performance of microfractures. This study highlights different care patterns that need to be investigated to determine which treatment results in improved patient care.

Level of evidence
V.

BACK

Full recovery of hip muscle strength is not achieved at return to sports in patients with femoroacetabular impingement surgery

Hallberg, S., Sansone, M. & Augustsson, J.

DOI: https://doi.org/10.1007/s00167-018-5337-0

Purpose
The purpose of this study was to study dynamic hip external rotation strength in patients with Femoroacetabular impingement surgery (FAI) syndrome who have undergone unilateral arthroscopic treatment and returned to sports.

Methods
A cross-sectional study was performed using an observational group (n = 22) and a matched control group (n = 22). Dynamic external rotation strength of the hip was measured using the Augustsson Strength Test, which has shown high reliability for examining side-to-side differences in hip muscle strength.

Results
Dynamic hip external rotation strength was significantly lower in the arthroscopically treated hip compared with the non-treated hip within the observational group ($p < 0.004$).

Conclusion
This cross-sectional study shows that at return to sports, patients who have undergone unilateral arthroscopic treatment for FAI syndrome do not have adequate hip muscle strength recovery. Rehabilitation protocols should, therefore, emphasise post-operative strength training of the hip muscles. Additional research is needed to determine the consequences of reduced hip strength for the long-term outcome after arthroscopically treated FAI. Clinical relevance: The results of this study underline the importance of post-operative strength training prior to returning to sports in patients with femoroacetabular impingement surgery.

Level of evidence
III.

BACK

Total volume of cam deformity alone predicts outcome in arthroscopy for femoroacetabular impingement

Ellis, S.H., Perriman, D.M., Burns, A.W.R. et al.

DOI: https://doi.org/10.1007/s00167-019-05383-9

Purpose
Rates for arthroscopic surgery for femoroacetabular impingement (FAI) are rising and there is growing concern related to the effectiveness and costs associated with this treatment. There is a general lack of consensus as to the criteria for surgical selection of patients. The purpose of this study was to determine whether patient outcome following arthroscopic surgery for FAI could be predicted based on the size and location of deformity. The specific questions were: (1) what is the morphology of FAI in terms of size and location of deformity in a cohort of patients selected for surgery? (2) Do morphological factors predict postoperative improvement in hip scores? (3) Do morphological factors predict preoperative hip scores? (4) Are there clusters of morphological factors which explain postsurgical improvement in hip scores?

Materials and methods
Computer tomography (CT) surgical plans of 90 hips in 79 patients who had undergone primary hip arthroscopy for FAI were retrospectively reviewed. Four parameters for the femur and acetabulum were created: total depth of deformity, maximal depth, extent and the position of maximal deformity. This data were compared with prospectively acquired preoperative and postoperative patient outcome data using generalised linear models.

Results
The cohort comprised 33 males and 46 females aged 37.9 (18–61). The majority (74%) had mixed morphology, 23% isolated cam, and 3% isolated pincer. Overall, the bone depth was greatest and more extensive on the femur. Increased total additional cam deformity alone predicted poorer postoperative outcome ($p = 0.045$). None of the morphological factors were related to preoperative scores and there was no association between the meta-variables and postoperative outcome.

Conclusions
The results of this study indicate that a greater total volume of cam deformity led to poorer postoperative patient outcome scores at 1 year. This information provides the surgeon with more accurate patient-specific data for prediction of expected outcomes.

Level of evidence
Level III diagnostic.

BACK

Risk factors for 30-day readmission following hip arthroscopy

Hartwell, M.J., Morgan, A.M., Johnson, D.J. et al.

DOI: https://doi.org/10.1007/s00167-019-05415-4

Purpose
Hip arthroscopy is known to be safe with low rates of postoperative complications. The purpose of this study is to evaluate hip arthroscopy cases in a national surgical database to identify risk factors associated with readmission.

Methods
The American College of Surgeons National Surgical Quality Improvement Program database was queried from 2012 to 2016 for current procedural terminology billing codes related to hip arthroscopy. International Classification of Diseases diagnostic codes were used to exclude cases involving infection, fracture, or open procedures. Univariate and multivariate analyses were performed to identify risk factors associated with 30-day readmission.

Results
1493 patients were identified who had undergone hip arthroscopy. The most common procedures were labral resection or chondroplasty (n = 589, 39.5%) and femoroplasty (n = 527, 35.3%). The 30-day complication rate was 1.7% and the most common complications following the procedure were bleeding (n = 12, 0.8%) superficial infections (n = 5, 0.3%), and returning to the operating room (n = 4, 0.3%). The 30-day readmission rate was 1.3%. On multivariate analysis, hypertension requiring anti-hypertensive medication (odds ratio [OR], 3.5; 95% confidence interval [CI], 1.4–8.7) and chronic corticosteroid or immunosuppressant use (OR 7.2; 95% CI 1.9–26.7) were identified as independent risk factors for readmission. There was no difference in complication rates when hip arthroscopy was performed with isolated femoroplasty (n = 340), isolated acetabuloplasty (n = 103), both (n = 187) or neither (n = 863).

Conclusion
These findings confirm that the 30-day readmission (1.3%) and complication rate (1.7%) are low for isolated hip arthroscopy procedures; however, hypertension and chronic steroid use are independent risk factors for readmission.

Level of evidence
Retrospective comparative study, Level III.

BACK

Clinical and radiographic predictors of failed hip arthroscopy in the management of dysplasia: a systematic review and proposal for classification

Shah, A., Kay, J., Memon, M. et al.

DOI: https://doi.org/10.1007/s00167-019-05416-3

Purpose
As indications for hip arthroscopy continue to expand, its efficacy in patients with more complex deformities of the hip, such as those with acetabular dysplasia, remains controversial. The purpose of this systematic review is to identify the predictors of failed hip arthroscopy in dysplastic hips and to propose a standardize prognostic sub-classification of dysplasia.

Methods
This systematic review was performed in accordance with the (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) PRISMA guidelines. Three databases [EMBASE, PubMed, and Ovid (MEDLINE)] were searched using terms including “hip arthroscopy” and “dysplasia”. Studies were screened and data extracted in duplicate. Study quality was assessed using the Methodological Index for Non-Randomized Studies criteria. Due to the non-uniform nature of study data, findings were presented in descriptive summary form.

Results
Thirteen studies were included in this systematic review, comprising 712 dysplastic patients (773 hips) with mean age 34.2 years and 74.1% females. Most studies defined hip dysplasia by a lateral centre-edge angle (LCEA) of 20°–25° (borderline) or 15°–20° (moderate). Failure was defined as progression to revision arthroscopy, peri-acetabular osteotomy, or total hip arthroplasty. Overall, failure rate was 192/743 (25.8%) at an average of 28.1 months following index arthroscopy. Smaller LCEA, larger Tönnis angle, broken Shenton line, and decreased joint space (≤ 2 mm) were radiographic predictors of failure. Severe cartilage lesions to the femoral head or acetabulum were associated with failure in five studies. Labral debridement led to more failures than labral repair.

Conclusion
Overall, hip arthroscopy yielded good outcomes in mildly dysplastic hips without severe chondral damage. Hip arthroscopy is expected to result in a failed outcome in individuals with moderate-to-severe hip dysplasia (LCEA < 15°), severe cartilage lesions, larger Tönnis angle (> 20°), broken Shenton line, and decreased joint space (≤ 2 mm). Arthroscopic surgery may be more effective in individuals with borderline-to-mild (LCEA 15°–25°) acetabular dysplasia in the absence of severe cartilaginous lesions (7-year survival: 89.6%). A standardized prognostic classification of hip dysplasia based on the LCEA and Tönnis angle is proposed.

Level of evidence
Systematic review of non-randomized studies, Level IV.

BACK

Good 5-year outcomes after arthroscopic treatment for femoroacetabular impingement syndrome

Öhlin, A., Ahldén, M., Lindman, I. et al.

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Purpose
The purpose of the present study was to evaluate the outcome of arthroscopic treatment for femoroacetabular impingement (FAI) syndrome 5 years post-surgery using patient-reported outcome scores (PROMs) validated for a young and active population with hip complaints.

Methods
Patients were prospectively included in the study. A total of 184 patients [males = 110 (59.8%), females = 74 (40.2%)], with mean age 38.0, underwent arthroscopic treatment for FAI syndrome and were analysed. Preoperatively and at the 5-year follow-up, patients completed a set of self-administered web-based PROMs consisting of the International Hip Outcome Tool (iHOT-12), the Copenhagen Hip and Groin Outcome Score (HAGOS), the Hip Sports Activity Scale (HSAS), the EuroQoL-5 Dimension Questionnaire (EQ-5D), the EQ-Visual Analogue Scale (VAS) and the VAS for overall hip function and overall satisfaction. The Wilcoxon signed rank test was used to compare preoperative PROM values with those obtained at the 5-year follow-up.

Results
A comparison of preoperative PROM scores and those obtained at the 5-year follow-up revealed statistically significant improvements for all outcome scores ($p < 0.05$), except for the HSAS score, which were unchanged; iHOT-12 (42.9 vs 67.2), HAGOS different subscales (50.2 vs 69.6, 55.7 vs 76.1, 59.2 vs 72.3, 41.1 vs 66.4, 30.8 vs 60.2, 31.6 vs 60.4), EQ-5D (0.570 vs 0.742), EQ-VAS (66.6 vs 74.4), HSAS (3.13 vs 3.17) and VAS for overall hip function (47.9 vs 69.2). At the 5-year follow-up, 154 patients reported that they were satisfied with surgery (84.6%). Survivorship at the 5-year follow-up was 86.4%.

Conclusion
Arthroscopic treatment for FAI syndrome yields good patient-reported outcome at the 5-year follow-up.

Level of evidence
II.

BACK

Arthroscopic matrix-associated, injectable autologous chondrocyte transplantation of the hip: significant improvement in patient-related outcome and good transplant quality in MRI assessment

Bretschneider, H., Trattnig, S., Landgraeber, S. et al.

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Purpose
Acetabular chondral lesions are common in patients with FAI. For large full-thickness cartilage defects, arthroscopic matrix-associated autologous chondrocyte transplantation (MACT) using an injectable in situ crosslinking product is an option. Aim of the study was to evaluate clinical and MRI results 12 months after MACT of acetabular cartilage defects in FAI patients.

Methods
We report data on 21 patients with a focal cartilage defect of the hip [2.97 ± 1.44 cm2 (mean ± SD)] caused by FAI treated with an arthroscopically conducted MACT combined with FAI surgery. The results were assessed with patient-reported outcome measures (iHOT33, EQ-5D) pre- as well as post-operatively and by MRI using MOCART scoring system 6 and 12 months post-operatively.

Results
The iHOT33 score improved from 52.9 ± 21.14 (mean ± SD) pre-operative to 81.08 ± 22.04 (mean ± SD; p = 0.0012) 12 months post-operatively. The lower the pre-operative iHOT33 score and the larger the defect size, the greater the observed improvement compared to pre-operative scores at 12 months. Patients showed a significant improvement in EQ-5D-5L index value (p = 0.0015) and EQ-5D VAS (p = 0.0006). MRI analysis after 12 months revealed a complete integration of the transplant in 16 of 20 patients.

Conclusions
Injectable MACT is a promising minimally invasive treatment option for full-thickness cartilage defects of the hip caused by FAI. A significant improvement in symptoms and function associated with an increase in quality of life was detected in patients treated with injectable MACT combined with FAI surgery. This is of considerable clinical relevance, since, in addition to the elimination of the mechanical cause, MACT allows the successful therapy of consequential cartilage damage.

Level of evidence
Level 4, case series.

BACK

American Journal of Sports Medicine (AJSM), Volume 47, Issue 5

Outcomes of Arthroscopic All-Inside Repair Versus Observation in Older Patients With Meniscus Root Tears

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Background: Meniscus root tears lead to de-tensioning of the meniscus, increased contact forces, and cartilage damage. Management of older patients with root tears is controversial and the efficacy of different treatment options is unclear.

Purpose: To compare the clinical outcomes of patients with moderate knee osteoarthritis who underwent an all-inside meniscus root repair technique versus nonoperative management for either medial or lateral meniscus root tears.

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

Methods: Patients with a diagnosed posterior meniscus root tear who underwent arthroscopic repair (AR: 30 knees) or nonoperative treatment with observation (O: 18 knees) were followed for a minimum of 2 years (mean follow-up, 4.4 years). The arthroscopic repair included all-inside sutures to reduce the root back to its remnant (reduction sutures), thereby re-tensioning the meniscus, and 1 mattress suture to strengthen the repair by reapproximating the construct to the posterior capsule. The data collected included the Knee injury and Osteoarthritis Outcome Score (KOOS), Lysholm, Tegner, and Veterans RAND 12-Item Health Survey (VR-12) Physical Component Summary (PCS) and Mental Component Summary (MCS) scores and conversion to total knee arthroplasty (TKA).

Results: Medial meniscus root tears comprised 80.0% of the AR group and 77.8% of the O group. The average Kellgren-Lawrence grade was 2 in both groups. The baseline scores for the KOOS Symptoms subscale were lower for AR (50.2 ± 19.3) than for O (66.5 ± 16.1) (P = .003), as were the KOOS Knee-Related Quality of Life scores (AR, 26.7 ± 16.1; O, 39.6 ± 22.1) (P = .046). No differences were found between groups for the absolute values at follow-up except that follow-up Tegner scores were lower in the O group than in the AR group (P = .004). Significant improvements were seen in the AR group from baseline to ultimate follow-up in average KOOS subscale scores (P < .001), Lysholm scores (P < .001), Tegner scores (P = .0002), and VR-12 PCS scores (P < .001), whereas the O group had a significant improvement only in average KOOS Pain (P = .003), KOOS Function in Daily Living (P = .006), and VR-12 PCS (P = .038) scores. Compared with the O group, the AR group had a significantly larger improvement from baseline to follow-up in average KOOS Pain (P = .009), KOOS Symptoms (P = .029), and Lysholm scores (P = .016). During follow-up, 3.3% of the AR group underwent a TKA compared with 33.3% of the O group (P = .008). The hazard ratio of TKA conversion was 93.2% lower for the AR group compared with the O group (P = .013).

Conclusion: All-inside medial or lateral meniscus root repair showed improved functional outcomes and decreased TKA conversion rates compared with nonoperative treatment and may be considered as a treatment option for the management of meniscus root tears in older patients with moderate osteoarthritis.

BACK

Outcomes After Arthroscopic Repair in Patients With Tears of Hypertrophic Versus Morphologically Normal Acetabular Labra

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Background: Recently, a hypertrophic labrum has been reported in the absence of hip dysplasia, which can possibly contribute to an acetabular labral tear.

Purpose: To compare the clinical outcomes and complications, including the incidence of iatrogenic acetabular labrum and cartilage injury, in patients with tears of hypertrophic versus morphologically normal acetabular labra over a minimum follow-up period of 2 years and to assess the morphologic changes at follow-up computed tomography arthrography in the 2 groups.

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

Methods: Between January 2010 and December 2016, 20 patients (22 hips) with a hypertrophic labrum underwent arthroscopic hip surgery. A total of 22 patients (22 hips) without a hypertrophic labrum were assigned to the control group based on matching criteria, including age, sex, body mass index, labral tear, and labral repair. Clinical outcomes were assessed with the visual analog scale score, UCLA activity scale score (University of California, Los Angeles), and modified Harris Hip Score. Radiologic outcomes were assessed through serial radiography. Patients were followed for at least 2 years.

Results: The mean age at surgery was 42 years. The most common cause of arthroscopic surgery in the study group was an isolated acetabular labral tear without any bony structural abnormalities (68.2%, 15 of 22 hips). All improvements in both groups were statistically significant at the last postoperative follow-up ($P < .001$). Although the radiologic and clinical outcomes were not significantly different between the groups, the complication rates, including iatrogenic labral perforations and cartilage injury, were significantly higher in patients with hypertrophic acetabular labral tears (9 vs 3, $P = .042$). The patient-reported satisfaction scores at the last postoperative follow-up were 8.4 and 7.9 in the study and control groups, respectively ($P = .351$).

Conclusion: The high rates of patient-reported satisfaction and the clinical outcomes after arthroscopic repair in both groups are encouraging. Arthroscopic treatment in patients with hypertrophic acetabular labral tears should be carefully performed to prevent iatrogenic injury during the surgery, and isolated hypertrophic labral tears can have good results after repair.

BACK

Defining Variations in Outcomes of Hip Arthroscopy for Femoroacetabular Impingement Using the 12-Item International Hip Outcome Tool (iHOT-12)

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Background: As health care moves toward a value-based payment system, it will be important that patient-reported outcome measures (PROMs) define variations in outcome over a follow-up period that allows a patient to achieve maximal improvement. Although there is evidence to support the use of PROMs to assess postoperative outcomes after hip arthroscopy, there is limited information available to assess for variations in outcome at a 2-year follow-up interval.

Purpose: To identify substantial clinical benefit (SCB) and patient acceptable symptom state (PASS) cutoff scores for the 12-item International Hip Outcome Tool (iHOT-12) that define patient status across a spectrum of potential outcomes after hip arthroscopy at a 2-year follow-up interval.

Study design: Cohort study (diagnosis); Level of evidence, 2.

Methods: These data were collected from a research registry of patients having hip arthroscopy for femoroacetabular impingement and/or chondrolabral pathology. On initial assessment and 2 years (±2 months) postoperatively, patients completed the iHOT-12, and categorical self-rating of function. They also completed a visual analog scale of postoperative satisfaction. Receiver operator characteristic analysis was performed to determine absolute SCB iHOT-12 scores associated with an “abnormal,”“nearly normal,” or “normal” self-report of function, and PASS scores for those reporting at least 50%, at least 75%, or 100% satisfaction with their surgery.

Results: Out of 723 eligible patients, 658 (91%) met the inclusion criteria. The patients consisted of 462 (70%) women and 196 (30%) men, with a mean age of 35.3 years (SD, 13 years) and mean follow-up of 722 days (SD, 69 days). Absolute SCB and PASS iHOT-12 scores ranging from 38 to 86 were accurate in identifying those who had abnormal, nearly normal, and normal self-reported function and were at least 50%, at least 75%, and 100% satisfied with surgery. The areas under the curve were >0.70, with sensitivity and specificity values ranging from 0.78 to 0.92.

Conclusion: This study provides absolute SCB and PASS iHOT-12 cutoff scores that can be used to define variations in 2-year (±2 months) outcomes in patients after hip arthroscopy for femoroacetabular impingement and chondrolabral pathology. iHOT-12 scores of 38, 60, and 86 were associated with abnormal, nearly normal, and normal reports of function respectively, with scores of 60, 71, and 86 associated with at least 50%, at least 75%, and 100% satisfaction after surgery, respectively.

BACK

Outcomes of Revision Hip Arthroscopic Surgery: A Systematic Review and Meta-analysis

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Background: While the indications for primary hip arthroscopic surgery in treating femoroacetabular abnormalities continue to be defined, the indications and outcomes for revision hip arthroscopic surgery remain ambiguous. However, revision hip arthroscopic surgery is performed in 5% to 14% of patients after their index procedure. While patient-reported outcomes (PROs) generally improve after revision procedures, the extent of their improvement is not well defined.

Purpose: To determine the outcomes and efficacy of revision hip arthroscopic surgery in patients who remain symptomatic after their index procedure.

Study Design: Meta-analysis and systematic review.

Methods: The terms "hip arthroscopy,""revisions,""outcomes," and "femoroacetabular impingement" were searched in PubMed, Web of Science, Scopus, Cochrane Library, and Google Scholar. After screening, 15 studies were included for review. In addition to hip-specific metrics, functional outcome measures were included. Pooled estimates and 95% CIs were calculated using inverse variance methods.

Results: A total of 4765 hips in 4316 patients were identified. The most common indication for revision surgery was inadequate bony resection during the index procedure. Meta-analysis showed that all PROs improved significantly from baseline to final follow-up after revision hip arthroscopic surgery. Notably, the modified Harris Hip Score (mHHS) increased a mean of 17.20 points after revision hip arthroscopic surgery, the Hip Outcome Score–Activities of Daily Living (HOS-ADL) improved by 13.98, and the visual analog scale (VAS) for pain decreased by 3.16. However, when compared with primary hip arthroscopic surgery, the mean PRO scores after revision hip arthroscopic surgery were lower. After revision hip arthroscopic surgery, the rates of conversion to total hip arthroplasty ranged from 0% to 14.3%, and the rates of further arthroscopic revision ranged from 2% to 14%.

Conclusion: Inadequate bony resection represents the most common indication for revision hip arthroscopic surgery. PROs improve significantly after revision hip arthroscopic surgery but remain lower than those of patients undergoing primary hip arthroscopic surgery

BACK

Miscellaneous

Arthroscopy, Volume 36, Issue 4

Global Rating Scales for the Assessment of Arthroscopic Surgical Skills: A Systematic Review

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Purpose
To evaluate whether sufficient validity and reliability evidence exists to support the use of global rating scales (GRS) as evaluation tools in both formative assessment and competency assessment of arthroscopic procedures.

Methods
A search of PubMed, Embase, and Scopus was conducted for articles published between 1990 and 2018. Studies reporting measures of validity and reliability of GRS relating to arthroscopic skills were included. Procedural checklists and other assessment tools were excluded.

Results
A total of 39 articles met the inclusion criteria. In total, 7 de novo GRS specific for arthroscopic education and 3 pre-existing GRS repurposed 4 times for arthroscopic education were identified in the literature. The 11 GRS were used to assess 1175 surgeons 3890 times. Three GRS tools explicitly defined an arbitrary minimum competency threshold, 6 of 11 tools demonstrated construct validity—the ability to significantly discriminate between groups of differing experience—and 5 of 11 tools assessed inter-rater reliability, but only the Arthroscopic Surgical Skills Evaluation Tool demonstrated excellent inter-rater reliability. The Arthroscopic Surgical Skills Evaluation Tool was validated by 16 articles for a total of 537 surgeons for hip, knee, shoulder, and ankle arthroscopy in both simulated and clinical environments but was found to be invalid in wrist arthroscopy. The Basic Arthroscopic Knee Skill Scoring System was validated by 15 articles for a total of 497 surgeons for knee, hip, and shoulder in both clinical and simulated environments. The remaining 9 GRS were validated by 2 or fewer studies.

Conclusions
Overall, GRS have contributed to training, feedback, and formative assessment practices. The GRS reviewed demonstrate both construct and concurrent validity as well as reliability in multiple arthroscopic procedures in multiple joints. Currently, there is sufficient evidence to use GRS as a feedback tool. However, there is insufficient evidence for its use in high-stakes examinations or as a minimum competency assessment.

Level of Evidence
Level III, systematic review of level I to III studies

BACK