Abstract Id: Poster 1
Abstract Title: Mapping of Cartilage Depth in the Knee and Elbow for Use in Osteochondral Autograft Procedures

Authors
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¹ Cleveland Clinic Foundation Cleveland, OH

Objectives:
Osteochondritis dessicans (OCD) of the elbow is a problematic condition that affects many young athletes each year. There exist a wide variety of treatments for these lesions, including the use of osteochondral autografts which are commonly taken from donor sites on the non-weight bearing surfaces of the knee. The purpose of this study is to use magnetic resonance imaging (MRI) to assess the cartilage depths of sites in the knee and elbow that are commonly used as donor and recipient sites in these procedures.

Methods:
All knee and elbow MRIs in the Cleveland Clinic system from December 2008 to August 2011 were identified. MRIs acquired from 3 Tesla (3T) machines in patients 16 to 25 years old were isolated. Studies were excluded if there had been previous surgery on the joint or if there were significant chondral defects in the areas to be measured.

Locations for measurement were determined by the principle investigating staff surgeon based on common sites of OCD lesions in the elbow and typical donor harvest sites in the knee. All cartilage depth measurements on all MRIs were independently performed by 3 different physicians on sagittal plane images to the nearest 0.01 mm, at an angle perpendicular to the underlying subchondral bone. At the elbow, 6 locations on the capitellum and 2 locations on the trochlea were chosen (Figure 1). At the knee, 4 locations along the anterior lateral femoral condyle, 5 locations surrounding the intercondylar notch, and 1 location on both the medial and lateral posterior femoral condyles were chosen (Figure 2).

Results:
There were 111 knee MRIs (74 male, 37 female) and 94 elbow MRIs (85 male, 9 female) that met all inclusion criteria. The average cartilage depths from each investigator were combined to provide an overall mean depth at each location (Table 1). All average cartilage depths within the elbow were thinner than those in the knee. The average variance between the mean cartilage depths measured by each investigator for each location was 0.12 mm in the elbow and 0.22 mm in the knee.

Figure: Figures and Table
### Conclusions:
On the whole, the cartilage depths in the knee were thicker than those in the elbow at all sites measured. The thinnest areas in the knee were the posterior aspect of the medial femoral condyle and the distal-most point of the anterior lateral femoral condyle. When choosing donor sites for osteochondral autograft procedures, these sites will provide the closest match to their recipient sites in the elbow.

### Table 1

<table>
<thead>
<tr>
<th>Location</th>
<th>Cartilage Depth in millimeters (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elbow</strong></td>
<td></td>
</tr>
<tr>
<td>Lateral Epicondyle</td>
<td></td>
</tr>
<tr>
<td>Anterior (a)</td>
<td>1.49 (0.17)</td>
</tr>
<tr>
<td>Mid Anterior/Posterior (b)</td>
<td>1.51 (0.19)</td>
</tr>
<tr>
<td>Posterior (c)</td>
<td>1.00 (0.11)</td>
</tr>
<tr>
<td>Medial Epicondyle</td>
<td></td>
</tr>
<tr>
<td>Anterior (d)</td>
<td>1.63 (0.38)</td>
</tr>
<tr>
<td>Mid Anterior/Posterior (e)</td>
<td>1.47 (0.37)</td>
</tr>
<tr>
<td>Posterior (f)</td>
<td>0.87 (0.12)</td>
</tr>
<tr>
<td>Trochlear Groove</td>
<td></td>
</tr>
<tr>
<td>45° Anterior (g)</td>
<td>1.92 (0.26)</td>
</tr>
<tr>
<td>Posterior (h)</td>
<td>0.75 (0.10)</td>
</tr>
<tr>
<td><strong>Knee</strong></td>
<td></td>
</tr>
<tr>
<td>Anterior Lateral Femoral Condyle</td>
<td></td>
</tr>
<tr>
<td>Proximal (i)</td>
<td>2.01 (0.43)</td>
</tr>
<tr>
<td>Mid Proximal (j)</td>
<td>2.14 (0.43)</td>
</tr>
<tr>
<td>Mid Distal (k)</td>
<td>2.06 (0.47)</td>
</tr>
<tr>
<td>Distal (l)</td>
<td>1.85 (0.46)</td>
</tr>
<tr>
<td>Intercondylar notch</td>
<td></td>
</tr>
<tr>
<td>8 o’clock (lateral) (m)</td>
<td>2.11 (0.43)</td>
</tr>
<tr>
<td>10 o’clock (lateral) (n)</td>
<td>2.01 (0.41)</td>
</tr>
<tr>
<td>Noos (o)</td>
<td>2.11 (0.47)</td>
</tr>
<tr>
<td>2 o’clock (medial) (p)</td>
<td>2.27 (0.45)</td>
</tr>
<tr>
<td>4 o’clock (medial) (q)</td>
<td>2.31 (0.46)</td>
</tr>
<tr>
<td>Posterior Pole Femoral Condyles</td>
<td></td>
</tr>
<tr>
<td>Medial Femoral Condyle</td>
<td>1.95 (0.46)</td>
</tr>
<tr>
<td>Lateral Femoral Condyle</td>
<td>2.15 (0.51)</td>
</tr>
</tbody>
</table>

Relevant disclosure for all authors:
Nothing to disclose.
Abstract Id: Poster 3
Abstract Title: Characterizing Bone Tunnel Placement in Medial Ulnar Collateral Ligament Reconstruction Utilizing Patient Specific 3-D CT Modeling

Authors
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Objectives:
Utilizing patient specific three-dimensional (3D) modeling with computer generated manipulations, we have examined the effect of varying the angles, sizes, and locations of tunnels for medial ulnar collateral ligament (MUCL) reconstruction. We attempt to define the optimal tunnel configuration in order to maximize humeral tunnel length and bony bridge size between tunnels.

Methods:
3D models were created from elbow CT scans of ten throwing athletes and analyzed using Materialise's Interactive Medical Image Control System (Mimics) software. MUCL reconstructions were simulated on each elbow utilizing three common techniques: Jobe, humeral docking, and ulnar interference screw. For each method, humeral tunnels were modified by size (4.0 and 4.5mm), medial-lateral starting point on the epicondyle, and angle with respect to the long axis of the humerus on the sagittal view. Humeral tunnel length and bony bridge size between humeral exit tunnels were measured for each reconstruction. Ulnar tunnels were also varied by size (3.2 and 3.5mm) and angle with respect to the long axis of the ulna. Ulnar bony bridge size and distance from the olecranon articular surface were measured for each Jobe reconstruction, while tunnel aperture was calculated for each interference screw simulation. Comparisons were made utilizing 1 way and 2 way ANOVA statistical testing.

Results:
Mean humeral tunnel length varied significantly by both starting point (p<.0001) and size of the tunnel (p<.008). Bony bridge size between humeral exit tunnels averaged 7.58mm, notably smaller than previously reported. Ulnar bony bridge averaged 5.96mm, also varying based on tunnel size (p<.0001), and angle of ulnar tunnels significantly affected distance from the articular surface (p<.0001). Tunnel aperture size varied significantly based on angle for interference screw techniques (p<.0001), with the commonly recommended angle of 45° providing an unacceptably large tunnel aperture.

Figure:
Conclusions:

Humeral and ulnar tunnel angle, starting point and size affect the lengths of tunnels, distance from the articular surface, and size of bony bridges created in MUCL reconstructions. Optimal humeral tunnel length was achieved by starting central or slightly lateral to the midpoint of the epicondyle with an angle of 30° to the long axis of the humerus. Ulnar tunnels should be aimed away from the articular surface for the Jobe technique but no greater than 30 degrees from the perpendicular for interference screw technique to minimize tunnel aperture size.

References:


Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 4

Abstract Title: Effect of Osteochondral Defect of the Humeral Capitellum on Elbow Valgus Laxity and Contact Pressure in the Radiocapitellar Joint: A Biomechanical Study

Authors
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5 VA Long Beach Healthcare System Long Beach, CA

Objectives:
Osteochondritis dissecans of the humeral capitellum commonly affects the elbows of adolescent baseball players and gymnasts. Patients with larger lesions have worse outcomes, possibly because of altered biomechanics of the elbow joint. We assessed the effect of capitellar osteochondral defects on elbow valgus laxity, ulnar collateral ligament (UCL) strain, and contact pressure in the radiocapitellar joint.

Methods:
Eight matched pairs of fresh frozen cadaveric upper limbs were tested in an elbow-testing system. Matched upper limbs were randomized to either a lateral or central osteochondral defect of the humeral capitellum with a diameter of 5, 10, 15, or 20 mm. Loads were applied to the biceps brachii (6 N), brachialis (9.2 N), and triceps (24.8 N). Five markers (two on the humeral shaft, one at the humeral insertion of the UCL, one at the ulnar insertion of the UCL, and one placed distally 10 cm down the ulna) were digitized with a three-dimensional digitizer (Microscribe 3DLX, Immersion Corporation, San Jose, CA) to measure elbow valgus laxity and UCL strain. Radiocapitellar joint contact pressure was measured with a Tekscan pressure sensor. All measurements were performed with 2 Nm of valgus torque at 30°, 60°, and 90° of elbow flexion in neutral forearm rotation and were compared between intact capitella and those with 5, 10, 15, or 20 mm defects, and between lateral and central defects.

Results: Elbow valgus laxity increased significantly with increasing size of the capitellar defect for both the central and lateral groups (P < 0.05). There was no significant difference in valgus laxity between central and lateral defects. UCL strain did not change after the creation of capitellar defects of any size. Contact pressure in the radiocapitellar joint was significantly increased at 60° and 90° of elbow flexion after creation of a 20 mm lateral capitellar defect (P < 0.05) but not a central capitellar defect.

Conclusions:
Large capitellar osteochondral defects increased elbow valgus laxity without increasing UCL strain and, in case of lateral defects, contact pressure in the radiocapitellar joint. This biomechanical change in the elbow joint may explain the pathomechanics and progression of osteochondritis dissecans of the humeral capitellum with valgus force, such as throwing.

Figure:

Elbow testing system

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 5

Abstract Title: Using Dynamic Elbow Ultrasound to Characterize Progression of Ulnar Collateral Ligament Abnormalities Over Time in Professional Baseball Pitchers

Authors
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2 Thomas Jefferson University Hospital Philadelphia, PA
3 Alfred I duPont Hospital for Children Wilmington, DE
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5 A.I. duPont Hospital for Children Wilmington, DE

Objectives: To use dynamic elbow ultrasound to characterize the progression of Ulnar Collateral Ligament (UCL) abnormalities over time and identify potential anatomic risk factors for a UCL tear in professional baseball pitchers.

Methods: Yearly dynamic elbow ultrasounds were performed bilaterally in 321 professional pitchers over 7 years. UCL thickness was measured at rest. The width of the ulnohumeral joint was measured with the elbow at 30° of flexion, both at rest and with 15 lbs of valgus stress using a Telos device. Any ligament heterogeneity, calcifications, and joint osteophytes were documented.

Results: Mean UCL thickness (6.15 vs. 4.82 mm; p<.0001), joint space stressed (4.56 vs. 3.72 mm; p<.02), change in joint space (stressed-rest)(1.24 vs. 0.78; p<.02), presence of heterogeneity (28% vs. 3.4%, p<.001), presence of calcifications (24.9% vs. 1.6%, p<.01), and presence of osteophytes (7.8% vs. 0%, p<.01) were greater in pitching arms compared to non-pitching arms. Mean stressed joint space (4.39 vs. 4.01 mm, p<.01), change in joint space (1.33 vs. 1.02 mm +/- .70, p<.01) and presence of heterogeneity (26.7% vs. 31%, p<.01) were significantly different in pitching arms comparing initial and final ultrasounds. There were no significant differences in any parameters when comparing asymptomatic elbows with those that have undergone UCL reconstruction.

Conclusions: The amount of stressed joint space, change in joint space, and ligament heterogeneity detected on dynamic elbow ultrasound changes over time. Longitudinal follow-up is needed to determine if these changes ultimately lead to UCL injuries in pitchers.

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 6

Abstract Title: Evaluation of Knee Donor and Elbow Recipient Sites for Treatment of Osteochondritis Dissecans with Osteochondral Autologous Transplantation Surgery

Authors
Alexander M. Vezeridis MD, PhD¹; Donald S. Bae MD¹
¹ Children's Hospital Boston Boston, MA

Objectives: Osteochondral autologous transplantation surgery (OATS) has been proposed for treatment of osteochondritis dissecans (OCD) of the capitellum in adolescents. Little information is available, however, regarding the optimal harvest site to match the contour and cartilage thickness of the elbow. The purpose of this study was to characterize the capitellar anatomy in children with and without OCD and to compare these measurements to normal knees in efforts to identify the “best-fit” for osteochondral graft harvest.

Methods: In this study, 21 patients with OCD were identified. 22 patients with normal elbows and 25 individuals with normal knees were identified that matched the OCD population with respect to age, height, and weight. Cartilage radii of curvatures (ROCs) in the sagittal and coronal-axial planes were measured in MRIs of normal humeral capitella and five sites in normal knees (posterior lateral femoral condyle, medial and lateral middle trochlear ridges, and medial and lateral inferior trochlear ridges [Figure 1]). Differences in apex and sides between the knee donor plug and capitellum recipient sites were calculated based upon the average radii of curvatures in orthogonal planes, using the common osteochondral plug diameter of 10 mm.

Figure: Figure 1
Results:

Conclusions:

Relevant disclosure for all authors

Nothing to disclose

Of all knee sites tested, the posterior lateral femoral condyle had average radii of curvatures (19.1 mm sagittal, 14.0 mm axial) most like the capitellum (10.6 mm sagittal, 12.6 mm coronal-axial), and therefore resulted in minimal calculated apex and edge differences (apex difference -0.59 mm and coronal-axial side difference -0.47 mm with no sagittal side difference). Of the anterior non-weight-bearing sites, the inferior medial trochlear ridge (29.6 mm sagittal, 11.6 mm coronal-axial ROCs) demonstrated the least calculated apex and side differences when compared to the capitellum (apex difference -0.83 mm and side difference -0.92 mm with no sagittal side difference). The frequently used middle lateral trochlear ridge (28.7 mm sagittal, 8.65 mm coronal-axial ROCs) had the largest side difference (-0.81 mm apex difference, -1.37 mm coronal-axial side difference, and no sagittal side difference).

The inferior medial trochlear ridge should be considered as a donor site for OATS procedures for OCD given its accessibility and favorable geometry.
Objectives:
Current methods for estimating glenoid bone loss in patients with chronic shoulder instability include CT imaging with 3-D reconstruction, specialized computer software, as well as imaging of the contralateral shoulder. An ideal method of glenoid measurement would require only MR imaging of the injured shoulder. The purpose of this study was to determine if MRI measure of glenoid height, as well as demographic variables, could be used to estimate glenoid width in healthy subjects with no history of shoulder instability.

Methods:
Bilateral shoulder MRIs were obtained in a healthy cohort of young athletes as part of baseline assessment in a prospective cohort study. A musculoskeletal radiologist measured glenoid height and width using the sagittal MRI cuts. Univariate and multivariate regression analyses were performed to see if demographic and MRI measures of the glenoid could be used to estimate glenoid width. We analyzed each shoulder independently and performed all analyses with STATA version 10.1.

Results:
Of the 1264 shoulder MRIs evaluated, the mean glenoid width was 26.67 (±2.49) mm and the mean glenoid height was 42.15 (±3.00) mm. There were significant differences between the 129 female glenoids and the 1035 male glenoids for both width (23.1mm, 27.1mm, p<0.0001) and height (37.9mm, 42.7mm, p<0.0001); however the relationship between glenoid height and width was similar for both males and females. The glenoid width was found to correlate with the height measurement (r=0.56) for the entire cohort. Based on the results of linear regression analysis, controlling for the influence of sex, a formula was created that represents the relationship between these variables for male subjects: Glenoid width = (1/3 height) + 15mm. Therefore, in a male with suspected bone loss where the glenoid height is 45mm, the estimated glenoid width would be W = 30mm. If the actual measured width is 20mm, this would represent a 33% loss in glenoid width. Female patients are estimated with a formula that represents the same slope but a different intercept: W = 1/3 H + 13mm.
This study uses the MRI measurements in a cohort of healthy young athletes to determine the relationship between glenoid width and height. Significant differences were found by gender; however the relationship between height and width was similar. These variables are correlated and the resultant formula ($W = \frac{1}{3} H + 15$) can be used to estimate the expected glenoid width in a male patient with bone loss. This formula allows for easy calculation of the amount of glenoid bone loss using only a ruler and an ipsilateral MRI.

Acknowledgements:

This project was aided by a grant from the Orthopaedic Research and Education Foundation.

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 8

Abstract Title: Rotator Cuff Weakness is not a Risk Factor for First-time Anterior Glenohumeral Instability

Authors
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1 John A. Feagin Jr. Sports Medicine Fellowship Program West Point, NY
2 Keller Army Hospital West Point, NY

Objectives:
Shoulder instability is a common problem in young athletes. Little is known about the modifiable risk factors for glenohumeral joint instability. A recent case-control study showed relative rotator cuff weakness in patients with untreated chronic, recurrent anterior instability.1 We hypothesized that isometric shoulder strength at baseline would be a modifiable risk factor associated with subsequent first-time anterior instability events.

Methods:
We conducted a prospective cohort study over a four year period within a high risk group of young athletes to address the research hypothesis. Subjects were freshman entering the United States Military Academy in June of 2006. Part of the baseline assessment included documenting a prior history of instability, and these shoulders were excluded from the present study. All subjects completed bilateral isometric strength evaluations with a hand-held dynamometer at baseline upon entry into the study. Variables measured included internal and external rotation at 0 degrees (IR0, ER0), and internal rotation and external rotation at 45º of abduction (IR45, ER45). All subjects were followed for subsequent glenohumeral joint instability events until graduation in May of 2010.

Results:
Baseline strength data for shoulders were available for 1317 shoulders with no prior history of instability, of which 26 went on to have an acute first-time anterior shoulder instability event while at the academy. There were no significant differences (Table 1) in strength between shoulders that experienced an acute anterior instability event during follow-up (N = 26) and those that did not (N=1291). Further, there were no differences in the ratio of internal to external rotation strength between groups. Similar results were observed in multivariable models after controlling for the influence of sex, height, and weight using Cox proportional hazards regression models to analyze the data.

<table>
<thead>
<tr>
<th>Strength</th>
<th>Injured Shoulders (N=26)</th>
<th>Uninjured Shoulders (N=1291)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>SD±</td>
<td>Mean</td>
</tr>
<tr>
<td>P Value</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>IR(0)</td>
<td>ER(0)</td>
</tr>
<tr>
<td>--------</td>
<td>-------</td>
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</tr>
<tr>
<td>IR(0)</td>
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<tr>
<td>ER(45)</td>
<td>38.98</td>
<td>10.31</td>
</tr>
<tr>
<td>Ratio IR/ER(0)</td>
<td>1.45</td>
<td>0.34</td>
</tr>
<tr>
<td>Ratio IR/ER(45)</td>
<td>1.21</td>
<td>0.23</td>
</tr>
</tbody>
</table>

Table 1

Conclusions:

We did not find an association between isometric shoulder strength measures at baseline and subsequent first-time anterior glenohumeral joint instability within the high risk athletic population studied in this prospective cohort.

Acknowledgements:

This project was aided by a grant from the Orthopaedic Research and Education Foundation.

References:


Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 9

Abstract Title: Can a Posture Shirt Decrease Injury Rates in Intercollegiate Overhead Athletes?

Authors
Michael F. Shepard MD¹; Brent R. Davis MD²; Benjamin D. Rubin MD¹
¹ Orthopaedic Specialty Institute Orange, CA
² Southern California Permanente Medical Group Irvine, CA

Objectives: Shoulder injuries are common in overhead athletes and result in a significant morbidity to the athlete and a loss of competition days. Scapular stabilization and postural training have been shown to improve rotator cuff function. Biofeedback and proprioceptive training have been shown to decrease ACL and ankle injury rates. We are unaware of studies looking at the ability of these techniques to be transferred to throwing athletes. A postural shirt is a reinforced undergarment used to increase the athletes’ scapular proprioception and provide biofeedback to improve scapular positioning. Our hypothesis is that a posture shirt can improve rotator cuff function and decrease injury rates in intercollegiate athletes.

Methods: The study is a prospective trial involving an entire NCAA male intercollegiate volleyball team over 3 seasons. Injury days (days of competition lost due to shoulder and elbow injuries) were monitored over all three seasons (2008-9, 2009-10, 2010-11). No team members wore a posture shirt in 2008-9 (n=21). All members of the team wore a posture shirt in 2009-10 (n=19) and 2010-11 (n=23). Scapular positioning and rotator cuff strength were assessed at regular intervals over each season. Scapular position was measured in relation to the anterior acromion as previously described by Tripp et al. Rotator cuff strength was measured using a dynamometer in a manner previously described by Kibler et al.

Results: While wearing the posture shirt, no competition days were lost to upper extremity injury (2009 season 0/2208, 2010 season 0/1932). This resulted in a significant difference (p<0.05) when compared to the 2008 number of days lost to injury (158/2058 = 7.7%, no shirt worn). A statistically significant improvement in scapular position was found during the seasons (paired T test p<0.05) when the athletes wore the shirt. Rotator cuff strength testing failed to show a significant improvement with postural shirt application at time zero as well as over the course of the season. In fact, the trend was for rotator cuff strength to decrease during the season despite use of the shirt. The postural shirt was well tolerated and worn by all athletes without loss of compliance.

Conclusions:
Use of a postural shirt resulted in decreased days lost to the disabled list over two seasons in NCAA Volleyball Players (p<0.05) at the same institution. Use of a postural shirt demonstrated an improvement in the athletes’ scapular positioning during both seasons (p<0.05). No improvement in rotator cuff strength was demonstrated with the use of the posture shirt.

Acknowledgements: Scapular measurements and rotator cuff strength were measured using techniques previously described by Tripp et al and Kibler et al.

Kibler WB et al. Evaluation of apparent and absolute supraspinatus strength... AJSM 34 [10], 1643-7.'06.

Relevant disclosure for all authors
Nothing to disclose
Objectives:
In recent years, there has been a documented increase in number of professional baseball players on the disabled list and total number of disabled list days. Pitchers account for the largest number of disabled list reports and shoulder injuries account for the largest number of disabled list days. The objective of this study was to examine the relationship between MRI findings of asymptomatic Major League Baseball (MLB) players and subsequent time on the disabled list (DL).

Methods:
Seventeen MLB pitchers from a single franchise underwent preseason MRIs of their dominant shoulder from 2000-2010. These studies were reevaluated by a fellowship trained musculoskeletal radiologist who was blinded to patient name, injury history or baseball history. A second investigator who was blinded to the MRI results, collected demographic data, total number of innings pitched, and any DL reports for each subject. Statistical analysis was performed with the student t-test.

Results:
The mean age at the time of MRI was 29.04 years (range 16-39). Sixteen of 17 pitchers had rotator cuff tendinosis, 6 had articular surface tears (AST) and there was 1 full thickness rotator cuff tear (RCT). Eleven of 17 had greater tuberosity cyst formation and 6 had Bennet lesions. Six patients had biceps tendinosis, 4 had SLAP tears and 4 had posterior labral tears. There was a statistically significant correlation between the number of innings pitched and ASTs. The mean number of career innings pitched by those with an AST was 984.7 compared to a mean of 603.8 innings pitched in the subjects without an AST (p- 0.01). There were no statistically significant findings between any single preseason MRI finding and subsequent time on the DL.

Figure: Table 1
Conclusions:

MRI findings in asymptomatic MLB pitchers do not appear to be related to future placement on the DL. However, there is a significant difference in numbers of innings pitched between pitchers who have an AST and those that do not. This supports the notion that AST of the rotator cuff occurs by repetitive overhead motion with subsequent strain on the rotator cuff tendons. To the author’s knowledge, this is the first study which has demonstrated a relationship between rotator cuff pathology and total number of innings pitched.

Relevant disclosure for all authors
Nothing to disclose
Abstract Title: Arthroscopic Capsulolabral Reconstruction for Posterior Instability of the Shoulder: A Prospective Study of 200 Shoulders

Objectives:
Arthroscopic capsulolabral reconstruction has become a popular method of restoring stability and function and alleviating pain in athletes with symptomatic unidirectional posterior instability. Intra-operative repair of the posterior instability may be performed by capsulolabral plication either with or without bone suture anchors, and to date no study has examined which method of internal fixation provides the best functional outcomes.

Methods:
One hundred eighty three athletes (200 shoulders) with unidirectional recurrent posterior shoulder instability were treated with an arthroscopic posterior capsulolabral reconstruction and evaluated at a mean of 36 months postoperatively. A subset of 99 shoulders in contact athletes were compared with the entire group of 200 shoulders. Patients were evaluated prospectively with the American Shoulder and Elbow Surgeons scoring system. Stability, strength, and range of motion were evaluated preoperatively and postoperatively with standardized subjective scales. Methods of intra-operative soft tissue fixation, anchorless (N=44) and anchored (N=156) plications, were recorded for each patient.

Results:
At a mean of 36 months postoperatively, the mean American Shoulder and Elbow Surgeons score improved from 45.9 to 85.1 (P < .001). There were also significant improvements in stability, pain, and function based on standardized subjective scales (P < .001). The contact athletes did not demonstrate any significant differences when compared with the entire cohort for any outcome measure. With regard to method of internal fixation, patients who underwent capsulolabral plication with suture anchors had a significantly greater improvement in ASES scores (p<.001) and a higher rate of return-to-play (p<.05) when compared to patients with anchorless capsulolabral plications.

Conclusions:
Arthroscopic capsulolabral reconstruction is an effective, reliable treatment for symptomatic unidirectional recurrent posterior glenohumeral instability in an athletic population. Overall, 90% of patients were able to return to sport, with 64% of patients able to
rurn to the same level postoperatively. With the incorporation of bone suture anchors in the capsulolabral reconstruction, patients had greater improvements in ASES scores and a higher rate of return-to-play.

References:  

Relevant disclosure for all authors  
Nothing to disclose
The Effect of Shoulder Immobilization on Driving Performance

Objectives:
There has been a growing interest in the investigation of a variety of orthopedic immobilization devices in the context of driving performance and safety. The majority of studies utilize surveys, driving simulators and controlled driving conditions to elucidate practice guidelines for patients utilizing these devices. The effect of upper extremity bracing using a shoulder sling has not been previously investigated. The purpose of this study was to evaluate the effect of upper extremity immobilization using a sling on driving performance using a driving simulator.

Methods:
A computerized driving simulator was used to develop a simulated circuit to test a variety of driving conditions. The circuit simulated normal rural driving with various hazardous conditions that necessitate evasive maneuvers and turns at varying angles. Twenty healthy volunteers were tested on two trials on a single simulated circuit. Trial 1 consisted of driving under natural conditions and served as the control group. Trial 2 consisted of driving with the dominant driving arm immobilized using a shoulder sling. Participants were randomized with respect to the temporal order of each trial and each course was customized to the driver’s reaction time to limit variability between course output measures.

Results: The mean +/- standard deviation for number of collisions, maximum angular change (rad/s) for each turn and proximity to any oncoming vehicles (m) and stationary objects was extrapolated from driving simulator output data. The total number of collisions for non-sling driving was 34 (mean 1.70 +/- 1.21) and 73 for sling driving (3.65 +/- 1.63) (p<0.01). Seventy percent of participants with upper-extremity immobilization were involved in > 3 collisions, 70% of non-sling participants were involved in < 2 collisions. There was no statistically significant difference between groups with respect to angular change for all simulated turning angles and with respect to proximity to oncoming vehicles and stationary objects.

Conclusions: Sling immobilization of the dominant driving arm results in a decrease in driving performance and safety with respect to the number of collisions in a simulated driving circuit (p<0.01). The decrease in driving performance is likely to be related to the effect the immobilized arm has on performing evasive maneuvers during hazardous driving conditions. This data has important implications for patients and decisions related to return to driving after shoulder injury or shoulder reconstruction.

Acknowledgements:
Relevant disclosure for all authors
Nothing to disclose
AOSSM 2012 Annual Meeting

Abstract Id: Poster 13
Abstract Title: Massive Rotator Cuff Tears in Active Patients with Minimal Glenohumeral Arthritis: Clinical and Radiographic Analyses of Reconstruction using Dermal Tissue Matrix Xenograft

Authors
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Objectives: To evaluate the clinical and radiographic outcomes of patients undergoing interposition reconstruction of massive, otherwise irreparable rotator cuff tears through a mini-open approach with the use of a porcine dermal tissue matrix, Conexa®.

Methods: We performed a prospective observational study of 27 patients who underwent reconstruction of massive rotator cuff tears using dermal xenograft. Inclusion criteria included a full thickness rotator cuff tear with tear retraction greater than five centimeters based on preoperative magnetic resonance imaging (MRI), failure of minimum six months conservative management, inability to reduce residual cuff to the anatomic footprint after full mobilization of the tendon, and the ability to fully participate in the postoperative rehabilitation protocol.

Pain level (scale 0-10, 10=severe pain), active range of motion, and supraspinatus and external rotation strength were assessed. Additional outcome measures included American Shoulder and Elbow Score (ASES) and SF-12 score. Clinical and radiographic analyses were performed at an average two-year follow-up period. Static and Dynamic ultrasound imaging of the operative shoulder was performed at final follow-up and compared to normal tendon to assess the integrity of the reconstruction.

Results:

Mean patient age was 60. Mean pain level decreased from 4.2 to 0.3 (p=0.0001). Mean active forward flexion, abduction, and external rotation improved from 128.7 to 153.4 (p=0.02), 107.6 to 149.34 (p= 0.001), and 57.1 to 64.7 degrees (p=0.17), respectively. Supraspinatus and external rotation strength improved from 7.2 to 9.0 (p=0.016) and 7.4 to 9.1 (p=0.005), respectively. Mean ASES improved from 62.7 to 92.7 (p=0.0004). Mean SF-12 scores improved from 48.4 to 57.4 (p=0.012).

Twenty-one patients returned for an ultrasound of the operative shoulder at an average two-year follow-up. Thirteen (62%) demonstrated fully intact tendon/graft reconstructions. The remaining eight (38%) had partially intact reconstructions. No patients demonstrated complete failure of the reconstruction.

Conclusions:

We present a reproducible surgical technique for the management of massive irreparable rotator cuff tears in patients with minimal glenohumeral arthritis. In our series, all patients demonstrated a significant improvement in both subjective and objective clinical outcomes. Radiographic analysis demonstrated that the majority of patients had fully intact reconstructions at an average two-year follow-up.

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 14
Abstract Title: Cost Effectiveness of Rotator Cuff Surgery

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Objectives:
Shoulder arthroscopy is the 2nd most common performed procedure in orthopaedic surgery with more than 75,000 cuff repairs per ano. However, there is scarce data regarding the cost-effectiveness of this procedure. This study tries to elucidate cost utility of rotator cuff surgery taking complications and re-tear rates associated with the procedure into account.

Methods:
We developed a cost effectiveness analysis model to examine the impact of the different health utilities according to complication probabilities and associated costs. The model input parameters were derived from published literature and included a mean risk of failure rate of 15% (3.9-32%), infection of 1.8% (1.7-1.9%), nerve injury of 1.0% and stiffness rate of 10% (2-20%). A minimum of two-year follow-up studies were used for health utility scores using SF36 Short Form. Average life expectancies were applied to generate cost-effectiveness ratios. Overall hospital costs ($10,605.20) were retrieved from literature and cost for additional physical therapy ($150), physician appointments ($250) and additional procedures for revision ($15,605.20) or for complications ($5302.60) for complications, were estimated. To examine variability of results to uncertainty in parameter estimates we conducted a wide set of sensitivity analyses.

Results:
The mean gain of QALY after rotator cuff surgery was 1.56 for an uncomplicated rotator cuff repair. The estimated lifetime gain in QALY for revision surgery was 0.50 and from complications 1.02 was noted if complications or a re-tear occurred after the index surgery. This yielded a cost-effectiveness ratio of $6793.20/QALY by the use of a minimum of 2-year follow-up of the SF-36 for uncomplicated rotator cuff repair. In revision rotator cuff surgery due to a complication or a re-tear the ratio increased to $20907.80/QALY and $62420.80/QALY. Sensitivity analysis demonstrated the robustness of the model.

Conclusions:
This study demonstrates the cost-effectiveness of rotator cuff surgery, even taken complications into account. However in case of a re-tear after the index surgery the cost-effectiveness is higher when compared to other surgical interventions in orthopaedic surgery.
References:

Cost-effectiveness of open versus arthroscopic rotator cuff repair.

Adla DN, Rowsell M, Pandey R.


Relevant disclosure for all authors
Nothing to disclose
Abstract Title: In-Office Supervised Home Therapy versus Traditional Outpatient Physical Therapy for Arthroscopic Shoulder Surgery Rehabilitation: A Case-Controlled Cohort Study

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Objectives: Traditional physical therapy is widely used in the rehabilitation of shoulder arthroscopy. Many orthopedic practices have added in-office physical therapy to the ancillary services provided from their groups. This practice has recently come under criticism suggesting that this structure leads to overutilization. It was the authors’ impression that in-office physical therapy actually decreased utilization, and that the improved communication of immediate feedback between the therapist and surgeon improved return to work rates and outcomes.

Methods:
100 patients from a multispecialty orthopedic group with in office physical therapy undergoing arthroscopic shoulder surgery on a work related basis were retrospectively compared to a similar cohort of patients undergoing the same procedures from the database of a large workers’ compensation company over a 12 month period. The in-office group emphasized a supervised home program, whereas physical therapy completed was at the discretion of the operating surgeons, subject to the approval of the compensation carrier. Capsulorrhaphy (29806), SLAP repair (20807), limited debridement (29822), extensive debridement (29823), claviculolectomy (29824), acromioplasty (29826), rotator cuff repair (29827), and arthroscopic biceps tenodesis (29828) were reviewed in each group. Patients were assessed for routine demographic information, pre and post injury SST scores, return to light duty, return to full duty, time off work, and disability rating based on AMA 5\textsuperscript{th} Edition guidelines. The number of physical therapy visits were assessed for each group in the post operative period until final rating.

Results:
Patient age, gender, occupation, and pre operative SST scores were similar for both groups. An in-office physical therapy program resulted in a 45% reduction in therapy visits, which created an average savings of $1185 per surgical case. Return to light duty averaged 22 days sooner, with full duty varying with occupation but averaging 2.7 months earlier. 85% of the patients in the in-office group had no ratable disability based on AMA guidelines, versus only 55% from the database.

Conclusions:
Despite assertions, in-office physical therapy provided a decreased in number of physical therapy encounters in this study compared to traditional outpatient physical therapy. Within the limitations of a level 3 study, outcomes between the two cohorts showed that a supervised home therapy program provided results superior to traditional physical therapy. Concerns about self referral seem unfounded.
Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 16

Abstract Title: The Effect of Concomitant SLAP Repair on Outcomes of Arthroscopic Rotator Cuff Repair

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Objectives:
Concomitant repair of an unstable superior labral tear (SLAP) in the setting of rotator cuff repair (RCR) is controversial. The goal of this retrospective study of patients treated by a single surgeon was to compare the outcome of arthroscopic RCR with or without concomitant arthroscopic repair of an unstable SLAP tear.

Methods: 54 shoulders in 51 patients that underwent both SLAP repair and RCR (SLAP group) were compared to an isolated-RCR group of 62 shoulders in 61 patients at a mean follow-up of 27 months (range 12 to 78). Patients completed the ASES shoulder score, Simple Shoulder Test (SST), and visual analog scale for pain (VAS), subjective shoulder value (SSV), and Short Form 12 (SF12). The two groups were compared using chi-square and t-tests.

Results:
The mean age in the SLAP group was 49 years compared to 59 in the RCR group (p<0.001). No significant differences between the groups were observed with respect to the ASES, VAS, SSV, or SF12 scores. The SLAP group averaged 11 functions on the SST compared to 10 in the RCR group (p=0.04). Two shoulders in the SLAP group had subsequent procedures (1 revision RCR and 1 capsular release) compared to nine shoulders (3 capsular releases, 5 distal clavicle excisions, and 1 biceps tenodesis) in the RCR group (p=0.04).

Conclusions: The outcome of the SLAP/RCR group was comparable to the isolated RCR group. Performing a SLAP repair in conjunction to RCR did not cause more stiffness, or have an adverse effect on clinical outcomes. Clinically significant pathology that necessitated re-operation was more common in the isolated RCR group in this study.

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 17

Abstract Title: Prediction of Coracoid Thickness Using a Glenoid Width-Based Model: Implications for Bone Reconstruction Procedures in Chronic Anterior Shoulder Anterior Instability

Authors
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Objectives: Chronic anterior shoulder instability with significant glenoid bone loss (>25%) requires a bone grafting procedure to restore stability; often a Latarjet procedure. However, in some cases with severe glenoid bone loss, iliac crest bone graft (ICBG) is needed to obtain a graft of adequate size. ICBG can provide a larger graft but is associated with a high rate of complications. While glenoid dimensions can be accurately determined using 3-D computed tomography (3-D CT) reconstructions, the thickness of the coracoid cannot be easily measured. This study aims to define a ratio between glenoid width and coracoid thickness that can predict if coracoid transfer will yield adequate bone graft to restore glenoid stability, or if ICBG must be taken.

Methods: 100 pairs (50 males, 50 females) of cadaveric scapula from the Hamann-Todd Human Osteological Collection at the Museum of Natural History in Cleveland, OH, were examined. Glenoid width (GW) and height, and coracoid length (knee to tip) and thickness (CT) were measured using digital calipers accurate to 0.01mm for each scapula. Each pair of scapulae was measured independently by two of the authors and the results averaged.

Results: The average male glenoid was 27.5 mm in width by 37.6 mm in height. The average coracoid thickness was 9.7 mm by 23.1 mm long. The average female glenoid was 23.1 mm in width by 32.6 mm in height. The average coracoid thickness was 7.9 mm by 18.5 mm long. Calculation of coracoid thickness from glenoid width is as follows: CT = GW (from 3-D CT) x 0.354 (for men) or x 0.344 (for women).

Conclusions: Our model predicts coracoid thickness, and the ability of a Latarjet to restore stability to the glenoid. A male patient with a 30 mm wide glenoid would have a predicted coracoid thickness of 10.6mm (35.4% of the glenoid width). If the measured glenoid bone loss was <10.6mm, a Latarjet should be successful. If the bone loss was >10.6mm, ICBG would be needed. This model may aid surgical planning and help promote successful glenoid reconstructions by determining if a Latarjet or ICBG is the most appropriate procedure given the predicted amount of coracoid bone graft available.


Relevant disclosure for all authors
Nothing to disclose
AOSSM 2012 Annual Meeting

Abstract Id: Poster 18
Abstract Title: Biomechanical Analysis of Massive Rotator Cuff Tear Repairs: Extended Linked Repairs and Augmented Repairs

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Objectives:
The objectives of this study were to compare the biomechanical properties of single-row (SR), extended double-row (DR), and augmented, extended double-row (aDR) rotator cuff repairs in a MRCT model to those of intact RC tendons.

Methods:
24 fresh frozen human cadaveric shoulder specimens were randomly divided into four groups. MRCT, involving both the supraspinatus and infraspinatus tendons, were created followed by a SR, DR or aDR-repair (six each). A collagen scaffold was used for augmentation of the aDR repairs. 6 intact RC tendons were used as a control group.
The SR repair was performed with 3 anchors and 3 mattress sutures for each anchor. The DR repair involved 3 medial anchors with 3 mattress sutures, and 3 lateral anchors and 6 suture tapes in a crossing, linked configuration. For aDR repairs, 3 medial anchors were inserted and the sutures and tapes were passed through the native MRCT. The MRCT and collagen scaffold were then fixed laterally with 3 anchors in a construct that was otherwise the same as the DR repairs.
All specimens were cyclically loaded from 25 – 75 N for 50 cycles. Every 50 cycles, the peak load was increased by 25 N, until failure occurred. The stiffness, number of cycles, maximum load range, and mode of failure were analyzed. Statistical analysis was performed using a one-way analysis of variance and a post-hoc Tukey’s test. Statistical significance was set at P < 0.05.

Results:
There was a significant difference in stiffness for SR (72.9 ± 4.64 N/mm) and aDR (72.6 ± 11.8 N/mm) repairs in comparison to intact specimens (93.1 ± 14.8 N/mm) from a maximum load range of 100 N and higher (P < 0.05).
The intact specimens, DR and aDR repairs endured significantly more cycles (1556 ± 677, 1302 ± 248 and 1211 ± 95 cycles respectively, Figure 1) and had higher maximum load ranges at failure (935 ± 331 N, 715 ± 124 N and 670 ± 41 N respectively) than SR repairs (388 ± 72 cycles, 260 ± 4 N) (P < 0.05 for all groups).
All SR failed at the tendon-suture construct (6/6), and all aDR failed due to the sutures tearing through the tendons medially (6/6). The mechanism of failure for the DR repairs included lateral anchor pull out (2/6), sutures cutting through the tendon medially (2/6), and tendon failure at the musculotendinous junction (2/6).

Figure: 1
Conclusions:

Extended, linked DR constructs were significantly stronger than the SR repair in this MRCT model. Furthermore, augmentation with a collagen patch did not negatively influence the biomechanical repair qualities. However, there is still room for optimizing MRCT repairs.

Acknowledgements:

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Relevant disclosure for all authors:
Nothing to disclose
Abstract Id: Poster 19

Abstract Title: Two Fixation Methods for Acromioclavicular Joint Reduction during Coracoclavicular Ligament Reconstruction: A Biomechanical Analysis.

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Objectives:

Purpose: To compare the biomechanical properties of a locking hook plate and PDS-suture braid for CC interval reduction during CC ligament reconstruction for AC joint injury.

Hypothesis: The locking hook plate will provide a significant biomechanical advantage during cyclical loading and maximal load to failure when compared with a PDS-suture braid for reduction of the CC interval during CC ligament reconstruction.

Methods:

Six matched pairs of fresh-frozen cadaveric specimens were tested. Following dissection, one specimen of each pair underwent a semitendinosus CC ligament reconstruction with a locking hook plate used for AC joint reduction while the other specimen utilized a PDS-suture braid for AC joint reduction. All specimens were then cyclically loaded for 2000 cycles at 70N, and then subjected to maximal load to failure testing. Displacement during cyclical loading, loads to 50% and 100% displacement, stiffness and maximal load to failure were determined for all specimens.

Results:

The locking hook plate allowed significantly less displacement of the CC interval during cyclical loading (3.41mm vs 9.67mm, p=0.0081) and withstood significantly larger loads prior to both 50% (225.5N vs 107.7N, p=0.0197) and 100% displacement (410.6N vs 240.1N, p=0.0077). The locking hook plate was found to be significantly stiffer than the PDS-suture braid (28.2N/mm vs 18.4N/mm, p=0.0029) but there was no difference in maximal load to failure between the two fixation methods (hook plate-434.4N, PDS-476.7N, p=0.76).

Conclusions: When compared to a PDS-suture braid, the locking hook plate is significantly stiffer, allows less CC interval displacement during cyclical loading and withstands larger loads prior to 50% and 100% displacement. These biomechanical advantages may potentially shield the CC ligament reconstruction from stresses during the period of biological healing.
Acknowledgements: We would like to thank Dr. William Hutton for his invaluable assistance in completing this project.

Relevant disclosure for all authors
Nothing to disclose
Objectives:
Various methods to reconstruct the CC ligaments have been described. This study was undertaken to compare the biomechanical properties of two reconstruction techniques using semitendinosus tendon allograft.

Methods:
Sixteen matched fresh frozen cadaveric shoulders were used for this study and one additional shoulder was used in the knot fixation group only. Specimens were randomly assigned to anatomical CC ligament reconstruction utilizing either: anatomical 2-bundle reconstruction technique described by Mazzocca et al. \((n=8)\)\(^2\)\(^3\) or modification of the knot fixation technique described by Lee et al. \((n=8)\)\(^1\). We modified Lee’s technique by looping the allograft through drill holes in anatomically positioned drill holes in the clavicle. The intact CC ligaments were tested to failure in the superior direction at a rate of 2 mm/sec. After failure, reconstruction was performed utilizing a semitendinosus tendon allograft. Load-to-failure was then repeated for each construct. Ultimate failure load, stiffness, and mode of failure were recorded for each specimen and compared by paired t-test \((p<0.05)\).

Results:
There was a significant difference \((p = 0.003)\) in failure modes between the two techniques tested. The majority \((7/8)\) of the repairs in the 2-bundle group failed when the tendon slipped through a clavicular drill hole. The majority of repairs \((8/9)\) in the knot fixation group failed because the allograft elongated more than 2 cm, which was considered clinical failure. There was no significant difference in load to failure between the techniques or between the native tissue and reconstruction. The stiffness decreased significantly after reconstruction from 34.3 N/mm to 22.5 N/mm for the 2-bundle group \((p=0.035)\) and from 35.5 N/mm to 21.9 N/mm for the knot fixation group \((p=0.043)\). There was no significant difference in stiffness between the two reconstruction groups.
Average stiffness (N/mm) of intact specimens vs repaired

Conclusions:

Although less stiff than the native ligament, either technique to reconstruct the CC ligament can be performed to yield a similar load to failure to the intact ligament. There are potential benefits to the modifications we made to the previously published techniques. The anatomically positioned clavicular drill holes recreating the conoid and trapezoid ligaments may more closely mimic the intact state. Also, the sling technique of passing the graft around the coracoid reduces stress risers secondary to drilling and fixation. This study also reinforces the excellent fixation strength of knot fixation of graft, while avoiding the need for additional hardware and a site of failure.

References:


Relevant disclosure for all authors
Nothing to disclose
Objectives:

An initial anterior cruciate ligament (ACL) tear can be treated with focused rehabilitation or surgical reconstruction. The KANON randomized control trial compared early ACL reconstruction to rehabilitation and optional delayed reconstruction and found no difference in outcome by intention to treat analysis of KOOS scores. The purpose of this study was to compare the cost-effectiveness of early ACL reconstruction to rehabilitation and delayed reconstruction.

Methods:

A Markov decision model was constructed for a cost-utility analysis of early reconstruction (ER) versus rehabilitation and optional delayed reconstruction (DR). Outcome probabilities and effectiveness were derived from two sources: The Knee Anterior Cruciate Ligament, Nonsurgical versus Surgical Treatment (KANON) Study and the Multicenter Orthopaedic Outcome Network (MOON) database of a prospective longitudinal cohort of anterior cruciate ligament reconstructions. Utilities were measured by the SF-6D. Costs were estimated from the societal perspective with use of the national average Medicare reimbursement for the procedures in 2011 U.S. dollars. Effectiveness was expressed in quality-adjusted life years gained (QALYs). QALYs measure the quantity and quality of life and are a unit of utility. Principal outcome measures were average incremental costs, incremental effectiveness, incremental quality-adjusted life years (QALYs), and net health benefits.

Results: In the base case, early ACL reconstruction resulted in an incremental gain of 0.32 QALYs and provided a cost savings of $1,006 compared to rehabilitation and delayed reconstruction. Sensitivity analysis revealed that if the proportion of rehab visits for early rehab to visits for postoperative rehab is below 75%, 50% or fewer patients opt for ACL reconstruction or less than 50% have symptomatic instability, the DR strategy becomes less costly. However, only one variable was sensitive to cost effectiveness – the rate of instability after rehab must be below 11% for DR to be the preferred treatment strategy.

Figure:
Conclusions:

Early reconstruction was both more effective and less costly, and therefore, a dominant treatment strategy. In other words, early ACL reconstruction provides a greater average benefit to the patient at a lower cost to society. These findings suggest that when considering optimal societal health care delivery, early ACL reconstruction is a viable treatment option.

Relevant disclosure for all authors
Nothing to disclose
AOSSM 2012 Annual Meeting

Abstract Id:  Poster 22
Abstract Title: Gender Based Differences In Outcomes Following ACL Reconstruction In Soccer Athletes from MOON Cohort

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Objectives:
ACL injuries are common among soccer athletes, and occur at a higher rate in females compared to males. There is limited information on the outcomes of ACL reconstruction specifically regarding return to participation in soccer athletes. The purpose of this study was to test the hypothesis that there are gender differences in return to play and risk for future ACL injury in soccer athletes.

Methods:
Subjects enrolled in the prospective MOON cohort, who were identified as soccer athletes, were contacted to review their return to play following ACL reconstruction. Information regarding if and when they returned to play and their current playing status was recorded. If they were not currently playing, they were asked for the primary reason they stopped playing soccer. Any additional ACL surgery following their initial ACL reconstruction was also recorded.

Results:
Data was collected on a total of 94 soccer athletes (49 male, 45 female) with 81% follow-up in this cohort. Overall 72% of soccer athletes returned to soccer at an average of 12.5 months after surgery. There was no significant difference between males and females in the rate of return (male 80% v. female 64%, p=0.1) or time to return to play (males 10.5 ± 7.5 months v. females 15.1 ± 20.7 months, p=0.3). Twelve soccer athletes (13%) had undergone further ACL surgery, including 9 on the contralateral knee (10%) and 3 (3%) on the ipsilateral knee. Females were more likely to need additional ACL surgery (27%) than males (6%) (p=0.04). At an average follow up of 7.0 years, only 36% of soccer athletes who underwent ACL reconstruction are still playing the sport, a significant decrease compared to initial return to play (p<0.0001). There was no significant difference in the long term return to play between males (41%) and females (31%) (p=0.3). However, men were more likely (59%) than women (29%) to attribute their ACL injury as the primary reason they were no longer playing soccer (p=0.02).
Conclusions:

Soccer players have a good initial rate of return to play following ACL reconstruction which declines over time. Males may be affected more directly than females by the injury itself as opposed to other factors or life events in terms of their potential return to play. Future research should identify factors that limit return to play initially and over time in these athletes. Female soccer players who undergo ACL reconstruction are at a higher risk of future ACL injury than males and may benefit from targeted injury prevention programs.

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 23
Abstract Title: Non-Contact Anterior Cruciate Ligament Injuries: A Risk Prediction Tool

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Objectives: The incidence of anterior cruciate ligament (ACL) injuries remains high. Methods to reduce risk of ACL injuries have been prescribed, with primary emphasis on neuromuscular training. Prediction methods for calculating ACL injury risk are not available. A biomechanical model incorporating anatomic risk factors has been developed including patellar tendon inclination angle (PaTIA) & posterior tibial slope (PTS) as anatomic ACL injury risk factors and fabella presence as a protective factor. Hypothesis: Using this model, ACL risk assessment can be calculated from radiographic measurements.

Methods:
Retrospective, cohort subgroups (N=1153) [ACL tears (ACL, N=451), isolated meniscus tears (MEN, N=351), & patellofemoral syndrome (PFS, N=351)] were evaluated. Lateral radiographs were used to measure PTS, patellar tendon length (PTL), patellar thickness (PT), tibial tubercle height (TTH), & bony fabella presence. PaTIA was calculated.

\[ \text{PaTIA} = \sin^{-1}\left(\frac{\text{PT} - \text{TTH}}{\text{PTL}}\right) \]

Unpaired t-tests were used to compare PTS & PaTIA between subgroups & sex differences within subgroups. A chi-squared test was used for fabella presence. A logistic regression model was used to estimate risk of ACL injury based on PaTIA, PTS, sex, & fabella presence.

Results:
The PaTIA means and standards are: ACL 22.34±4.53 deg, MEN 21.53±4.34 deg, PFS 20.12±3.83 deg. PaTIA was statistically different between subgroups: ACL vs MEN (p=0.0108), ACL vs PFS (p<0.0001), MEN vs PFS (p<0.0001). There was no difference in PaTIA by sex in any subgroup. The PTS means and standard deviations are: ACL 11.34±3.75 deg, MEN 8.32±3.80 deg, PFS 8.61±3.51 deg. The PTS was statistically different for ACL compared to MEN & PFS: ACL vs MEN (p<0.0001), ACL vs PFS (p<0.0001), MEN vs PFS (p=0.2803). There was no difference in PTS by sex in any subgroup. The fabella prevalences are: ACL 12.9%, MEN 22.8%, & PFS 20.5%. The prevalence differences are significant (p=0.0006). The logistic regression model equation is

\[ \logit = -3.96 + 0.0595*\text{PATIA} + 0.211*\text{PTS} - 0.00709*\text{SEX} - 0.220*\text{FABELLA} \]

The model coefficients were all statistically significant except for SEX (p=0.9142). The model R^2 coefficient equals 14.7%. Fabella
Conclusions: Patellar tendon inclination angle & posterior tibial slope are independent risk factors for ACL injury. Presence of a bony fabella reduces the risk of ACL injury. The logistic regression model provides a simple tool for estimating ACL injury risk for an individual athlete.

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 24
Abstract Title: Use of a Fluoroscopic Overlay to Guide Arthroscopic ACL Reconstruction

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Objectives:
1. To evaluate the efficacy of using an overlay based on fluoroscopic landmarks to guide surgeons to more anatomic tunnel placement for ACL reconstructions.
2. To evaluate the accuracy of a literature based ACL insertion site compared to the insertion sites identified in 20 cadaveric specimens.

Methods:
The femoral and tibial ACL insertion sites were identified arthroscopically in 20 cadaveric knees. Using an optical measurement system (Spectra, NDI) ten to 25 points surrounding the footprint were recorded and mapped on to 3D bone models generated from high resolution CT scans using a co-registration process (1). Digitally reconstructed radiographs were then created to simulate a lateral radiograph of the knee and the insertion sites were quantitatively defined in the coordinate system previously described by Bernard for the femur (2) and along the Jakob Amis line (3) for the tibia. Inter and intra observer reliability was evaluated.

Twenty experienced orthopaedic surgeons were recruited. Each participant identified and marked the locations on the femur and tibia where they would place ACL tunnels. A lateral fluoroscopic image of the knee was obtained and the image overlay applied. Surgeons then adjusted their initial location to match the location given by the overlay, a point based on literature data (4,5) (Figure 1). The distance between the literature point and the surgeon’s position was measured.

Figure:
Results:

Prior to use of the overlay 15/20 surgeons were >2.5mm from the point given by the femoral overlay and 6/20 were >2.5mm from the point given by the tibial overlay. Surgeons made statistically significant (p<0.05) improvements in tunnel starting position on both the femur and tibia. After use of the overlay only 5/20 surgeons were >2.5mm from the femoral target point while all surgeons were <2.5mm from the target tibial point.

The average femoral insertion site obtained differed from the literature average point by 4% and 5% along the x and y axis respectively as shown in Figure 1. The tibial insertion site differed by 3% along the Jakob Amis line.

Conclusions:

This study showed that radiographic landmarks help decrease variability in ACL tunnel starting position, even in experienced surgeons. There is inherent variability in natural insertion sites as evidenced by the difference by the literature point and the point obtained in this study and further work should focus on defining an accurate point to place on the fluoroscopic overlay and methods to generate patient specific values.

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AOSSM 2012 Annual Meeting

Abstract Id: Poster 25
Abstract Title: Military Movement Training Program Improves Jump Landing Mechanics Associated with ACL Injury Risk

Authors
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Objectives:
Recent studies have shown that improved landing mechanics are teachable to at-risk young athletes. We sought to evaluate a standardized course at a US service academy that is designed to develop skills and improve performance in military-related physical tasks as well as obstacle navigation. The purpose of this study was to determine if completion of this course would also result in changes in jump landing technique that reduce the risk of anterior cruciate ligament (ACL) injury.

Methods: Subjects were recruited immediately upon enrollment in the 8-week movement training course. Study participants (119 male, 79 female) performed a two-footed jump-landing from a height of 30cm prior to and upon completion of the movement training. A 3-d motion capture system synchronized with two force plates was used to collect kinematic and kinetic data. The Landing Error Scoring System (LESS) was also used to evaluate overall landing mechanics. ANOVA was performed to determine changes in landing technique following the intervention.

Results:
Subjects demonstrated significantly improved landing technique with lower LESS scores (p=0.001) after the intervention. Beneficial kinematic changes noted include greater hip abduction at initial ground contact (p=0.012) and at maximum knee flexion (p<0.001). No significant kinematic changes were noted at the knee. Landing time was also increased (p=0.013). However, increases were also noted in anterior tibial sheer (p=0.003) and medial-lateral ground reaction force (p<0.001). No differences were noted in vertical or anterior-posterior ground reaction forces.

Conclusions:
The studied military movement course appears to improve overall lower extremity jump landing mechanics associated with risk for
ACL injury. Further study of the specific aspects of this course that mitigate high risk movement patterns is recommended, as they may be incorporated into injury prevention interventions to reduce ACL injury risk in athletic and military populations.

Acknowledgements: This study was funded by the Orthopaedic Research and Education Foundation.

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 26
Abstract Title: Correlation between the Child Health Questionnaire and the International Knee Documentation Committee Score in Pediatric and Adolescent Patients with an Anterior Cruciate Ligament Tear

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Objectives: A modified International Knee Documentation Committee (Pedi-IKDC) outcomes questionnaire has been recently shown to be valid, reliable, and responsive in pediatric and adolescent patients. This study reports that seven of the twelve domains on the CHQ correlate significantly with the Pedi-IKDC in patients with ACL ailment. Pediatric patients are affected differently than adults by ACL injuries and varying approaches to treatment, including consultation with a sports psychologist, may be of utility in these patients. The purpose of this study was to further analyze correlations between the Pedi-IKDC score and the Child Health Questionnaire (CHQ) in a group of adolescent patients

Methods: A prospectively collected database of patients with ACL injuries was analyzed to indentify all patients who had completed both the IKDC and CHQ (CHQ-CF87) questionnaires. These were analyzed to determine significant correlations between domains of the CHQ and the IKDC.

Results: One-hundred thirty five patients were included (80 male, 55 female) with a median age of 15.3 years (range 13.1-17.2). The cohort included patients treated both operatively (120) and non-operatively (15). The total IKDC score was found to correlate with the majority of the CHQ including expected domains such as physical function (correlation coefficient = 0.64), bodily pain (0.7), and family activities (0.41), in addition to emotional role (0.45), mental health (0.46), self esteem (0.45), and social limitations – physical (0.38) (p < 0.001 for all correlations).

Conclusions: Seven of the twelve domains on the CHQ are significantly correlated with the IKDC in pediatric and adolescent patients with an ACL tear. Self esteem, mental health, emotional role, and social limitations categories are significantly correlated with knee function suggesting that quality of life in this population is affected in domains outside of physical function and pain. Pediatric patients are affected differently than adults by ACL injuries and varying approaches to treatment, including consultation with a sports psychologist, may be of utility in these patients.

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 27
Abstract Title: Comparison of Tibial Tunnel Placement using Independent Femoral Tunnel Drilling and Transtibial Tunnel Drilling Techniques

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Objectives:
Independent femoral tunnel drilling (IFTD) has become a popular technique to place femoral tunnels more anatomically during ACL reconstruction. The effect of independent femoral tunnel drilling on the accuracy of placing the tibial tunnel in the tibial footprint has not been determined. The purpose of this study was to compare the accuracy of tibial tunnel placement using IFTD and transtibial (TT) techniques. This study used a novel method of fusing the preoperative tibial footprint with the postoperative tibial tunnel and allowed for evaluation of the same knee under normal arthroscopic conditions. We hypothesized that IFTD would lead to more accurate placement of the tibial tunnel in the anatomic footprint compared to TT drilling.

Methods:
Ten matched pairs of cadaver knees were used for the study. One knee in the pair underwent arthroscopic transtibial drilling of the femoral tunnel and the other underwent drilling through an accessory medial portal. All tibial tunnels were drilled using a tibial guide set at 55º and an 8mm reamer. All knees underwent computed tomography (CT) both pre and postoperatively with a technique optimized for ligament evaluation. The CT scans were fused using commercially available third party software (TeraRecon iNtuition). This allowed anatomic comparison of the ACL tibial footprint to the drilled tibial tunnel. The percentage of tunnel aperture contained within the native footprint, the distance from the center of the tunnel aperture to the center of the footprint, and the tunnel aperture area were measured.

Results:
The percent shared footprint in the IFTD group was 72±17% versus 52±23% in the TT group (p=.04). The distance from the center of the footprint to the center of the tibial tunnel aperture was 3.5±1.6 mm in the IFTD group and 4.4±1.7 mm (p=0.27). The tibial tunnel aperture area was 56±16 mm² for IFTD drilling and 62±13 mm² in the TT group (p=0.32).

Figure: 1
Representative CT scan of tibial plateau from the independent femoral tunnel drilling group showing the ACL tibial footprint (outlined in blue), tibial tunnel aperture (outlined in purple) and shared area between the two (outlined in red).

Conclusions:
This study demonstrates that independent femoral tunnel drilling leads to more of the tibial tunnel being placed in the tibial ACL footprint than during TT drilling. The distance from the center of the tibial tunnel aperture to the center of the footprint with IFTD was less than with TT drilling, but not significantly so. As expected with the eccentric drilling that occurs with the TT method, the tibial tunnel area was greater than with the IFTD technique, though this was not statistically significant.

Relevant disclosure for all authors
Nothing to disclose
Abstract Id:  Poster 28
Abstract Title: Variability in ACL Tunnel Placement

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Objectives: An increasing amount of ACL research is being performed by multi-center groups in the United States and abroad. In addition, ACL tunnel placement is currently an area of great interest. The purpose of the following studies was to investigate ACL tunnel variability relative to surgeon technique and experience level, and to demonstrate inter- and intra-surgeon variability in both laboratory and clinical settings.

Methods: First, a cadaveric study was done with 12 knee surgeons performing ACL tunnels on 6 knees each. The surgeons were selected based on preferred femoral tunnel drilling technique [two-incision (TI), trans-tibial (TT) or medial portal (MP)] and experience level. All knees underwent CT scan evaluation. In addition, a clinical study of 78 ACL reconstructions performed by 8 surgeons was done. All patients underwent post-operative CT scan. For cadaver and clinical knees, CT scan data was used to create 3-D knee surface mappings. A novel Cartesian coordinate system was utilized to standardize measurements between knees. ACL tunnels on the tibia and femur were analyzed for tunnel angulation and tunnel aperture into the joint.

Results: The cadaveric data demonstrated more tunnel variability in terms of femoral tunnel depth than height related to technique. TI surgeons placed tunnel more posterior than other techniques. On the tibia, more variability was demonstrated in the tunnel aperture location from anterior to posterior on the tibial plateau than from medial to lateral. TT surgeons placed ACL tunnels more posteriorly on the tibia than other techniques. Only small differences were found for tunnel location by experience level. In the clinical study ACL surgeons were very consistent between each other for tibial tunnel aperture location from medial to lateral. More variability exists for tunnel aperture location in terms of femoral depth and height, and tibial depth. Most surgeons are relatively consistent within their own cases in ACL tunnel placement.

Conclusions: These studies demonstrate small to modest differences in ACL tunnel placement relative to surgeon preferred technique. Essentially no ACL tunnel differences were found for analysis of tunnel placement by experience level in a cadaveric lab setting. Overall, surgeons were relatively consistent with each other and with themselves in ACL tunnel placement given that surgeons all have individual preferences and biases for appropriate tunnel location. This information can be useful when considering multi-surgeon and collaborative ACL research.

Figure:
Demonstration of 3D surface mapping of femur with Cartesian coordinate measurement application.

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Relevant disclosure for all authors
Nothing to disclose
Objectives:

The geometrical characteristics of the tibial plateau are emerging as key anatomical risk factors for anterior cruciate ligament (ACL) injury. Specifically, it has been reported that steep lateral tibial slope (LTS) and shallow medial tibial plateau (MTD) in combination are critical factors in ACL injury. However, it is important to establish whether these risk factors remain significant for subjects that have undergone ACL reconstruction. We hypothesized that the individuals that have undergone ACL reconstruction and have experienced a second injury after reconstruction, have very extreme tibial slopes and shallow medial tibial depths.

Methods:

Twenty four subjects with multiple ACL injuries were selected for this study. Subjects were excluded from analysis if they exhibited deep intra-articular knee infection, an untreated LCL or PCL injury, a thermal shrinkage of the graft tissue, a direct contact to the knee, or poor graft position. The resulting population was reduced to 17 subjects. All subjects underwent a revision anterior cruciate ligament surgery with bone-tendon-bone allograft or with bone-patellar tendon-bone autograft from the contralateral knee. Each subject underwent MRI and 3-D CT imaging. All relevant tibial plateau geometries were measured. Odds ratio (OR) was calculated based on the measured values of MTS, LTS, and MTD for the multiply injured subjects in comparison to uninjured controls and subjects with only a single injury. A previously developed logistic regression model was applied to the current population for prediction of ORs for both female and male populations.

Results:

In males, the subjects with multiple ACL injuries had an OR of 18.98 compared to the average male control subject and an OR of 2.99 compared to male subjects with only one ACL injury. In females, the subjects with multiple ACL injuries had an OR of 6.31 compared to the average female control subject and an OR of 1.96 compared to female subjects with only one ACL injury. When the multiply injured subjects' tibial geometry data were superimposed on uninjured and singly subjects (from our previous studies), majority of the multiply injured subjects were positioned in region IV of the diagram indicating a steep LTS and shallow MTD combination, Figure 1.
Figure 1. Location of Multiply-Injured (red), Single Injury (yellow), and Control (green) Subjects on the Injury Plane LTS-MTD. The dark horizontal and vertical lines are the normalized medians of the MTD and LTS values of the uninjured population; they divide the graph into four regions.

Conclusions:

In both male and female populations, a combination of steep posterior LTS slope and shallow MTD results in a critical and adverse anatomical state for ACL injury. The tibial geometry parameters including MTS, LTS, and MTD are robust risk factors for ACL injury.

References:


Relevant disclosure for all authors
Nothing to disclose
Objectives:
Failure of ACL reconstruction presents a problem for patients and physicians alike. Early failure is often attributed to tunnel malposition or failure of the graft to incorporate while later failures are usually due to another injury. Our goal was to examine specimens from failed ACL reconstructions and determine if a bacterial biofilm was present. We hypothesized that if present, bacterial biofilms could lead to a subclinical infection potentially inhibiting graft incorporation or weakening the fibers of the ACL reconstruction.

Methods:
Specimens were collected from 10 failed ACL reconstructions, and 5 native ACL’s. Our study population consisted of 8 females and 7 males with an average age of 33.5 years. All patients had a pre-operative CBC, ESR, CRP and radiographs to assess for tunnel malposition or widening. Intra-operatively, cultures were obtained of the knee joint, and two samples of the failed ACL were collected. One sample was sent to pathology for gram stain and culture and the other sample was sent to be analyzed using IBIS technology (Ibis T-5000- IBIS Inc. Carlsbad, CA). The 5 native ACL failures were collected to serve as controls. All labs were blinded from any clinical results. If a biofilm was found to be present, fluorescence in situ hybridization (FISH) was performed to confirm the presence of live bacteria.

Results:
For the 10 patients who underwent revision ACL reconstruction, the index reconstruction was performed with hamstring autograft 7/10 times, bone patellar bone autograft 2/10 times, and patellar tendon allograft 1/10 times. The average time to the revision surgery was 6.7 years. A review of the pre-operative radiographs revealed no evidence of tunnel malposition or widening. Pre-operative labs were all within normal limits. All cultures and pathology samples were negative for bacterial growth. 6/10 of the specimens analyzed via IBIS technology showed positive results. All 5 of the control specimens were negative when analyzed utilizing the IBIS technology. Bacteria present included Staph. epidermidis, Strept. pneumonia, Staph. aureus, B. pertussis, P. acnes, and Methicillin-Resistant Staph.epidermidis. All positive samples had FISH stains that were studied using a confocal scanning microscope. 2 of the 3 of the patients who had early graft failure (<15 months) had biofilms present.

Conclusions:
Our study confirms the presence of bacterial biofilms in failed ACL reconstructions. Whether the presence of a biofilm contributes to graft failure is something that warrants further investigation.

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 31

Abstract Title: Assessing Tunnel and Graft Position between Failed and Successful ACL Reconstructions: Correlation of Postoperative Radiographic Measurements

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Objectives:
There are several postoperative radiographic measurements described that have been used to analyze the position of ACL graft and tunnels. It would be very valuable to know which ones if any could be used to predict the failure of the operation. This study is designed to determine if there is a difference in any of those measurements between patients with failed and successful ACL reconstruction.

Methods:
One hundred and seventy-seven patients were identified by a computerized relational database (Access 2000, Microsoft Inc, Redmond, Wash), with postoperative AP and lateral radiographs between 2005 and 2010. Failure was defined as a + Lachman, + Pivot Shift, and 5mm difference or more on the KT 1000 arthrometer measurement. The radiographs were all digital and measured utilizing our PACS system. The following angles were analyzed; Lateral to Medial Distance of the Tibial Tunnel, Coronal ACL Angle, ACL Inclination Angle, Lateral Tibial Tunnel Angle, AP Femoral Tunnel Angle, AP Distance of the Tibial Tunnel and AP Tibial Angle.

Results:
There were 17 (9.6%) of the 177 ACL reconstructions defined as failures. We tested for differences in mean response of the seven different angles between cases that were failures and non-failures. We failed to find significant differences between the two groups. The p values for the differences for the radiographic measurements comparing failure and non-failure were: Lateral to Medial Distance of the Tibial Tunnel (p=.632), Coronal ACL Angle (p=.967), Tibial Tunnel Angle Lateral (p=.949), Femoral Tunnel Angle AP (p=.544), AP Distance of the Tibial Tunnel (p=.493), Tibial Tunnel Angle AP (p=.762), and ACL Inclination Angle (p=.589).

Conclusions:
Our study demonstrated that there is no significant difference in the commonly used postoperative radiographic measurements between patients with failed and successful ACL reconstructions using a transtibial technique. We failed to find evidence that those postoperative measurements can be used as a predicator of success of the surgery. Based on our results, the anatomic
characteristics of the tunnels and the graft that were measured did not appear to contribute to the failure in this patient population.

Relevant disclosure for all authors
Nothing to disclose
AOSSM 2012 Annual Meeting

Abstract Id: Poster 32
Abstract Title: Evaluation of the Femoral Tunnel Characteristics Using Either Flexible or Straight Reamers Though a Medial Portal During ACL Reconstruction

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Objectives:
This study evaluates the femoral tunnel characteristics when drilled either with rigid- or flexible drills through a medial portal (MP) during ACL reconstruction. Characteristics were assessed in cadavers using both direct vernier caliper and 3D-CT scan measurements.

Hypothesis: Flexible drills allow obtaining more horizontal tunnel, more circular tunnel aperture, and shorter intra bony length of the guide wire.

Methods: Under arthroscopy, 10mm femoral sockets were drilled through a MP portal either with straight or flexible drills in the ACL footprint center of 9 pairs of human fresh knee cadavers. Distances of the pin exit to the lateral structures were measured. Direct measurements on the specimens and 3D CT were used to measure socket aperture diameters (D & d), socket orientation and, distal femoral bone morphometry: bicondylar diameter, lateral femoral condyle width, intercondylar notch width and, divergence angle of the condyles. Statistical analysis evaluated the influence of gender on the results.

Results: The mean distance to the LCL femoral attachment was 30.5mm for straight pins (SP) and 17.3mm for flexible pins (FP) (p<0.0001). The mean distance to the popliteus tendon attachment was 40.7mm for SP and 27.2mm for FP (p<0.0003). The mean distance to the peroneal nerve was always superior to 40mm for both pins. There was no significant difference in the bone morphometry parameters for both groups either with direct measurements or 3D-CT. D was significantly larger for rigid- compared to flexible drills (p<0.001). Flexible drills lead to a more circular aperture. The surface area of the aperture was significantly larger for rigid drills (p<0.001). There was no significant difference for d between each drill’s types. The mean interosseous length was not significantly different with FP or SP. In the coronal plane, the socket was more horizontal for flexible drills (p< 0.001). There was no gender influence on the socket characteristics; only the drill’s type was significant.

Conclusions: The results are in accordance with the hypothesis: drilling the femoral socket with flexible drills through a MP leads to a more circular aperture than with rigid drills with a significantly lower surface area. The drilled socket is more horizontal, but the interosseous lengths of the guide wires are not significantly different. Tunnels are always long enough to allow suspensory fixation. The intra articular aperture of the socket is more circular than with straight drilling which potentially provides a better graft stability at the aperture.

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Relevant disclosure for all authors

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Objectives:
A number of orthopaedic procedures require secure healing of bone to tendon to obtain a successful outcome, including ACL reconstruction using a soft-tissue graft. Healing of a tendon graft within a bone tunnel requires the ingrowth of new bone at the bone-tendon interface. The purpose of this study was to determine the effect of magnitude, timing, and duration of mechanical stimulus on biomechanical strength of tendon-bone interface, bone formation, and osteoclastic activity.

Methods:
After obtaining IACUC approval, 101 skeletally mature male Sprague-Dawley rats underwent surgical placement of an Achilles tendon autograft within a femoral tunnel. Prior to surgery, each animal was assigned to one of ten loading groups: 1) immobilized 2) immediate 3N 3) immediate 6N 4) delayed 3N 5) delayed 6N these were loaded for 3 weeks. Groups 6-10 were the same; however loaded for 6 weeks. The daily loading regimen included application of 50 cycles of uniaxial load at 0.7 mm/sec. Ten animals in each experimental group were assigned to biomechanical testing. Ultimate load-to-failure tests of the tendon-bone construct were evaluated. Trabecular architecture, bone formation, and bone remodeling along the tendon-bone interface were assessed with use of micro-CT (4-5 specimens per group). Osteoclast activity was evaluated using tartarate-resistant acid phosphatase (TRAP) at the bone-tendon interface within the femoral tunnel.

Results:
Immediate 3N loading resulted in an ultimate load (16.8±5.8N) that was greater (p<0.05) than that of immobilization, delayed 3N, immediate 6N, and delayed 6N-loading groups at 3 weeks (Figure 1). Total bone volume at the proximal aspect of the tunnel was higher in the immediate 3N group (7.0±0.1mm³) when compared to the immobilized group (6.7±0.1mm³) at 3 weeks (p<0.05). Our histological data demonstrated greater osteoclastic activity at the proximal aspect of the tunnel from 2.2±2.4 cells per HPF in the immobilized group to 15.1±14.1 cells per HPF (p<0.05) in the immediate 6N group at 3 weeks.
Conclusions:

Immediate application of low magnitude (3N) cyclic axial load in a tendon-bone rat model resulted in superior biomechanical parameters of tendon-bone healing as compared to the other groups at 3 weeks. These results indicate that the healing of the tendon-bone interface is sensitive to the magnitude and time of onset of loading during the early postoperative period, and loading specifically affects bone formation and osteoclastic activity along the bone-tendon interface.

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 34
Abstract Title: Serial MRI of the Anterior Cruciate Ligament (ACL) Reconstructed Knee - Longitudinal Assessment of ACL Grafts, Donor Sites, and the Lateral Compartment over 2 years with Clinical Correlation

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Objectives:
Longitudinal assessment of the anterior cruciate ligament (ACL) reconstructed knee in the literature is limited. This study attempts to investigate MRI changes in the ACL graft, bone-patellar tendon-bone (BTB) donor site, and the lateral femorotibial compartment over the first 2 postoperative years and to compare those data with clinical outcomes scales and KT-1000.

Methods:
A prospective series of patients that underwent ACL reconstruction (ACLR) using bioabsorbable screw fixation on both the femoral and tibial sides was conducted. Surgical technique and postoperative rehabilitation were standardized. MRI was performed on the day of surgery, as well as 6, 12, 24, 52 and 104 weeks postoperatively. MRI data reviewed included graft and donor site signal intensity, ACL tunnel/donor site bone incorporation, and lateral compartment cartilage and subchondral bone changes. Lysholm and KT-1000 scores were also reviewed. Kruskal Wallis and bivariate correlation non-parametric analyses were performed (p=0.05).

Results:
19 knees (18 patients) were included. Average Lysholm scores improved from 62.2 to 85.8. Side-to-side KT-1000 differences at final follow-up were 1.0mm. Increasing graft signal intensity throughout the graft, synovitis, and bone tunnel incorporation were noted over time (p<0.05). No significant changes were noted in the lateral compartment subchondral bone or cartilage. BTB donor site signal intensity significantly changed over time (first increasing, then decreasing) and BTB donor site bone incorporation significantly increased over time. Lysholm scores were associated with graft signal intensity at 12 months (r= 0.544, p=0.036), bone tunnel incorporation at 24 weeks (r=0.759, p=0.003), and BTB donor site signal intensity at 24 weeks (r= -0.653, p=0.021). Side-to-side KT-1000 differences were associated with bone tunnel incorporation at 12 weeks (r= -0.538, p=0.047).

Conclusions: There is an increase in ACL graft signal intensity and bone incorporation of the ACL graft in the bone tunnel over time following ACLR. There is also a progressive increase in synovitis. There were no significant degenerative changes in the lateral femorotibial articular surface. In the early postoperative period, graft signal and bone tunnel incorporation may be indicators of healing and may positively affect clinical outcomes whereas increased anterior tibial translation on exam may be indicative of slower
bone tunnel incorporation. Further study is needed to better understand the mechanisms of ACLR healing over time.

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Relevant disclosure for all authors
Nothing to disclose
Abstract Title: Viscosupplementation Improves Short-term Proteoglycan Content in Superficial Knee Cartilage by T1 rho MRI: Implications for Disease Modifying Capacity

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Objectives:
Viscosupplementation (VS) increases the viscoelastic properties of synovial fluid and may modify articular cartilage disease [1]. Efforts to directly study human cartilage have been limited by biopsy morbidity [2]. T1ρ MRI is a novel way of imaging cartilage and correlates with proteoglycan changes in OA cartilage [3]. We hypothesize: (1) T1ρ MRI will demonstrate an improvement in proteoglycan content of knee articular cartilage at 6 weeks and 3 months following VS, and (2) this improvement will reflect functional outcome scores.

Methods:
With IRB approval, ten subjects (mean age 56, Kellgren-Lawrence Grades 1 or 2) without prior VS or surgery were scanned at baseline, 6-, and 12-weeks post-VS using Hylan G-F 20. MRI acquisition parameters and analysis methods have been described previously [4]. Volumetric T1ρ means were calculated by depth (superficial, middle, deep) as well as by region (medial and lateral (a) patella, (b) femoral condyles, and (c) tibial plateau). Data are reported as the mean percent change in T1ρ. Subjects completed VAS, WOMAC, and IKDC subjective scores at each visit. All analyses were performed using one-tailed paired t-tests (significance if p<0.05).

Results:
Mean T1ρ trended towards improvement at 6 weeks (Table 1A), suggesting an increase in proteoglycan content and changes in other matrix components within articular cartilage. Statistical significance was found only in the superficial patella. In contradistinction, the deep lateral tibia had significantly worse mean T1ρ. At 6 weeks, there was improvement in VAS (5.9 to 3.9, p<0.01), IKDC-9 (55.3 to 63.7, p=0.03), and WOMAC (43.9 to 32.8, p=0.03). No significant changes in mean T1ρ or functional scores occurred between 6 and 12 weeks (Table 1B). Comparing 12 week data to baseline (Table 1C), no significant improvement in T1ρ within the patella remained, but significant worsening of T1ρ in the middle and deep tibia was seen. Functional scores improved for the VAS (4.0, p=0.02), IKDC-9 (67.8, p=0.04), and WOMAC (30.0, p=0.04).

Figure: Table 1:
Percent change in mean T1ρ by region. Negative values indicate a decrease in T1ρ value, suggesting an increase in proteoglycan content. Asterisks indicate statistical significance (p < 0.05). Image: representative patella T1ρ maps (A) before VS and (B) 6 weeks after VS showing a substantial decrease of T1ρ value. Trochlear T1ρ map not shown. (Side bar, T1ρ scale from 0-60 ms.)

Conclusions:

T1ρ MRI is a feasible non-invasive method of studying human articular cartilage changes. These data suggest that VS has a positive effect on knee articular cartilage early after VS, but then reverses by 12 weeks. Conversely, subjects’ functional scores continued to improve at 12 weeks. The reversal in T1ρ may reflect degeneration from increased activity due to symptom relief.

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Relevant disclosure for all authors
Nothing to disclose
AOSSM 2012 Annual Meeting

Abstract Id: Poster 36
Abstract Title: Prospective Comparison of Intraarticular Morphine and Bupivacaine for Postoperative Pain Management in Knee Arthroscopy

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Objectives:
Recent literature indicates that intra-articular administration of bupivacaine may harm hyaline cartilage. However, surgeons still routinely inject it into the knee perioperatively for pain control. Morphine has been injected into the knee with good pain relief. Studies comparing morphine to bupivacaine have been confounded with methodological errors including variable dosing and volumes of medications, variable anesthetic protocols, tourniquet use, postoperative drain use, variety of procedures performed, use of epinephrine, and poor study design with lack of statistical power. This study removes these confounding variables to compare these two medications. The hypothesis is that morphine will be as effective as bupivacaine with no worsening of side effect profile.

Methods:
82 patients who underwent partial meniscectomy or abrasion chondroplasty were prospectively randomized to receive morphine 10 mg in a 10 cc volume of arthroscopy fluid (LR) or 10 cc of .5% bupivacaine immediately postoperatively. VAS scores and side effect profile were recorded in the PACU, transitional carer unit, and then every 4 hours post operatively until 24 hours. Protocol was followed for anesthesia administered pre and intraoperatively and postop pain medication rescue protocol was followed with recording of all oral pain medication intake.

Results:
The 47 patients in the morphine group and 35 patients in the bupivacaine group did not differ by gender or type of surgery. All patients had PACU data, but only 64 had data for the full 24 hours. VAS scores in the PACU decreased from 3.4 to on admission to 2.4 on discharge for the morphine group and from 2.6 to 2.4 for the bupivacaine group with no statistical difference (p>.217 for all time points). Medication use was the same for both groups in the hospital at between 62% and 78% with no statistical difference. VAS scores decreased from 3.0 to 1.5 between 4 and 24 hours for the morphine group and from 2.8 to 1.8 for the bupivacaine group with no statistical difference (p>.376 for all time points). Medication use decreased between 4 and 24 hours for both groups from 71.7% at 4 hours to 52.9% at 24 hours with no statistical difference at all time points. Only 5 patients total in both groups had side effects.

Conclusions:
10 mg of intraarticular morphine is as effective as 10 cc of .5% bupivacaine for postoperative pain control for partial meniscectomy and abrasion chondroplasty of the knee. It does not increase side effects and it circumvents the issue of chondral toxicity of bupivacaine.

References:

Relevant disclosure for all authors
Nothing to disclose
Objectives:

Articular cartilage defects in the knee present a challenging problem for orthopedic surgeons. Several cartilage restoration procedures have been developed and the indications for these procedures are evolving. Minimal data exists on the practice patterns of orthopedic surgeons treating this problem or demographics of patients undergoing these procedures. The purpose of this study was to evaluate trends in surgical treatment of articular cartilage defects of the knee with regards to time, gender, age, and region in the United States.

Methods:

The CPT codes of patients undergoing articular cartilage procedures of the knee were searched using the PearlDiver Patient Record Database, a national database of insurance billing records that includes over 11 million orthopedic patients. The CPT codes for chondroplasty, microfracture, osteoarticular transfer system (OATS) open and arthroscopic, osteochondral allograft open and arthroscopic, and autologous chondrocyte implantation (ACI) were searched. Each code was then searched in combination with high tibial osteotomy. The type of procedure, date, gender, and region of the country was identified for each patient.

Results:

A total of 163,448 articular procedures of the knee were identified. An increase in procedures was observed from 2004 (19,772) to 2009 (29,432). All procedures were performed more commonly in males (P<0.001). This gender difference was smallest in patients undergoing chondroplasty (51% male, 49% female) and greatest for open osteochondral allograft (61% male and 39% female). The total number of procedures identified in the Northeast region was decreased compared to the region’s patient representation in the database (9% versus 13%, respectively) (P<0.001). Chondroplasty and microfracture were most commonly performed in patients aged 40-59 while all other procedures were performed most frequently in patients aged less than 40 years old (P<0.001). High tibial osteotomy was performed less than one percent of the time in combination with all procedures except when in conjunction with autologous chondrocyte implantation (6.3%) and open osteochondral allograft (4.5%).

Conclusions:
This study demonstrates that there has been an overall increase in number of articular cartilage procedures of the knee from 2004 to 2009. Chondroplasty and microfracture were more likely to be performed in middle-aged patients whereas all other procedures were performed in younger patients. High tibial osteotomy was performed much more commonly in conjunction with ACI and open osteochondral allograft compared to all other procedures.

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 38
Abstract Title: Lateral Meniscus Tears in the High-Level Athlete

Authors
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Objectives:
Isolated meniscal tears are uncommon in the young, athletic population. The aim of this study is to examine the prevalence, type, and clinical evaluation of meniscal tears in this population.

Methods:
The senior author’s operative log was retrospectively reviewed from 2004-2010 for patients who underwent surgery for meniscal tear. Data was evaluated based on: the total number of meniscus tears, medial versus lateral tears, medial versus lateral less than age 30 and age 20, number of lateral radial tears, and whether or not the radial tear was reported on the preoperative MRI. Patients under age 30 with isolated lateral tears were identified and clinical data, imaging, and operative reports were reviewed.

Results:
925 meniscal tears were treated operatively during the time period 2004-2010. Of these 731 (79%) were medial meniscus tears and 194 (21%) were lateral meniscus tears. There were 163 meniscal tears in patients 30 years or younger. 107 (66%) were isolated lateral tears and 56 (34%) were isolated medial tears. A total of 30 lateral radial meniscal tears were identified arthroscopically in patients 30 years or younger. All included radial tears in the middle third of the meniscus, some with horizontal cleavage extension into the anterior third. All tears were found in cutting athletes, the majority high-level. These patients all had positive exam findings, as well as correlating histories. Of these 30 patients, 21 preoperative MRI reports were available for review and only 8/21 correctly identified the lateral radial tear.

Conclusions:
Isolated lateral meniscal tears are more common than medial tears in the high level cutting athlete under the age of 30. The morphology of the tears in this population is a radial tear in the middle third of the meniscus often with extension into the anterior third. These tears are frequently missed on routine MRI.
References:

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 39

Abstract Title: Normative Values for a Young Athletic Population on the KOOS and WOMAC: History of Knee Ligament Injury is Associated with Lower Scores

Authors
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Objectives:
The use of patient reported outcome measures to assess clinical outcomes following injury and surgery have become common in treating young athletes with orthopaedic injuries; however, normative data for these measures is limited and often includes a wide range of ages and activity levels. The purpose of this study was to provide normative data for the KOOS and WOMAC in a young and athletic population, and to compare scores between subjects with a history of knee ligament injury and those with no prior history.

Methods:
We administered the KOOS and WOMAC to 1177 college freshman entering a US Service Academy in June 2011. All subjects were healthy and had been medically screened to meet the physical induction standards for military service. The KOOS and WOMAC were administered within the first week of arriving at the Academy. A prior history of knee ligament injury was documented at the time of administration. We calculated mean scale scores along with standard deviations for the KOOS and WOMAC among those with no prior history of knee ligament injury. We also compared mean scale scores for those with a history of knee ligament injury to those with no prior history using independent t-tests. Similarly, we compared the results for the current study with previously published norms.

Results:
Among the 1177 subjects 971 were males (18.8, ±0.9 years) and 206 were females (18.7, ±0.8 years). Among the males, 139 reported a prior history of knee ligament injury and 33 females reported a similar history. For those with no history of injury, the mean scale score for the five KOOS sub-scales by sex were: Pain (M=97.47±6.27; F=95.90±7.98), Symptoms (M=93.96±7.98; F=92.90±8.99), Activities of Daily Living (M=98.86±3.83; F=97.92±4.80), Sports/Recreation Function (M=94.89±10.14; F=92.74±12.94) and Knee Related QOL (M=92.62±11.20; F=90.51±13.84). All KOOS sub-scale scores and the WOMAC Stiffness and Function sub-scales were significantly lower (p<0.05) for males who reported a history of knee ligament injury. Only Knee Related QOL was significantly lower (p<0.05) among females with a history of prior knee ligament injury. When values for the KOOS were compared to previously published norms, scores were significantly higher (p<0.05) for males only.

Conclusions:
Norms for the KOOS among males in this young and physically active population were significantly higher than those previously published. Despite meeting the medical standards for military service, subjects with a history of knee ligament injury had significantly lower KOOS and WOMAC scores upon entry to military service.

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 40

Abstract Title: First Time Patellofemoral Dislocation in Pediatric and Adolescent Patients

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Objectives:
The goal of this study was to describe the demographics of pediatric and adolescent patients with a first time patellofemoral dislocation, and to determine predictors of recurrent instability.

Methods:
This single institution IRB approved (#11-003720) retrospective study from January 1998 to December 2010 generated 2039 patients after searching the Mayo Medical Index database. Inclusion criteria were: (1) age 18 years or younger (2) no prior history of patellofemoral subluxation or dislocation of affected knee (3) x-rays within four weeks of the initial instability episode (4) a dislocated patella requiring reduction, or convincing history/findings suggestive of acute patellar dislocation (a subluxation or dislocation event associated with full giving away, effusion/hemarthrosis, tenderness along the medial parapatellar structures and apprehension with lateral patellar translation).

Exclusion criteria were associated ACL, PCL, or LCL injury. Patients with chronic or recurrent instability were excluded. Those who did not have radiographs within the appropriate time frame were also excluded. X-rays were evaluated for trochlear dysplasia (Dejour classification) and patella alta (Caton-Deschamps index and Insall-Salvati index); and were graded for skeletal maturity of the distal femoral and proximal tibial physes (open vs. closing vs. closed).

Results:
236 patients, 127 males (53.8%) and 109 females (46.2%) with an average age of 14.9 years (range 9-18), met the above criteria. 98 patients (41.5%) had trochlear dysplasia, 109 (46.2%) had patella alta and 49 (20.7%) had both. 121 patients had open (31) or closing (90) physes, and 115 patients had completely closed physes. 28 patients (11.8%) underwent early surgery for the treatment of osteochondral fractures. All others were initially treated nonoperatively. 86 patients (36.4%) had recurrent patellofemoral instability, and 43 (50%) of these required subsequent surgical treatment. Recurrent instability events were associated with an open/closing physis p=0.0005. Age, gender, patella alta and trochlear dysplasia were not statistically associated with recurrent instability.

Conclusions:
First time patellofemoral dislocation in patients aged 18 years or younger had a nearly equal distribution between males and females. Conservative treatment for first time patellofemoral dislocation yields a 64% success rate. However, half of patients with recurrent instability require surgical intervention to gain stability. Immature physes were associated with recurrent instability events.
References:


Relevant disclosure for all authors
Nothing to disclose
Abstract Title: Platelet-Rich Plasma as a Treatment For Patellar Tendinopathy: A Double-Blind Randomized Controlled Trial

Authors
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Objectives: Previous research has shown improvement in symptoms of patellar tendinopathy after treatment with platelet-rich plasma (PRP) injections. A randomized controlled trial (RCT) has also shown improvement in elbow tendinopathy after PRP. However, there have been no RCTs comparing treatment with PRP to dry needling alone in patellar tendinopathy.

Methods: 10 patients with patellar tendinopathy on clinical exam and MRI imaging, and who had failed greater than 6 weeks of physical therapy, were enrolled in a double-blind RCT comparing dry needling (DN; n=6) to dry needling with PRP (PRP; n=4). Both groups also completed a standardized program of eccentric exercises. Participants completed the VAS pain scale, VISA score for patellar tendinopathy, Tegner activity scale, Lysholm knee scale, and SF-12 questionnaire before and at 3, 6, 9 and 12 weeks after the intervention. Patients who failed DN at 12 weeks were allowed to cross over into a separate unblinded PRP treatment arm (n=2). Results were analyzed using two-tailed paired and unpaired T-tests.

Results: Within the PRP group, we observed clinically and statistically significant improvements at 12 weeks by a mean of 37 points for VISA (p=0.04), 3.5 for VAS (p=0.03), and 42 for Lysholm (p=0.02). We also found clinically significant improvements of 3.0 points for Tegner (p=0.28) within the PRP group, and 29 points for Lysholm (p>0.05) within the DN group. SF-12 scores improved within the PRP group and worsened within the DN group, but these results were not significant. Between-groups comparisons showed a clinically and statistically significant 37-point greater improvement in VISA scores for PRP relative to DN treatment (p=0.04), and a clinically significant greater improvement by 2.3 points on VAS (p=0.17), 3.3 points on Tegner (p=0.13), and 13 points on Lysholm (p=0.42). Within the cross-over arm, patients’ VISA scores initially improved by only 1.7 points after DN, but improved by an additional 14.0 points after receiving PRP (p=0.18).

Figure:
Our results indicate that a therapeutic regimen of eccentric exercise and ultrasound-guided PRP injection with dry needling leads to clinically significant improvement in activity (Tegner), function and stability (Lysholm), pain (VAS), and symptoms (VISA) at 12 weeks. Furthermore, we have shown that this regimen is both clinically and statistically significantly better than exercises and dry needling alone based on VISA score of patellar tendinopathy symptoms. We have also shown preliminary data to suggest that PRP may still be effective even in patients who have failed dry needling alone.

References:


Relevant disclosure for all authors
Nothing to disclose
AOSSM 2012 Annual Meeting

Abstract Id: Poster 42

Abstract Title: Anatomic Transtibial ACL Reconstruction: Effect of Tunnel Placement, Size and Reamer Characteristics

Authors
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Objectives: Dependence of femoral tunnel positioning on tibial tunnel orientation in ACL reconstruction (ACLR) using a transtibial technique has been well established. The purpose of this study is to identify: 1) the impact of tibial reamer size and placement on the creation of anatomic femoral tunnels via a transtibial approach and 2) the reamer design that best preserves tibial tunnel integrity while maintaining anatomic femoral tunnel placement during transtibial drilling.

Methods: 8 cadaveric knee specimens were fixed at 90° flexion and neutral rotation. After removing the anterior capsule and patella, native joint anatomy was recorded with the MicroScribe™ digitizer. Tibial and femoral tunnels were drilled in a transtibial ACLR manner using the optimal tibial starting point described by Piasecki et al. Tibial tunnels were drilled progressively with 6, 7, 8, 9, 10, 11 mm reamers. After each reaming, a beath pin was placed in the posterior aspect of the tibial tunnel and digitized. After drilling the 11mm tibial tunnel, femoral tunnels were drilled with a 10mm half fluted reamer, followed by a 10mm full reamer. Each tibial tunnel’s location and geometry relative to the native anatomy were digitized.

Results: In 6 knees, the center of the femoral ACL footprint was first reached by the 9mm tibial tunnel; in 2 knees, this was reached with an 8mm tunnel. The 6 and 7mm tibial tunnels did not allow for anatomic positioning in any specimen, with errors of 4.75±1.95mm and 2.94±0.54mm, respectively. After use of 11mm tibial reamer, tibial tunnel length was 32.07 ± 2.62mm. Femoral reaming with a 10mm full reamer posteriorized the articular aperture of the tibial tunnel 5.44 ± 1.84mm, resulting in a 59.62 ± 28.1% expansion of tunnel area at the posterior surface, while the half fluted reamer preserved the aperture of the tibial tunnel. The center of the native ACL tibial footprint was 2.0 ± 0.49mm anterior to the posterior aspect of the lateral meniscus’ anterior horn.

Figure:
Conclusions: Use of the transtibial ACLR technique may result in nonanatomic femoral tunnel placement with tibial tunnels smaller than 8 or 9mm. Creating at least a 9 mm tibial tunnel, however, allowed for anatomic femoral placement. Half fluted reamers may be more advantageous for femoral tunnel reaming, with less posterior tibial tunnel expansion than full reamers. The center of the tibial attachment site was found to be anterior to the posterior aspect of the lateral meniscus’ anterior horn, which has been traditionally described as the anatomic center.

Relevant disclosure for all authors
Nothing to disclose
Abstract Title: Gait Deviations Occur at 1 Year After ACL Reconstruction Regardless of Return to Sport Status at 6 Months

Authors
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Objectives: After ACL reconstruction there is strong motivation to return to playing sports as quickly as possible by both the athlete and their medical care providers. Several studies have used return to sport (RTS) criteria to determine when to allow athletic play. These RTS measures objectively evaluate functional limb symmetry. Previous studies have found that half of athletes are able to pass these RTS criteria at or before 6 months after ACL reconstruction. However, previous biomechanical studies have found that gait deviations in these individuals can persist for up to 1 year. Therefore the purpose of this study was to evaluate gait biomechanics in a specific cohort of ACL non-copers 1 year after surgery and retrospectively compare individuals that passed RTS criteria at or before 6 months after surgery to those that failed.

Methods: Thirty-nine athletes included in this study participated regularly (>50hrs/year) in cutting, jumping and pivoting activities, and sustained an isolated, unilateral ACL rupture. All subjects underwent reconstruction by the same surgeon and received standardized post-operative physical therapy. Clinical data were measured at 3, 6 and 12 months after surgery using the RTS criteria. In order to pass our RTS criteria subjects must demonstrate greater than 90% on performance-based and self-report measures. In this cohort, nineteen subjects passed RTS criteria (PASS) at or before 6 months after surgery and 20 subjects did not (FAIL). Biomechanical variables were captured at 1 year after surgery and knee flexion angle at peak knee flexion during stance phase of gait and knee excursion measures were evaluated for these subjects.

Results: For knee flexion angle measures, a main effect of limb was found (p=0.009, involved mean 22.8°, 95%CI 20.0,25.7; uninvolved 25.5°, CI 23.4,27.5), however, no effect of group (p=0.13), and no interaction between limbs and groups was found (p=0.429). For knee excursion measures there was a main effect of limb (p<0.001, involved 14.8°, CI 12.9,16.6; uninvolved 17.3°, CI 15.9,18.8) and again there was no effect of group (p=0.428) and no interaction was found (p=0.728).

Conclusions: One year after ACL reconstruction, non-copers demonstrate biomechanical limb asymmetries regardless if they passed RTS criteria. Limb asymmetries during gait may potentially predispose a higher risk for re-injury during participation in athletic activities. It has been suggested that persistent gait asymmetries may have detrimental long term effects on the knee joint and has the potential to contribute to joint degeneration.

Acknowledgements:

Relevant disclosure for all authors
Nothing to disclose
AOSSM 2012 Annual Meeting

Abstract Id: Poster 44
Abstract Title: Biomechanical Analysis of Femoral Suspensory Fixation Devices: A Practical Comparison

Authors
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Objectives:
The objectives of this study were to test if there was a significant difference in displacement during cyclic loading or failure load and failure displacement during single load to failure between the Stryker VersiTomic G-Lok, Smith & Nephew Endobutton, Biomet ToggleLoc, or Arthrex Retrobutton.

Methods:
Forty fresh frozen porcine femurs and flexor digitorum profundus tendons (for grafts) were obtained. The grafts were sized to 9.0±0.5mm, minimum 140mm in length to create 70mm long double stranded grafts. The grafts were then placed in the femur at the 2 o’clock (left) or 10 o’clock (right) position using a Stryker G-Lok, Smith & Nephew Endobutton, Biomet ToggleLoc, or Arthrex Retrobutton with product specific technique described in company literature. All suspensory devices had 20mm loops. Suspensory fixation was placed through the femoral tunnel onto the lateral cortex, and the button was toggled in order to place maximum force perpendicular to the bone surface. The graft-femur complex was secured to a servohydraulic test machine with a cryo-clamp and custom built fixture. The actuator axis was in line with the femoral tunnel to maximize tension of the suspensory fixation and prevent load sharing by graft-tunnel interference. The graft was cyclically loaded from 50 to 250 N for 1000 cycles at 1 Hz then loaded to failure at 20mm/min. Actuator load and displacement were recorded. Failure load was defined as the first drop in load. Data were analyzed with one-way ANOVA and Tukey HSD with p<0.05 considered statistically significant.

Results:
There were no significant differences in cyclic displacement between any of the groups (p=0.43). The Endobutton exhibited a significantly higher failure load than the Retrobutton (p=0.04) but there were no other significant differences in failure load. The Endobutton had significantly greater failure displacement than the G-Lok (p=0.005), Toggleloc (p=0.005), and the Retrobutton (p=0.003). There were no other significant differences in failure displacement.
Table 1 Biomechanical Test Results

<table>
<thead>
<tr>
<th>Device</th>
<th>Displacement @ 1,000 cycles (mm)</th>
<th>Failure Load (N)</th>
<th>Failure Displacement (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>G-Lok</td>
<td>6.64 (1.97)</td>
<td>613.6 (176.0)</td>
<td>9.78 (3.75)</td>
</tr>
<tr>
<td>Endobutton</td>
<td>7.21 (1.07)</td>
<td>716.7 (128.2)</td>
<td>14.67 (2.89)</td>
</tr>
<tr>
<td>Toggleloc</td>
<td>6.62 (0.88)</td>
<td>559.7 (101.3)</td>
<td>9.77 (1.65)</td>
</tr>
<tr>
<td>Retrobutton</td>
<td>6.13 (1.55)</td>
<td>525.5 (160.2)</td>
<td>9.36 (2.98)</td>
</tr>
</tbody>
</table>

Conclusions:

Suspensory femoral soft tissue fixation devices are biomechanically different with respect to failure load and failure displacement. However, there was no significant difference in displacement after cyclic loading. Therefore, all four fixation devices should withstand the forces associated with typical daily activities [1,2], without failure, during the time it takes for the graft to incorporate into the femoral tunnel.

References:

2 Kvist et al. AJSM 2001;29:72-82.

Relevant disclosure for all authors
Financial compensation was received for this research from the following organization(s): Stryker Joint Preservation
Abstract Id: Poster 45

Abstract Title: ACL Reconstruction Femoral Tunnel Characteristics Using an Accessory Medial Portal Versus Traditional Transtibial Drilling

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Objectives:
Previous studies have evaluated femoral tunnel characteristics after independent femoral tunnel drilling through an anteromedial portal. The tunnel characteristics may have an effect on the strain placed on the graft, the graft bending angle, whether enough graft can be placed into the tunnel, and ultimately the ability of the body to fully heal the graft. We employ a third, or accessory medial, portal in order to visualize the femoral footprint from the anteromedial portal, but the femoral tunnel characteristics are unknown using this technique. We compared the femoral tunnels created using an accessory medial portal and a traditional transtibial technique; emphasizing anatomic reconstruction in both.

Methods:
Ten matched pairs of cadaver knees were randomized such that within each pair one knee underwent arthroscopic transtibial (TT) drilling and the other underwent drilling through an accessory medial portal (AM). After the procedures, all knees underwent CT scanning (Siemens SOMATOM Definition) at 80 keV. All knees were evaluated using the Carestream PACS client for tunnel aperture area, shape as described by the length of the long and short axes, location of the tunnel relative to the inferior and anterior aspects of the articular surface with the knee in 90 degrees of flexion, tunnel angle in the coronal and axial planes, tunnel length, and tunnel volume. Fig. 1

Figure: Figure 1
Results:

The femoral tunnel aperture area was 35.9 +/- 13.6 mm² for AM and 42.4 +/- 6.9 mm² for TT (p=0.2). The femoral tunnel aperture long axis was 8.5 +/- 1.1 mm for AM and 9.2 +/- 1.3 mm for TT (p=0.2). The femoral tunnel aperture short axis was 7.6 +/- 0.7 mm for AM and 7.7 +/- 0.4 mm for TT (p=0.6). The femoral tunnel aperture was 5.0 +/- 1.4 mm from the posterior wall for AM and 9.9 +/- 1.7 mm for TT (p<0.001). The femoral tunnel aperture was 7.6 +/- 2.4 mm from the inferior articular surface for AM and 8.9 +/- 2.2 mm for TT (p=0.2). The femoral tunnel orientation in the coronal plane was 42.1 +/- 4.8 degrees for AM and 60.9 +/- 6.7 degrees for TT (p<0.001). The femoral tunnel orientation in the axial plane was 20.9 +/- 4.4 degrees for AM and 22.7 +/- 13.5 degrees for TT (p=0.7). The femoral tunnel length was 35.6 +/- 2.8 mm for AM and 40.3 +/- 7.9 mm for TT (p=0.1). The femoral tunnel volume was 1659 +/- 177 mm³ for AM and 1829 +/- 369 mm³ for TT (p=0.2).

Conclusions:

The use of an accessory medial portal creates a smaller and more circular tunnel aperture, a tunnel more anterior and lower on the lateral wall, a shorter tunnel length, and a more horizontal tunnel than tunnels created using a transtibial technique.

Acknowledgements:

We wish to thank Winston Evatt, Carmen Spitzer, Jamie Weathersbee, and Rick Stewart for their time and assistance in scanning the cadaver specimens.

References:

Objectives:

Increased femoral tunnel length can be reliably achieved during anterior cruciate ligament (ACL) reconstruction through the anteromedial (AM) portal with the use of a flexible reamer. Concern of increased femoral tunnel and interference screw divergence angle using this technique has limited its use in our institution. We hypothesize that the use of a flexible reamer for femoral tunnel drilling will result in a clinically unacceptable divergence angle when performing anatomic single-bundle ACL reconstruction through the AM portal.
Anteroposterior (A,C) and Lateral (B,D) fluoroscopic images of divergence angles measured between the femoral tunnel interference screw (solid arrow) and the center of the femoral tunnel (dashed arrow).

Methods:

Ten fresh cadaveric knees underwent anatomic single bundle ACL reconstruction through the AM portal with the use of a commercially designed flexible reamer system for femoral tunnel drilling and guide-pin placement. Femoral fixation of the patella tendon graft was achieved with a bioabsorbable interference screw placed with a standard screwdriver. Femoral tunnel and screw divergence was measured radiographically, using a 2.0mm Steinmann pin placed through the interference screw and drilled out the lateral femoral cortex, marking the interference screw trajectory, and a 2.4mm guide pin placed antegrade through the exit point of the femoral tunnel guide pin, marking the graft trajectory. All specimens then underwent fluoroscopic examination in the anteroposterior (AP), lateral and oblique plane, to observe the maximum angle of divergence between the femoral tunnel and the interference screw, which was measured and recorded using a digital protractor (ImageJ v.1.45h, Bethesda, MD) by three independent examiners. (Figure #1)

Results:

The average radiographic divergence between the femoral tunnel on the AP and Lateral radiograph was found to be 8.03 and 8.19 degrees respectively. The average maximum divergence angle, in either the AP, Lateral or Oblique plane, was found to be 13.73 degrees. The average sum of divergence on the AP and Lateral radiographs was 16.23 degrees. A 20 degree divergence in the lateral plane was observed in one specimen. There was strong interexaminer agreement for AP and Lateral radiograph divergence (r=.99-.95), with the 95% limits of agreement less than 5 degrees.

Conclusions:
The use of a flexible reamer during femoral tunnel drilling for anatomic ACL reconstruction through the AM portal results in an acceptable amount of femoral screw divergence. The results of this study minimize the concern of screw divergence when performing ACL reconstruction with a flexible reamer through the AM portal.

References:


Relevant disclosure for all authors
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Abstract Id: Poster 47

Abstract Title: Bony Incorporation of Soft Tissue ACL Grafts in an Animal Model: Autograft vs. Allograft with Low Dose Gamma Irradiation

Authors
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Objectives: The effect of low-dose gamma irradiation on healing of soft tissue allografts remains largely unknown. The purpose of this study was to compare soft tissue healing in a bone tunnel using three types of ACL grafts: non-irradiated allografts, low-level (1.2 MRad) gamma irradiated allografts, and autograft controls. We hypothesized that soft tissue allograft healing to bone would be delayed compared to that of autograft tissue and that low-dose (1.2 MRad) gamma irradiation would not affect the healing response of allograft tissue after ACL reconstruction.

Methods: Surgery: 48 New Zealand white rabbits underwent bilateral ACL reconstructions with semitendinosus tendon graft. Sixteen rabbits were reconstructed with autografts, the remainder with allografts. The 32 allograft rabbits each received one irradiated allograft (1.2 Mrad), with the contralateral leg receiving a non-irradiated allograft. Animals were euthanized at 2 weeks or 8 weeks post-operatively. Biomechanics: Tensile stiffness, maximum load, and displacement at maximum load were measured using custom designed grips on an electro-mechanical materials testing system. Histology: Tibial and femoral segments were sectioned perpendicular to the tunnel axis (at the mid-portion of the tunnel length) allowing for histologic and histomorphometric analyses at the tendon-bone interface. Image J software (NIH, Bethesda, MD) was used to compute the percentage new growth within the bone tunnels.

Results: There were no significant differences between the maximum load or stiffness values among all groups at 8 weeks. At 2 weeks, autograft exhibited significantly (p<0.01) lower maximum load compared to the non-irradiated grafts. There was no statistical difference between autograft and irradiated allografts, or between irradiated allografts and non-irradiated allografts at 2 weeks. Regarding histology, at both 2 and 8 week time points, autograft tendon displayed more advanced degenerative and remodeling processes in comparison with irradiated allograft and non-irradiated allograft. Histomorphometric analyses demonstrated no differences between the grafts at any time point.

Figure:
Conclusions: The maximum load and stiffness of a healing tendon allograft in ACL reconstruction appears to be unaltered by low-dose (1.2 Mrad) irradiation. At 8 weeks, there were no biomechanical differences in tendon-bone healing of allografts when compared with autograft controls. Histologic analyses suggested a faster remodeling response in autograft specimens in comparison with allografts at both time points.

Acknowledgements: This project was funded by the American Orthopaedic Society for Sports Medicine (AOSSM) Young Investigator Grant.

Relevant disclosure for all authors
Nothing to disclose
Objectives:
Removal of the calcified cartilage layer (CCL) during microfracture (MFx) allows for an optimal environment for formation and attachment of repair tissue to the subchondral bone. Autologous chondrocyte implantation (ACI), conversely, calls for the preservation of the CCL for optimal healing. Currently there are no methods to confirm CCL removal or retention. This study aims to quantify whether current surgical techniques allow surgeons to reliably remove or preserve the CCL, utilizing a novel method for evaluation of the CCL.

Methods:
10 fellowship-trained surgeons familiar with MFx and ACI were to prepare 2 sets of chondral defects on the femoral condyle as follows: open defects preserving and removing the CCL, and equivalent arthroscopic defects. These were completed on a single specimen, peripherally cored, and fixed in formalin for analysis. Samples were analyzed in a blinded fashion using a computed tomography 120 μCT scanner. μCT is an established assay for cartilage and osseous structures, the digitized projections were used to reconstruct a 3-D dataset using a convolution back-projection approach, giving a 80×80×50 mm³ volume of image data. Image datasets were calibrated to the conventional scale of Hounsfield radiodensity units (HU) using a water/bone phantom scanned with the samples. Histograms of the subchondral plate, the calcified layer, and cartilage zones were created to define minimum/maximum attenuation ranges for each zone. Analysis included unpaired t-test with sig. of p<0.05.

Results:
Discrete layers were delineated on 2D / 3D μCT images. Boundaries were defined as mean attenuation values for subchondral plate were 126±60 ADU, CCL were -302±63, while cartilage attenuated at -472±51. In the open specimens, CCL removed (93.0±2.0%) was significantly greater than that removed when surgeons were asked to preserve the CCL in an open preparation (34.3±27.5%). With arthroscopic technique, statistical sig. was not achieved when asked to remove CCL arthroscopically, but CCL removed (75.4±38.2%) was greater than that removed when surgeons were asked to preserve the CCL arthroscopically (44.8±33.4%). No sig. difference was noted in surgeon ability to remove or preserve CCL when open and arthroscopic techniques were compared.

Figure:
Figure A. Gross specimen of cored sample with region debrided involving microCT analysis (background) Figure B. Histogram of attenuation values delineating different boundaries from calcified cartilage layer (dark green) to middle (teal), transitional, and superficial zone. Figure C. Removal vs. preserved CCL, comparison of defects

Conclusions:

µCT provides a reliable means to detect proper debridement of the CCL. Considerable variability exists in preserving or debriding the CCL and results of this study suggest a need for novel instrumentation, intra-operative imaging, or methodology to more effectively and homogeneously address the CCL.

Acknowledgements:

MWOR Division of Sports Medicine

Funding provided by Arthrex (Naples, Florida)

References:

Relevant disclosure for all authors
Nothing to disclose
Objective: The clinical importance of the meniscal posterior root attachments has been recently reported by both biomechanical and clinical studies (1, 2). While several studies have been performed to evaluate surgical techniques, there is an absence of studies on the qualitative and quantitative anatomy of the meniscal root attachments. This study sought to determine the quantitative anatomy of the posterior meniscus root attachments.

Methods: Twelve non-paired fresh frozen cadaveric knees were utilized for this study. All soft tissue and ligaments were removed, and the medial and lateral menisci root attachments labeled. Measurements from arthroscopically pertinent landmarks to the posterior meniscal root attachments were performed using a 3 dimensional calibrated stylus.

Results: The most important measurements are listed below and are seen in Figure 1. All measurement variations are reported in standard error of the mean (SEM).

Medial Meniscus Posterior Root Attachment
The distance between the medial tibial eminence and the medial meniscus posterior root attachment center was directly 11.5 (±0.9) mm. When split into directional components along the knee’s main axes, the medial meniscus posterior root attachment center was 0.7 (±0.4) mm lateral and 9.6 (±0.8) mm posterior along the bony surface from the medial tibial eminence. The medial meniscus posterior root attachment was located 3.5 (±0.4) mm lateral from the medial articular cartilage inflection point and directly 8.2 (±0.7) mm from the nearest tibial attachment margin of the PCL.

Lateral Meniscus Posterior Root Attachment
The distance between the lateral tibial eminence apex and the lateral meniscus posterior root attachment center was directly 5.3 (±0.3) mm. When split into directional components using the knee’s main axes, the lateral meniscus posterior root attachment center was 4.2 (±0.4) mm medial and 1.5 (±0.7) mm posterior along the bony surface from the lateral tibial eminence. The lateral meniscus posterior root attachment was located 4.3 (±0.5) mm medial from the nearest articular cartilage margin and directly 12.7 (±1.1) mm from the nearest margin of the tibial attachment of the PCL.

Figure:
Fig. 1. This figure displays the posterior attachments of the medial and lateral menisci in relation to the most pertinent landmarks. MPRA= medial meniscus posterior root attachment; LPRA= lateral meniscus posterior root attachment; MTE= medial tibial eminence; LTE= lateral tibial eminence; LARA= lateral meniscus anterior root attachment; SWF= transverse shiny white fibers of the posterior horn of the medial meniscus.

Conclusions: This quantitative study reproducibly identifies the posterior root attachment centers of the medial and lateral menisci in relation to arthroscopically pertinent landmarks and guidelines. This data can be directly applied to assist in anatomic meniscal posterior root repairs.

Acknowledgements: This study was funded by the Norwegian South-East Regional Health Authority and by the Steadman Philippon Research Institute.


Relevant disclosure for all authors
Nothing to disclose
AOSSM 2012 Annual Meeting

Abstract Id: Poster 50
Abstract Title: Anatomical Characteristics of the Posterior Intercondylar Fossa: Tibial Insertion Site of the Posterior Cruciate Ligament

Authors
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Objectives:
It has been demonstrated that double-bundle reconstruction of the posterior cruciate ligament (PCL), using both the anterolateral (AL) and posteromedial (PM) bundle, restores knee kinematics better than single-bundle reconstruction. We reported that these two bundles were located in different planes on the posterior intercondylar fossa. However, because arthroscopic observation of the tibial insertion site was complicated intraoperatively, the different planes on the posterior intercondylar fossa could not be identified. The objective of this study was to identify the posterior intercondylar fossa with anatomical reference points and a simplified schematic diagram to help guide surgeons in the performance of an anatomical reconstruction of the PCL.

Methods: Twenty-one unpaired human cadaver knees were evaluated. The AL and PM insertions were outlined using fine pins, and all soft tissue was removed (Fig. 1A, 1B). The geometric data and surface features of the posterior intercondylar fossa: tibial insertion site of the PCL and its bundles, were studied with macroscopic observation and virtual arthroscopy using three-dimensional laser photography (Fig. 2A, 2B).

Results: The PCL was attached to the posterior intercondylar fossa, and it also extended below the posterior part of the tibial rim. In all specimens, the posterior intercondylar fossa and its corners were clearly identified as a depression between the plateaus of the tibia by virtual arthroscopy (Fig. 3). The fossa was trapezoid-shaped and became wider inferiorly (Fig. 4A). The average linear length (and SD) of the medial side (M) was 13.7±2.2 mm. The superior side (S) averaged 7.0±1.6 mm, the lateral side (L) measured 15.7±2.1 mm, and the inferior side (I) measured 15.7±2.2 mm. The AL bundle was attached to the superolateral aspect of the fossa, and the PM bundle was attached to the inferomedial aspect of the fossa. A dividing line between AL and PM bundles was located in an average of 38±12.8% from the superior boundary on the medial side and in an average of 76±7.0 % from the superior boundary on the lateral side on a simplified schematic diagram (Fig. 4B).

Figure: Figure 1-4
Conclusions:

The tibial insertion site of the PCL and its bundles is very complex. However, the shapes and positions of the insertion sites of the two bundles are consistent in the posterior intercondylar fossa. We noted the anatomic characteristics of the posterior intercondylar fossa. Anatomic reference points that represent the corners of the fossa were clearly identified by virtual arthroscopy in all specimens included in the study.

References:


Relevant disclosure for all authors
Nothing to disclose
Radiographic Landmarks for Tunnel Positioning in Posterior Cruciate Ligament Reconstructions

Objectives: Radiography is a standard method to assess PCL reconstruction tunnel placement both intraoperatively and postoperatively (1). This study aimed to establish quantitative radiographic guidelines for identifying the femoral and tibial attachment sites of the anterolateral (ALB) and posteromedial (PMB) of the native PCL.

Methods: Twenty non-paired fresh knees were dissected and their PCL bundles separated, excised from the bone, and attachment centers labeled using 2-mm metal spheres. Arthroscopically pertinent landmarks not readily observable on radiographs were labeled using 1-mm diameter T-pins or wire. To assess bundle attachment margins, the bundle attachment area was labeled using a radio-opaque BaSO$_4$ emulsion. Anteroposterior (AP) and lateral radiographs of the femur and tibia were obtained before, and lateral images repeated after, the addition of BaSO$_4$. Digital measurements were conducted from the bundle centers and margins to radiographically pertinent landmarks and superimposed lines. Variations are reported as standard deviations.

Results: On the AP femur view (Fig. 1), the ALB and PMB bundle centers were located 14.1 (+/- 1.3) mm and 15.8 (+/- 2.1) mm superior to the distal joint line, respectively. The ALB center was located 34.1 (+/- 3.0) mm lateral, and PMB center 29.4 (+/-3.1) mm lateral to the medial epicondyle line.

Lateral femur images (Fig. 1) revealed that the ALB and PMB centers were located 4.9 (+/- 1.3) mm and 10.8 (+/- 1.4) mm posteroinferior and perpendicular to Blumensaat’s line. The ALB center was 17.5 (+/- 1.3) mm posterior from a perpendicular line at the most anterior margin of the medial femoral condyle along a line parallel to Blumensaat’s line. The PMB center was 24.1 (+/- 2.7) mm posterior from this reference line.

On the lateral tibia view (Fig. 1), the ALB, PMB, and bundle ridge centers were located 9.1 (+/- 1.7) mm, 3.3 (+/- 1.3) mm, and 6.4 (+/- 1.6) mm superior to the champagne glass-dropoff, respectively. The ALB was 3.5 (+/- 1.1) mm anterosuperior and perpendicular to the bundle ridge, while the PMB was 3.6 (+/- 0.9) mm posteroinferior and perpendicular to the bundle ridge. A simulated guide wire line was located 7.2 (+/- 1.5) mm anterosuperior from the nearest concave edge of the posterior tibia.

Figure:
Figure 1. This figure displays the most important measurements (in mm) and reference lines from the AP femur (left), lateral femur (middle), and lateral tibia (right) views.

Conclusions: This study identifies radiographic guidelines of the native anatomy of the PCL bundles using clinically relevant radiographic landmarks. These findings can be directly applied to proper tunnel positioning intraoperatively during PCL reconstructions, and also to assess post-operative tunnel placement.

Acknowledgements: This study was funded by the Norwegian South-East Regional Health Authority and by the Steadman Philippon Research Institute.


Relevant disclosure for all authors
Nothing to disclose
Objectives:
In order to prevent injuries in young athletes, it is important to determine what pathology exists in asymptomatic youth. The purpose of this study was to determine the prevalence of acetabular labral tears in athletes 19 years of age or younger who compete in a club sport. Our hypothesis was that the prevalence would increase with age and the number of years the athlete had participated in their particular sport.

Methods:
As part of a screening program for young athletes, 45 individuals, with no symptoms of hip pathology including history of hip pain, injury, or surgery, underwent a clinical hip exam and hip MRI in this IRB approved study. Participants underwent a unilateral MRI scan of the extremity side the participant considered their dominant hip. All MRI scans were reviewed by an experienced musculoskeletal radiologist.

Results:
Among the 45 participants, there were 38 males and 7 females. The average athlete age was 15.2 years (range, 11 to 19). A total of 25 ice hockey players and 20 skiers were screened. Labral tears were identified in 30 (67%) of hips, 9 had femoral bone edema, and 12 demonstrated fibrocystic changes of the femoral head neck junction. The average alpha angle was 56.6 degrees and the average version was 4.6 degrees. 73% of the participants over 16 years of age had labral tears, while 63% of those participants 16 years or younger had labral tears. Gender was not associated with the presence of a labral tear. The number of years that the athlete had participated in sport was not associated with the presence of a labral tear.

Conclusions:
The prevalence of labral tears on magnetic-resonance images of asymptomatic young athletes was 67%. This high prevalence of abnormal hip pathology on MRI emphasizes the importance of monitoring young athletes for the onset of hip pain. By ignoring symptoms, these athletes may be putting their hip at risk of further damage. Although not significant in this small sample, there was a trend toward more labral tears as the athlete’s age increased. This may be due to more intense training or more repetitions. More research is needed to determine the causes of acetabular labral tears in the asymptomatic youth athlete.
Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 53
Abstract Title: Outcomes of Hip Arthroscopy For Labral Tears at a Minimum 2 Year Follow-up

Authors
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Objectives:
Utilization of hip arthroscopy is expanding. Indications, techniques, and measurements of patient outcomes are evolving. There is a paucity of objective hip arthroscopy outcome measures in middle-aged active patient populations using hip arthroscopy specific outcome measures at a minimum two-year follow-up. The purpose of this study was to assess the efficacy of hip arthroscopy and to identify risk factors for poor outcome after hip arthroscopy.

Methods: We performed a retrospective review of 204 consecutive hip arthroscopies for labral tears performed between 2001 and 2009. Patients completed Modified Harris Hip Score (MHHS) and Hip Outcome Score (HOS) questionnaires. Patients who underwent additional surgeries or reported a MHHS score of less than 80 on the MHHS were considered to have achieved poor outcome. We conducted univariate and multivariate analyses to evaluate associations between variables and outcomes. Post-hoc analysis between survey responders and non-responders was performed. Analyses were performed using SAS software.

Results:
204 patients received hip arthroscopy for labral tears. Mean patient age at surgery was 40.8 years. Average follow-up was 4.56 years. Data was obtained on 125 of 204 (62%) patients. 27 of the 125 (22%) had undergone subsequent hip surgery, the remaining 98 completed questionnaires. Of those undergoing a terminal procedure: 15 received THR, 7 hip resurfacing, 5 revision arthroscopy. 73 of 125 (58%) respondents obtained good to excellent surgical outcome. Average scores were: MHHS 83.7 (SD 16.8); HOS ADL 86.6 (SD 16.0); HOS Sports 71.5 (SD 27.4). Age over 40 was a consistent predictor of poor outcome across all measures: MHHS (OR 3.61; 1.29, 10.15); HOS ADL (OR 3.78; 1.15, 12.44); HOS Sports (OR 2.75; 1.06, 7.14). Being employed was protective against low HOS scores: HOS ADL (OR 0.23; 0.07, 0.83); HOS Sports (OR 0.23; 0.07, 0.81). Being overweight increases the risk of poor MHHS score (OR 3.62; 1.06, 12.31). Race, gender, psychiatric history, health insurance status, smoking status, presence of FAI and method of labral intervention do not significantly impact patient outcome scores after hip arthroscopy. 92 (84.6%) patients were satisfied and 75 (76.5%) still expressed some residual pain. No difference was observed among survey respondents and non-respondents

Conclusions:
Hip arthroscopy for labral tears is a successful operation with mid-term follow-up of 58% patients having good to excellent results in the middle-age active patient population. Mild to moderate pain is common. Age over 40, unemployment and obesity appear to increase the risk for poor outcome.
Relevant disclosure for all authors
Nothing to disclose
AOSSM 2012 Annual Meeting

Abstract Id: Poster 54
Abstract Title: Cost Effectiveness Analysis of Early Surgery versus Nonoperative Treatment with Optional Delayed Surgery for Femoroacetabular Impingement

Authors
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Objectives:
Femoroacetabular impingement (FAI) is a common cause of hip pain and is a potential etiologic factor in the development of osteoarthritis. Several authors have reported successful treatment of FAI with hip arthroscopy, yet many payers still consider it an experimental treatment. As such, extensive nonoperative treatment of up to 6 months is required for approval. Due to the structural abnormalities present in FAI, nonoperative treatment is often unsuccessful and can worsen symptoms while adding costs do not create value. The purpose of this study was to evaluate the value of early hip arthroscopy (EHA) versus nonoperative treatment with optional delayed hip arthroscopy (DHA) for FAI using the power of decision analysis.

Methods:
A Markov decision model was constructed for a cost-utility analysis of EHA compared to DHA for symptomatic FAI. The baseline was set at 6 months of nonoperative treatment, but was tested in 6 week increments. Outcome probabilities and effectiveness were derived from the literature. Utilities were measured using an established conversion of the Harris hip score. Costs were estimated from the societal perspective with use of the national average Medicare reimbursement for the procedures in 2011. Costs and utilities were discounted in accord with the U.S. Panel on Cost-Effectiveness in Health and Medicine. Effectiveness was expressed in quality-adjusted life years gained (QALYs). Principal outcome measures were average incremental costs, incremental effectiveness, incremental quality-adjusted life years (QALYs), and net health benefits. Multivariate sensitivity analysis was conducted on all variables in the model.

Results:
In the base case, EHA resulted in an incremental gain of 0.08 QALYs and provided incremental cost savings of $5410 over DHA. Therefore, EHA is a dominant treatment strategy. Sensitivity analysis revealed that the model was sensitive to only the success of nonoperative treatment; if the success of nonoperative treatment rises above 60%, DHA is the preferred treatment strategy.
Conclusions: EHA was more effective and less costly than DHA and therefore a dominant treatment strategy. The model was sensitive only to the rate of success with nonoperative treatment and the delayed strategy is likely preferred for smaller deformities (alpha angle<60). These findings suggest extended nonoperative treatment for large deformities in FAI may be an inefficient treatment.

Acknowledgements: Ryan Freedman BS

References:


Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 55

Abstract Title: Athletic Pubalgia: How Long Are Patients Out? And What Does This Really Mean?

Authors

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Objectives:

Athletic pubalgia (AP) (“sports hernia”) causes significant loss of time from athletics and work. AP is not a true hernia; instead it involves a variety of injuries to muscles normally attaching to a fibro-cartilaginous plate surrounding the pubic symphyses. The timing of return to play/work after surgery remains an important question for coaches, employers, and others.

Methods:

We analyzed 152 patients from October 2010 to October 2011. Operative repairs depended on the exact pathologies and included direct reattachments and side-to-side muscle repairs, with or without compartmental releases, of the rectus abdominis, adductor longus, adductor brevis, and pectineus. Like our long-term studies, outcomes were patient derived: 1=worse; 2=no change; 3=improved but not at fully desired level; 4=at desired level of performance, minimal discomfort; 5=at desired level, no discomfort. Capability assessment for return to play/work also came from the patients and took into account such factors as schedule, contract, importance to team, workmen’s compensation, team protocols, sense of well-being, severity and type of injury, or co-existence of other injuries.

Results:

140/152 patients were athletes: 31 professional, 56 collegiate, 12 high school, 47 recreational, and four others (semipro soccer, national ballet, national track & field, retired NBA player). 12/152 were military or laborers. 68% (103/152) returned to full play or work status within 4 wks. 97% (148/152) returned within 6 weeks. Two other patients returned at 8 weeks and 12 weeks respectively, a third developed symptoms from a brain AVM at six weeks postop after beginning pre-season football, and the fourth was still rehabbing from ACL surgery. 22 of the 103 (22%) patients at full return within 4 wks and 6 of the 148 (4%) within 6 wks, reported only Grade 3 scores despite full return to play/work.

Conclusions:

Surgery for athletic pubalgia appears very successful; 99% of otherwise healthy patients were able to return to full play/work within 6 weeks. Success likely depends on accurate identification of pathologies and optimal procedures. Divergences occur between outcome scores and return to play, and many other factors likely enter into the overall picture.

Relevant disclosure for all authors: Nothing to disclose
AOSSM 2012 Annual Meeting

Abstract Id: Poster 56

Abstract Title: Short-term Outcomes After Early Repair of Adductor and Rectus Abdominis Avulsion Injuries

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Objectives:
Athletic pubalgia (AP; “sports hernia”) involves injuries of muscles normally attaching to a fibrocartilage plate that surrounds the pubic symphyses. True (50% or more) avulsions represent relatively severe forms of the injuries. Critically analysed outcome studies regarding this topic are scarce. We chose to analyze the severest form of these injuries.

Methods:
We analyzed prospectively short-term outcomes of 53 patients seen between April and July 2010 who underwent repair within 3 months of injury. Repairs included direct re-attachment and/or mobilization and incorporation into adjacent muscle. Initial follow-up was at 3-week intervals up to 12 weeks. A longer-term follow-up occurred at 1 year.

The patients adjudged their own scores: 1=worse; 2=no change; 3=improved but not at fully desired level; 4=at desired level of performance, minimal discomfort; 5=at desired level, no discomfort. Follow up was 100%.

Results:
Fifty-two (99%) patients were male and 49 (96%) athletes. Twenty (20) were professional and 10 Division 1 college athletes. The most common sport was football (14 patients), followed by track (9) and hockey (8). Twenty-six (48.1%) had bilateral injuries, and 32 (60.4%) had combination avulsions (rectus abdominis and at least one adductor).

Short-term Follow-up (SEE TABLE):

Thirty-eight (71.7%) of 53 patients competed/performed at previously high levels at 3 weeks of repair, and 92.5% at 12 weeks. One athlete was not better in the short term; this athlete underwent successful adductor scar tissue release 3 months after the initial surgery and was competing within 3 weeks after that. At 1 year, 50 (94.3%) patients were at pre-injury levels of performance. All were better, and 2 of the 3 patients at Grade 3 had undergone recent arthroscopy for concomitant hip pathology. Three athletes in Grade 4 at 3-weeks and Grade 5 at 1 year remarked retrospectively that they did not “really feel back to normal” at the earlier time point.

Figure:
Conclusions:

Early surgery for severe AP injuries appears very successful in the short-term, and results remain excellent after one year. Accurate assessment and early correction provide the athletes with a high likelihood for quick return to play. Concomitant hip injuries remain an important consideration. As time goes on, athletes to feel better and better.

Relevant disclosure for all authors
Nothing to disclose
Abstract Id:  Poster 57
Abstract Title: Prevalence of Radiographic Hip Pathomorphology in Patients Presenting to an Orthopaedic Clinic with “Hip” Pain

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Objectives:
There is limited data with regards to the prevalence of radiographic hip pathomorphology in patients presenting with “hip” related complaints. The purpose of this study was to determine said prevalence within a consecutive series of patients presenting with "hip" related complaints.

Methods:
499 consecutive patients (998 hips) presented to two orthopaedic surgeons at two centers with “hip” related symptoms. There were 228 males and 271 females with a mean age of 38 years (range, 10 – 81 years). An anteroposterior (AP) radiograph of both hips and a lateral radiograph of the hip was obtained for all patients. A detailed radiographic evaluation including lateral center edge angle (LCE), neck-shaft angle, alpha angles on AP and lateral radiographs, cross-over sign, ischial spine sign, posterior wall sign, and Tonnis grading was performed on all radiographs. The presence of dysplasia, cam and or pincer-type femoroacetabular impingement (FAI), and a classification for pincer-type FAI (retroversion, focal anterior overcoverage, profunda, protrusio) was determined for all hips. The above named parameters were also evaluated with respect to symptoms, gender, age, and bilaterality.

Results:
The presence of at least one finding consistent with FAI was noted in 96.67% of patients (89.8% of hips) and was bilateral in 83.0%. The prevalence of dysplasia was 10.6% in patients (6.7% of hips) and was bilateral in 2.8%. The prevalence of isolated cam-type FAI was in 24.8% of all FAI hips, isolated pincer-type FAI was 20.7% in all FAI hips and combined-type FAI was 54.5% of all FAI hips.

Symptoms were more prevalent in the presence of cam (p<0.001) and combined-type FAI (p<0.001). In addition, increasing alpha angle was highly predictive of “hip-related” symptom (p<0.001). Pincer-type FAI had a greater prevalence with decreasing age (p<0.001). Combined-type FAI was seen more frequently in males (p<0.001), whereas pincer-type FAI and coxa profunda were seen more frequently in females (p<0.001).

Conclusions:
FAI is highly prevalent (96.6%) and frequently bilateral (83%) in patients presenting to an orthopaedic clinic with “hip” pain. Increasing alpha angle was highly predictive of “hip related” symptoms. This study also confirmed that pincer-type FAI was more prevalent with decreasing age. Combined-type FAI was more prevalent in males, whereas pincer and coxa profunda was more prevalent in females.

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 59
Abstract Title: Operative Management of Partial Thickness Tears of the Proximal Hamstrings in Athletes

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Objectives:
Chronic insertional tendinopathy of the hamstring origin represents a challenging clinical problem to the orthopaedist, and can lead to significant impairment of recreational and competitive athletic performance. Non-operative treatment is frequently met with limited success, while there is a paucity of data on the efficacy of surgical management for partial proximal hamstring tears in the setting of tendinopathy. The purpose of this study is to evaluate the results of operative treatment for partial tears of the hamstring origin in athletes in the setting of underlying tendinopathy.

Methods:
The records of 17 patients with chronic hamstring tendinopathy and partial tearing were reviewed after IRB approval was obtained. All patients were treated with open debridement and primary tendon repair after failure of an appropriate course of non-operative therapy. Clinical and operative records, radiographs and MR imaging were reviewed for all patients. A patient reported outcomes survey was completed by 14 patients including the Lower extremity functional score (LEFS), Marx activity rating scale, and subjective patient satisfaction scores. Early and late post-operative complications were recorded.

Results:
Patients included 3 males and 14 females with an average age of 43 years 4 months (range, 19-64y) and an average follow-up of 32 months (12-51m). Post-operative LEFS was 73.3 ±9.9 (56-80), average Marx activity scores was 6.5 ±5.3 (0-16). No patient underwent a subsequent surgery on their hamstring, although 1 patient was not satisfied with their surgical result. Complications include 1 superficial suture abscess treated with dressing change and 1 patient with residual foot numbness without motor deficit. Two patients had a recurrence of symptoms following return to activities treated with physical therapy and local injection. All patients were able to return to their pre-operative level of activity, although a single patient reported persistent symptoms during competitive distance running.

Conclusions:
Surgical treatment of partial proximal hamstring tears in the setting of tendinopathy can lead to satisfactory functional outcomes, a high rate of return to athletic activity, and low complication rate. This procedure should be reserved for patients who have failed an extended course of non-operative treatment, and the proximity of the sciatic nerve mandates a careful assessment of the risk/benefit
ratio before proceeding to the operating room.

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 60

Abstract Title: Prevalence of Chondral Defects of the Hip in Professional Hockey Players vs Non-Contact Professional Athletes

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Objectives:
Recent literature suggests that arthroscopic hip microfracture gives excellent clinical outcomes and return to play percentages for athletes with chondral defects. Hockey players may have an increased risk for chondral damage due to the repetitive, forceful maneuvers required of the hip. Little research has been done to identify the prevalence of chondral lesions of the hip in hockey players. Purpose: To determine the prevalence of chondral defects of the hip in professional hockey athletes compared to professional non-contact athletes.

Methods:
This study was IRB-approved. All professional hockey players and professional non-contact athletes who underwent hip arthroscopy by a single surgeon between March 2005 and November 2011 were identified. Only male athletes were included. Seventy-six professional hockey players (87 hips) were identified. Sixty-six non-contact professional athletes (75 hips) were identified in the following sports: acrobatics, archery, baseball, golf, skiing, snowboarding, and tennis. Non-professional athletes and hips that underwent previous surgery were excluded. Defects were identified by arthroscopic surgical data that was prospectively collected and retrospectively reviewed.

Results:
Ninety-nine percent of hockey players’ hips and ninety-six percent of non-contact athletes’ hips had a chondral lesion (p=0.337). Of the hips with chondral lesions, 85% in the hockey group and 71% in the non-contact group had an Outerbridge grade 3 or 4 defect (p=0.026). Hockey players’ hips were 2.4 (95% CI 1.02 to 5.49) times more likely to have a grade 3 or 4 chondral lesion. There was no difference in mean age between the hockey group (29.5 years) and the non-contact group (29.2 years) (p=0.748). There was no difference in mean age between athletes with grade 3 or 4 lesions (29.8 years) and athletes without grade 3 or 4 lesions (27.9 years).

Conclusions:
Professional hockey athletes are 2.4 times more likely to have grade 3 or 4 chondral lesions of the hip than professional non-contact athletes.

Relevant disclosure for all authors: Nothing to disclose
Objectives:

Although iatrogenic articular cartilage injuries are estimated to occur in 18% of hip arthroscopies (1), the consequences of these inadvertent scuffs have not been documented. This study compared the clinical results of patients with iatrogenic articular cartilage injuries (IAI patients) to those of patients that did not have articular cartilage injuries (NAI patients) during their hip arthroscopy.

Methods:

From a data base of 750 patients who had their hip arthroscopy performed by the senior author, 52 patients with IAI’s and one or more years of follow-up were identified. The IAI’s were recorded on each patient’s “hip sheet” at the time of their arthroscopy. The results of hip arthroscopy in these patients were compared to a matched-group of 52 patients that had similar arthroscopic procedures but did not sustain iatrogenic articular injuries (NAI patients). The IAI and NAI groups were matched so that there were no significant differences (p> 0.05) in average age, gender, body mass index, arthroscopic findings and procedures, and pre-operative modified Harris hip scores.

Results:

Preoperative scores for the IAI and NAI patients averaged 43 points. At surgery, 17 of the IAI patients had needle scrapes (18 gauge spinal needle, scrape length 3-8 mm), and 33 sustained cannula scuffs (5 mm width, scuff length 3-8 mm). Average joint distraction for the IAI and NAI patients (Figure 1) was 12.6 mm (range 9-18 mm) and 12.9 mm (range 8-18 mm), respectively. The average and range of joint distraction was the same for both groups of patients (p=0.6), and achieving even 18 mm of joint distraction did not prevent IAI’s from occurring. However, the number of patients that had arthroscopic treatment of femoroacetabular impingement (56% IAI vs. 42% NAI patients), and the incidence of both pincer (31% vs. 25%) and CAM deformities (37% vs. 29%) were significantly higher (p<0.01) in the IAI patients. After surgery, the 6 month scores averaged 81 and 84 points for the IAI and NAI patients, and the 12 month scores averaged 86 points for both groups, respectively. At all follow-up intervals, there were no significant differences between the scores of the two groups.

Conclusions:

Iatrogenic articular cartilage injuries: did not affect the one-year outcomes of patients who sustained these injuries during hip arthroscopy; were more common in patients with femoroacetabular impingement; and were not prevented by the amount of joint distraction achieved.

References:

Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 62
Osteochondroplasty.

Authors
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Objectives:

Purpose: The use of hip arthroscopy in the treatment of femoral acetabular impingement has greatly changed the ability to restore
normal osteochondral congruency about the hip. Cam-type FAI can be successfully treated with arthroscopic techniques. To date,
however, review of the literature demonstrates little published description of the normal amount of exposed articular cartilage
covering the femoral head in relation to the labrum. This measurement is an important guide about how proximal the
osteochondroplasty can be extended. The purpose of this study is to quantify the articular cartilage exposed distal to the acetabular
labrum in order to guide the extent of osteochondroplasty that may be performed safely along the femoral neck.

Methods: Ten cadaveric femoral heads were marked at five distinct points: 1.) the most superior/lateral aspect, 2.)
the AIIS, 3.) the psoas U, 4.) most inferior/medial aspect, and 5.) a point halfway between the AIIS and the psoas U. Lines were
extended from these five points down the femoral head and neck, parallel with the femoral neck. Measurements were taken along
these five lines between the free edge of the labrum and the edge of the articular cartilage of the femoral head. These measurements
were taken 1.) in neutral abduction/abduction and internal/external rotation at full extension, 2.) 45° of flexion, and 3.) 90° of flexion.
Measurements were also taken in 45° of internal rotation and 45° of external rotation at full extension and 45° of flexion

Figure:

![Distances Measured](image)

Results:
The specimens demonstrated 17±4.4mm of exposed articular cartilage in full extension when measured from the AIIS and 20±2.6mm of exposed cartilage when measured from the psoas U. These measurements decreased to 2±3.5mm and 5±2.6mm from the AIIS and psoas U, respectively, at 45° of flexion.

**Conclusions:** This is the first published guideline regarding the amount of femoral head articular cartilage that must be preserved in order to maintain normal articular cartilage distal to the labrum when performing femoral osteochondroplasty. The measurements at 45° of flexion are less than the 1 cm of articular cartilage that is often recommended and suggests that a more aggressive osteochondroplasty may be performed. It appears that the distance from the psoas U may be the most reliable and most easily reproduced measurement in the intra-operative setting. This data may also be utilized to decrease the need for intraoperative dynamic testing when performing hip arthroscopy for femoral acetabular impingement.

**Relevant disclosure for all authors**
Nothing to disclose
Abstract Id: Poster 63
Abstract Title: Anatomic Lateral Ligament Reconstruction in the Ankle: A Hybrid Technique in the Athletic Population

Authors
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Objectives:
Surgical strategies for addressing lateral instability include anatomic reconstruction and checkrein procedures. Concerns over inadequate reparative tissue, scarring and over tightening of the subtalar joint have prompted the introduction of a hybrid reconstruction. Using a peroneal tendon autograft fixed to the isometric points of the ATFL, and plicating rather than substituting the CFL provide the benefits of both techniques while reducing the drawbacks of both.

Methods:
Between 2006 and 2009, 57 patients underwent a hybrid lateral ankle ligament reconstruction technique. Each patient failed a 3-month conservative triple-phase therapy program. All patients were followed for a minimum of one-year following surgery. Surgery included substituting the native ATFL with a 4 centimeter split peroneus longus autograft in addition to a vest-over-pants plication of the CFL. All patients had pre- and post-operative Foot and Ankle Outcome Scores (FAOS) and Short Form-36v2 scores. Pre- and post-operative MRIs were compared to evaluate ankle and subtalar arthrosis.

Results:
FAOS scores increased significantly pre- to post-operatively from 58 to 89 points. SF-36v2 scores also increased significantly from 67 points pre-operatively to age adjusted normal levels.

Two of 57 patients had pre-operative grade II cartilage loss in the posterior facet of the subtalar joint. In one case, this had advanced to grade 3 at 2 years follow-up. Two additional patients had grade I changes in the subtalar joint at two years and one patient demonstrated grade II changes in the ankle joint at 1-year follow-up.

All patients reported competing at some level of athletic sport prior to surgery. 5 of 57 patients did not return to pre-operative sporting levels. All 5 patients had mechanical stability but all had functional instability. The incidence of functional instability was 22% overall and persistence of functional instability was a predictor of failure to return to sports.

Complications included a painful hypertrophic peroneal tendon, two cases of superficial peroneal nerve neurapraxia and a post-operative sinus tarsi syndrome.

Conclusions:
The hybrid procedure described in the current study may provide an alternative to the Brostrom procedure when inadequate reparative tissue limits a direct repair. Functional stability training is critical to facilitate a full return to sports.
Relevant disclosure for all authors
Nothing to disclose
Abstract Id: Poster 64
Abstract Title: Return Outcomes Following Microscopic Lumbar Discectomy in Professional Athletes

Authors
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Objectives:
It has been shown that a microscopic lumbar discectomy (MLD) is successful in getting professional athletes back to their sport following a herniated nucleus pulposus (HNP). However, there is a need for more information on the time it takes professional athletes to return to their sport following the surgery. Our objective was to determine the return rate and average time to return to sport for these patients.

Methods:
Between 1996 and 2010, the senior author treated 171 professional athletes with lumbar herniated nucleus pulposus. A retrospective review was performed using patient charts, operative reports, team medical records, and internet search. A microscopic lumbar discectomy was performed on 85 patients, while 86 were treated non-surgically. The return rate and average time to return to sport were the primary outcome measures. These data points were then evaluated by operative disc level and sport. Progressive return time was also measured. This data point included an adjustment for the length of professional seasons, which accounts for the fact that players are not always in-season, and therefore not always eligible to return.

Results: Follow-up showed that on average, 89.3% of patients in the study returned to play their sport. The average return time was 5.8 months. There was no statistically significant difference in return to play rates when compared between different operative disk levels (p = 0.62) or sports (p = 0.48). There was also no difference in return time when compared between disk levels (p = 0.63) and sports (p = 0.44). Progressive return data showed a steady increase in the percentage of athletes that returned to play from 50% at 3 months to 72% at 6 months to 88% at 13 months.

Figure:
Figure 2. Progressive Return Data. Return to play data adjusted to account for the fact that players are not always in-season, and therefore not always eligible to return. Players were deemed eligible once their sport was in-season at a data point. Return defined as having logged at least one minute of playing time in a regular season game.

Conclusions: Average return time was 5.8 months, but this includes the major confounding variable of season length. For example, an NFL player that has surgery at the end of the season must wait 8 months, the length of the NFL offseason, before even being eligible to play in a game. This can skew results towards a longer average return time. After accounting for offseason length, return to sport rates in professional athletes are comparable to return to work rates published for non-athletes in other studies. The chance of a player returning to play after MLD is 50% at 3 months, 72% at 6 months, and 88% at 13 months.

Relevant disclosure for all authors
Nothing to disclose
AOSSM 2012 Annual Meeting

Abstract Id: Poster 65

Abstract Title: Characterization of Fractures in Collegiate Football Players

Authors

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Objectives:

Fractures in collegiate athletics are common injuries that may preclude the athlete from participation in competition. Previous studies have demonstrated that collegiate football has the highest injury rate of NCAA sports, however there is a paucity of literature which specifically assess the characteristics and effect of fractures on intercollegiate athletes. The purpose of this study is to determine the demographics and incidence of fractures in NCAA Division I football players and evaluate the impact of these fractures on the ability of athletes to return to sport.

Methods: After Institutional Review Board approval, we retrospectively identified all NCAA Division I football players that sustained a fracture between years 2000 and 2009. Subjects were identified in the Sports Injury Monitoring System and trainer records. Patient demographics, injury characteristics, treatment and return to sport were recorded in all patients. Athlete exposures were calculated using the total number of athletes on the varsity rosters, as determined from published media guides.

Results: One hundred and forty-one fractures were sustained in NCAA Division I football players between 2000 and 2009. Of the mean 513 football injuries (range 469 to 548) that occur each season, fractures represent 2.7% (141/5130) of injuries. The overall fracture incidence rate was 0.97% per 1000 athlete exposures. Fifty percent (71/142) of fractures involved the hand, 16.9% (24/141) involved the tibia or fibula, 14.1% (20/141) involved the foot, 6.3% each (9/141) involved the face and forearm, and 4.9% (7/141) involved the spine or torso. Thirty-two percent (46/142) of athletes that sustained a fracture required operative fixation. Fractures were more frequent during the season (56%, 79/142), compared to pre-season (24%, 34/141) and off-season (20%, 28/141). Of the athletes that sustained an in-season fracture, 63% (50/79) returned to competition during the season.

Conclusions:

Few studies assess fractures in collegiate football players and no studies assess the impact of these fractures on the ability of athletes to return to sport. In the largest series evaluating fractures in NCAA Division I football players, we demonstrate that 63% of players return to sport and 32% of fractures require operative fixation. With these data, athletic programs may tailor protective gear, training programs, and rehabilitation resources to optimize athlete performance.

Relevant disclosure for all authors

Nothing to disclose
Abstract Id: Poster 66

Abstract Title: Incidence, Mechanisms, and Severity of Match-Related Collegiate Women's Soccer Injuries on FieldTurf Versus Natural Grass

Authors
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Objectives: In the past, numerous studies have attributed serious articular and concussive injuries to playing on artificial turf. Newer generations of synthetic turf, however, have been developed to duplicate the playing characteristics of natural grass. Although FieldTurf has been determined, in many cases, to be safer than natural grass in the prevention of American football injuries (Meyers et al., 2004, 2010), and listed by FIFA as a recommended surface for international soccer, research into the long-term effects of FieldTurf on collegiate soccer injuries, during actual match conditions, has been limited. Therefore, this study quantified the incidence, mechanisms, and severity of match-related collegiate women's soccer injuries on FieldTurf versus natural grass.

Methods: A total of 8 universities, from three NCAA Div-IA conferences, were evaluated over 3 competitive seasons for injury incidence, injury category, time of injury, injury time loss, player position, injury mechanism and situation, field location at time of injury, injury time loss and grade, anatomical location and type of injury, head and knee trauma, cleat design, and environmental factors.

Results: A total of 373 college matches played on FieldTurf (n=156;41.8%) and natural grass (n=217; 58.2%), resulted in a total of 279 injuries. Statistical analyses indicated a significantly lower total injury incidence rate (IIR) reported on FieldTurf (IIR=6.4 injuries per 10 team matches; 95% CI, 5.6-7.1) versus natural grass (IIR=8.2; 95% CI, 7.7-8.7). Findings also indicated significantly less trauma (p=0.046 to 0.001) documented on FieldTurf versus natural grass while attempting a slide tackle (0.0%; IIR=0.0; 95% CI, 0.0-0.0 vs 7.8%; IIR=0.6; 95% CI, 0.4-1.1), wearing combination molded conical/cleats (57%; IIR=3.7; 95% CI, 2.9-4.4 vs 77.1%; IIR=6.4; 95% CI, 5.7-7.0), during adverse weather/field conditions (15.0%; IIR=1.0; 95% CI, 0.6-1.5 vs 29.1%; IIR=2.4; 95% CI, 1.9-3.0), and acute trauma (79.0%; IIR=5.1; 95% CI, 4.3-5.8 vs 86.6%; IIR=7.1; 95% CI, 6.5-7.7), respectively. No significant differences in head or knee trauma, injury category, time or field location of injury, injury time loss and grade, anatomical location or type of tissue were observed between surfaces.

Conclusions: Although similarities existed between FieldTurf and natural grass during competitive match play, FieldTurf is a viable alternative to natural grass when comparing injuries in collegiate women's soccer. The findings of this study, however, may only be generalizable to this level of competition and this specific artificial surface.

References:

Relevant disclosure for all authors
Nothing to disclose
Objectives:

Injuries sustained in collegiate athletics requiring surgical intervention are common and generally preclude the athlete from participation in his or her sport. While numerous studies provide sport-specific epidemiologic data, they lack characterization of the surgical procedures. The purpose of this study is to provide an epidemiologic description of the surgical procedures performed in NCAA Division I athletes.

Methods:

Following approval by the Institutional Review Board, all NCAA Division I athletes that sustained injuries requiring surgical intervention between the years 2000 and 2010 were recorded. Subjects were identified in the Sports Injury Monitoring System and trainer records. Patient demographics, injury characteristics, and surgical information were recorded in all patients. Injury was defined as any event during practice or competition requiring medical intervention or necessitating time away from sport.

Results:

Between 2000 and 2010, 671 surgeries were performed in NCAA Division I athletes at a single institution. Eight-nine percent (597/671) of surgeries were performed in male athletes. In this study population, football accounted for 36% (243/671), lacrosse 14% (92/671), and wrestling 11% (73/671) of surgical procedures. By men’s sports, 22.5% of the gymnastics team, 17% of the basketball team, 15.6% of the football team, 14.2% of the lacrosse team, and 13.3% of the wrestling team had surgery each year during the ten year study period. By women’s sports, 14% of the soccer team, 11% of the volleyball team, and 7.3% of the basketball team had surgery each year during the ten year study period. Thirteen percent of women’s volleyball injuries, 9% of women’s soccer injuries, 6% of men’s basketball injuries, and 5% of football injuries received surgical intervention. The most common surgical sites were the knee in 38% (255/671), shoulder in 24% (161/671), and foot and ankle in 19% (128/671). There was no significant difference in the number of surgeries performed each year (p>0.05).

Conclusions:

In the largest epidemiologic description of surgical procedures performed at a single NCAA Division I institution we demonstrate that women’s volleyball and soccer injuries are most likely to require surgery. Although the total number of surgeries was greatest in football, the actual risk of surgery per number of team members was greatest in men’s gymnastics. This data may assist team physicians and athletic trainers to establish effective injury prevention and treatment protocols.
Relevant disclosure for all authors
Nothing to disclose
AOSSM 2012 Annual Meeting

Abstract Id:  Poster 68
Abstract Title: Intramuscular Ketorolac Injections in the Athlete

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Objectives:
Pain control is a crucial factor in the sideline treatment of competitive athletes. Ketorolac, also known as Toradol (Roche Pharmaceuticals, Nutley, New Jersey), is a nonsteroidal anti-inflammatory medication that can be used in its injectable form for the treatment of acute pain (1). Ketorolac injections by team physicians as a pain control measure are seemingly becoming more mainstream, although there has been little data published on its use. A survey of NFL teams in 2000 revealed 93% of teams administered Toradol to players for pain control (2). However, there has been no further research on its use in athletes at the high school, college, and professional levels. Our goal is to determine the prevalence, indications, administration patterns, and efficacy of ketorolac use at all competitive levels.

Methods: A 19-question survey was designed and generated online for distribution to physician members of the American Orthopaedic Society for Sports Medicine, the Arthroscopy Association of North America, and the American Medical Society for Sports Medicine. The survey link was emailed, with reminders sent every two weeks, and results were collected from April to June 2011.

Results: This survey was sent to approximately 4750 orthopaedic surgeons and 2200 primary care sports medicine physicians. The total number of respondents was 1100 (60% orthopaedics, 40% primary care-sports medicine). 94% of the respondents are involved in the direct care of athletes and 48.9% use IM ketorolac in their treatment. Of the primary care physicians who care for athletes, 57.3% use IM ketorolac, in comparison to 38.1% of orthopaedic surgeons. The most frequently recognized reasons causing respondents not to use IM ketorolac is fear of renal and bleeding complications. Post-injury pain (90.6%) is the most recognized indication for IM ketorolac use, and 95.8% feel that its administration decreases pain effectively in athletes (Fig 1). Few adverse reactions have been recognized with local skin reaction (5%), bleeding (2.9%) and kidney problems (1.9%) being the most frequent (Fig 1).

Figure: Fig 1
Complete results for ketorolac survey questions.

Conclusions:

Intramuscular ketorolac injections are being used by approximately 49% of sports medicine physicians in their care of athletes. These team physicians have noted a high rate of improved pain control and a low incidence of adverse reactions. The most frequently cited reasons for not administering ketorolac include fear of renal failure and bleeding complications, although the incidence of these events is low.

Acknowledgements: The authors would like to acknowledge Celeste Carriere for her work on the development and maintenance of the online survey.

References:


AOSSM 2012 Annual Meeting

Abstract Id: Poster 69
Abstract Title: Medical Expenditures in Collegiate Athletics - Analysis by Sport and Gender

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Objectives:
In order to better understand medical expenditures in collegiate athletics, the insurance claims of 36 teams at a single Division 1 athletic department were analysed. The focus of this report is on the medical expenses beyond the training room. These expenses have not been widely reported. Any analysis of medical costs of college athletics would be enhanced by awareness of the variation of medical expenses by specific sport. To this end, an analysis of medical expenses by individual sport was conducted at a large NCAA division 1 collegiate athletic program for a 5 year period.

Methods:
The claims and charges data for all athletic related injuries/illness over a 5 year period were obtained from the insurance coordinator for the athletic department. The data was analyzed for annual fluctuation and change over time. Sports were divided into corresponding male and female teams, female-only sports, male-only sports and coed sports. Linear regression analysis was used to compare the corresponding male and female teams. Number of claims and total charges were analyzed by team/year and after normalizing for roster size, by athlete/year.

Results:
The team claims and charges were stable over the 5 year timeframe. In 11 of the 14 gender matched sports the female athletes had higher average annual charges; correspondingly female athletes had higher average number of annual claims in 13 of the 14 matched sports. After normalizing for roster size in the gender matched sports, female athletes had .97 more average annual claims (p<0.01) and $1,459 higher annual charges (p=0.001) than their male counterparts. The charges per claim were similar between the genders. The five teams with the highest average annual charges were: football, wrestling, softball, crew, and men’s lacrosse. When normalized for roster size the five sports with the highest average annual charges per athlete were: softball, women’s diving, men’s basketball, wrestling, and men’s gymnastics.

Figure:
Conclusions:

Charges per claim were similar between the matched gender sports, but the female athletes had a higher number of annual claims and thus higher total charges per athlete/year. Football had the highest average annual total charges, but when normalized for roster size, the charges per athlete/year were similar to many other sports. More research is needed into why gender differences in athletic medical expenses exist.

Relevant disclosure for all authors
Nothing to disclose
AOSSM 2012 Annual Meeting

Abstract Id: Poster 70
Abstract Title: Biomechanical Analysis of the Pectoralis Major and Comparison of Techniques for Tendo-osseous Repair

Authors
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Objectives: Pectoralis major repair is indicated in young active patients to improve strength and cosmesis after full thickness muscle rupture, yet literature on surgical management is sparse and without consensus. The goal of this study is to evaluate the biomechanical profiles of the native tendon and three repair techniques: traditional trans-osseous (TO), suture anchor (SA), and the novel endosteal “pec button” (PB), in order to make evidence-based treatment recommendations for pectoralis major repair.

Methods: 24 human cadaveric shoulders were dissected, standardized for bone density, and randomized into one of 4 groups: intact tendon, TO, SA, and PB. Native footprint length/width were recorded to determine %footprint restoration for each technique. Repair of an isolated pectoralis major tear was performed by methods determined by the senior authors using #2 Orthocord (Depuy Mitek, Raynham, MA) with 6 sutures in a modified Mason-Allen suture configuration. The only variable tested was bony fixation type. Tensile testing using an adjustable-angle fixture at 30° involved: (1) 10N preload for 2 minutes, (2) cyclic loading of 10-160N for 100 cycles at 100N/s, (3) pull-to-failure at 1 mm/s. Gap formation was measured by optical tracking. Data was statistically assessed using ANOVA with a Tukey post-hoc test for multiple comparisons.

Results: Pectoralis major native footprint length and width were 65.4±12.2 mm and 6.2±1.2 mm, respectively. No significant difference in %footprint restoration was found among repairs. Maximum load to failure of the intact tendon (1454.8N ±795.7) was significantly greater than those of the TO (359.2N ±110.4), SA (307.7N ±44.4), and PB (353.5N ±88.3) groups (p<.001). No statistically significant differences existed among repair types with regard to maximum load to failure (p>.05). None of the repaired specimens failed at the bony interface. Mode of failure for all specimens in each repair group was suture pulling through tendon.

Conclusions: This study shows that current tendo-osseous repair techniques for pectoralis major rupture have similar biomechanical profiles. All repairs failed at the suture-tendon interface, suggesting that bony fixation type may be less important, and technique choice should remain influenced by surgeon experience. Future research should focus on suture characteristics and configuration to improve the strength of the biomechanical construct. The significant difference between the strength of the intact tendon and time-zero repair groups provides a rationale for protection and immobilization during the early post-operative healing period.

Relevant disclosure for all authors
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