2014 Scientific Program
Abstracts — Wednesday

(An asterisk (*) by an author's name indicates the presenter.)

Wednesday, December 17, 2014

General Session 6: Shoulder I
(Palomino Ballrooms 8-10)

Civilian Moderator: **Robert A. Arciero, MD**
Military Moderator: **LCDR Michael P. McCabe, MD**

0815-0820

Return To Play In Intercollegiate Collision Sports Following Latarjet Procedure

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Introduction: Anterior glenohumeral instability related to glenoid bone loss is a challenging problem in a young, athletic population. The return to play (RTP) percentage and factors affecting RTP after Latarjet among collegiate athletes participating in collision sports are not well defined. The purpose of this study was to provide outcome data pertaining to RTP in collision sports after surgery and validated outcome testing specific to the shoulder and shoulder instability after surgery.

Methods: A retrospective review of seven collegiate athletes participating in collision sports who had undergone the Latarjet procedure for treatment of recurrent anterior glenohumeral instability was conducted to determine RTP. Clinical outcomes were assessed with the Western Ontario Shoulder Instability (WOSI) Score, pain as assessed by the Visual Analog Scale (VAS), Single Assessment Numeric Evaluation (SANE), and Simple Shoulder Test (SST).

Results: Seven National Collegiate Athletic Association (NCAA) Division I collegiate athletes-including five Football Bowl Subdivision (FBS) players- participating in collision sports were treated with the Latarjet procedure. At an average of two year follow-up, four out of the seven (60%) of players were able to RTP following surgical treatment. The average time to RTP was 7.25 months. There were no post-operative complications. One patient was noted to have recalcitrant anterior glenohumeral instability with athletic activities following surgery. The average WOSI, SANE, and SST scores were 174.9, 91.1, and 12 respectively.

Discussion and Conclusion: The RTP rate following the Latarjet procedure is acceptable for collegiate athletes participating in collision sports based on a small cohort of patients; aside from RTP, all players had excellent patient-based outcome scores.

Notes:

0820-0825

Return To Intercollegiate Football Following Arthroscopic Anterior Shoulder Stabilization

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Introduction: High rates of recurrent instability following arthroscopic stabilization for anterior shoulder instability in collision athletes have led some authors to favor open stabilization techniques in this patient population. There is no consensus on the optimal method of stabilization (arthroscopic or open) in collision athletes with anterior shoulder instability.

The purpose of this study was to examine the rate of recurrent shoulder instability following arthroscopic stabilization in an intercollegiate American football population.

Methods: Over 10 academic years, 50 intercollegiate football players underwent primary arthroscopic anterior stabilization for recurrent anterior shoulder instability and returned to football. Preoperatively, 20 patients experienced recurrent subluxation and 30 patients experienced a single or recurrent dislocation. The primary outcome of interest was the ability to return to football without subsequent instability. Data collection at the time of primary stabilization included, previous instability events, type of instability (subluxation or dislocation), bone loss on preoperative MRI, and intraoperative capsulolabral pathology. Subjects were followed for time to a subsequent instability event (subluxation or dislocation) following return to play using days of exposure to football and total follow-up time in days following arthroscopic stabilization. Kaplan-Meier survival estimates were calculated for potentially important baseline characteristics that were suspected to be associated with subsequent instability during follow-up and between group differences were assessed using the log-rank test.

Results: Fifty subjects returned to American football for a mean 1.5 seasons (range 1-3 seasons). Three of fifty (6%, 95%CI: 1.3%-16.5%) subjects experienced recurrent instability following return to football after arthroscopic anterior shoulder stabilization. All recurrent instability events were sustained playing football and required revision open stabilization in two subjects and revision arthroscopic stabilization in one subject. Postoperative instability occurred in the first year following return to sport for two subjects. One athlete experienced postoperative recurrent instability three years after the index surgery. Athletes that had >15% glenoid bone loss at the time of primary arthroscopic stabilization were much more likely to experience recurrent instability requiring revision during the follow-up period ($p<0.001$). Subjects who had primary stabilization procedures that only addressed anterior structures were also significantly more likely to experience recurrent instability during the follow-up period ($p=0.023$). Significantly fewer anchors were used during the primary arthroscopic stabilization procedure in subjects who experienced recurrent instability requiring revision during follow-up ($p=0.005$) and lesions spanned significantly more extensive portions along the circumference of the glenoid ($p=0.001$).

Discussion and Conclusion: Modern arthroscopic stabilization techniques for anterior shoulder instability in intercollegiate American football players without glenoid bone loss may provide reliable outcomes with recurrence rates that are similar to open stabilization methods.

Notes:

0825-0830

The Presence Of An Anterior Labroligamentous Periosteal Sleeve Avulsion Lesion Not Predictive Of Failure Compared To Arthroscopic Bankart Repairs

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Objectives: Anterior labroligamentous periosteal sleeve avulsion lesions (ALPSA) have been identified as a potential risk factor for failure of an arthroscopic labral repair. The objective of this study was to compare the failure rates and clinical outcomes of arthroscopic ALPSA repair to arthroscopic Bankart repair. Additionally, the role of glenoid bone loss on failure rates was analyzed within each group.

Methods: This was a retrospective review of 72 consecutive patients with anterior shoulder instability (73 shoulders) who underwent an anterior arthroscopic labral repair at a single military institution by one of three Sports medicine fellowship trained orthopaedic surgeons. At the time of surgery, a diagnostic arthroscopy identified 13 (17.8%) ALPSA lesions and 60 (82.2%) isolated Bankart lesions. All lesions were repaired and placed on standard post-operative protocol. Data was collected on demographics, the Western Ontario Shoulder Instability (WOSI) score, SANE score, and recurrence rates. Failure was defined as recurrent dislocation. Additionally, glenoid bone loss in all patients was calculated using a standardized technique on preoperative images. Outcomes were analyzed by type of initial lesion.

Results: The average age at surgery was 26.3 years (range, 20-42) with average follow-up of 53.3 months (range, 28-63). There were 13 distinct ALPSA lesions and 60 Bankart lesions identified on diagnostic arthroscopy. There were no significant differences between groups with respect to any demographic data. There was 1 failure (7.7%) in the ALSPA group and 8 failures (13.3%) in the Bankart group (p=0.10). The ALPSA group had 13.1% glenoid bone loss compared to 13.5% in the Bankart group (p=0.88). There was no significant difference between groups for WOSI or SANE scores. When analyzing both groups using a previously established glenoid bone loss of 13.5%, there were significantly more failures in the Bankart group (7/31) than the ALSPA group (0/5).

Conclusions: Contrary to previously published data, we did not find patients with ALPSA lesions to be at an increased risk for failure of an arthroscopic repair compared to an isolated Bankart repair. Further, the presence of an ALPSA lesion was not predictive on increased glenoid bone loss. Additionally, there was no difference in functional outcomes between the two groups.

Notes:

0830-0835

Comparison Of Axial Width And Version Measurements Of Standard 2-Dimensional And Anatomically Aligned Computerized Tomography Scans

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Introduction: Standard computed tomography (CT) scans of the shoulder are aligned to the plane of the body as opposed to the scapula and glenoid. Consequently, this may result in imaging studies that distort the glenohumeral anatomy, and result in errors when measuring the glenoid, both in terms of anterior-posterior (AP) glenoid width and version. The hypothesis of this project is that the orientation of 2-dimensional (2D) CT scans in standard protocols is not optimized, and that failure to align a CT scan to the plane of the scapula may result in substantial differences in glenoid AP width and version measurements. The purpose of this study was to compare the axial AP width and version measurements of standard 2D CT scans of the glenohumeral joint done with traditional methods as opposed to methods that align the axial CT scan to the scapula and glenoid anatomically.

Methods: Thirty patients were selected from a database of shoulder imaging studies. Inclusion criteria to qualify a glenohumeral CT scan for this study was minimal to absent glenoid bone loss, absence of osteoarthritis, and no evidence of degenerative joint disease or joint space narrowing. Utilizing Osirix ™ software, traditional sagittal oblique CT scans of the glenohumeral joint were reformatted using 3-dimensional (3D) multi-planar reconstruction (MPR) to anatomically re-orient the scan to the plane of the glenoid and scapula, in both the axial and coronal planes, in order to achieve a new 2D sagittal image of the glenoid that was a true en face view of the glenoid. Once an en face view was attained, the image was then rotated in the sagittal plane to align the glenoid face along the 12 o'clock to 6 o'clock axis. This longitudinal axis of the glenoid, from the superior tubercle to the inferior tubercle, is defined in this study as 0o, and was approximated based on previous anatomic studies. The degree of rotation required to align the sagittal en face view from the standard angle to the 0o angle was noted and recorded as the "sagittal rotation" angle. Axial anterior-posterior (AP) width and version measurements were then taken at five cuts across a best-fit circle of the inferior glenoid, in both the standard and 0o rotations.

Results: Unoptimized (UNOPT) CT scans aligned to the plane of the body required a mean correction for coronal inclination of the glenoid of 5.8 degrees (range, -10.7 to 4.5, SD 5.6). Scapular angle required a mean correction of 34.7 degrees (range, 17 to 55, SD 8.3) to optimize the scans. In the sagittal plane, 20.1 degrees of rotation was required to optimize the scans. Over five cuts, optimized (OPT) CT scans had a mean difference in glenoid version of 2.4 degrees (2.6%), (range, 2.2 to 2.5, SD 0.12), and a mean difference in axial AP width of 1.2 mm (5.2%) (range, 0.8 to 1.7 mm) depending on the axial cut. This corresponds to a 3-9% error in measurement of the AP width of the glenoid in the axial image.

Discussion and Conclusion: These findings demonstrate that UNOPT CT scans of the glenohumeral joint do not correct

for the axial plane and coronal inclination of the glenoid by a large degree. This results in substantial error in both version and AP width measurements of the glenoid. In order to obtain an ideal glenohumeral joint representation, one should correct the axial and coronal images to be aligned with the plane of the glenoid and not in the plane of the body, as this may have notable implications for decision making and surgical treatment.

Notes:

0835-0840

Comparison Of Glenoid Version And Posterior Humeral Subluxation In Patients With And Without Posterior Shoulder Instability

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Introduction: Posterior shoulder instability is less common than anterior instability and often can be more challenging to diagnose. While clinical examination is the primary means of diagnosis, MRI is an important adjunct in diagnosis and clinical decision-making. However, clear evidence of posterior labral pathology even with a contrast MRI can be elusive and other diagnostic findings and criteria may be helpful. Determining other findings on MRI that are characteristic of posterior instability may assist clinicians in diagnosis and treatment of posterior shoulder instability.

Methods: All patients over a two year period from two shoulder surgeons treated operatively for posterior instability and having a preoperative magnetic resonance imaging (MRI) or magnetic resonance arthrogram (MRA) were included. Patients who had additional procedures were allowed to be included if those procedures did not account for any instability (ie - subacromial, biceps tendon or distal clavicle pathology). A cohort of patients who were operated on for rotator cuff tears (excluding subscapularis), superior labrum or distal clavicle pathology without instability who also had an MRI or MRA were matched by sex, laterality and age (+/- 2 years). MRIs were reviewed for presence or absence of a posterior labral tear, glenoid version and percentage of humeral subluxation. No patients with anterior instability, multi-directional instability, subscapularis tears or those having revision surgery were included.

Results: There were 41 patients in each group. The average age of both groups of patients was 35 (range 16 - 63). 73% of patients in the experimental group and 2% in the control group had a documented posterior labral tear on MRI or MRA. Glenoid version averaged 8.5 degrees of retroversion (st dev 6.00) in the documented posterior instability group and 6.9 degrees of retroversion (st dev 3.9) in the control group and was not statistically significant (p=0.18). Humeral subluxation averaged 58% posterior (st dev 0.07) in the documented posterior instability group and 54% posterior (st dev 0.06) in the control group, however this difference was statistically significant (p=0.02).

Discussion and **Conclusion:** Glenoid version is a known risk factor for the development of glenohumeral arthritis and posterior labral tears are more prevalent in shoulders with moderate to severe glenoid dysplasia compared to those shoulder with no dysplasia or mild dysplasia. The position of the humeral head in relation to the glenoid can be measured on the axial cuts of an MRI or computed tomography (CT) scan and the percentage of subluxation has implications in the treatment of glenohumeral arthritis. The implications of posterior humeral head subluxation in regards to the treatment of posterior shoulder instability has not been evaluated previously. Patients with posterior instability do not often present with the same sensations of subluxation or the reports of dislocations as their counterparts with anterior instability. Diagnostic imaging is often a key component of the decision making of whether or not an operative procedure is indicated. This study demonstrates that despite the similar glenoid version between groups, there was a statistically significant difference in the amount of posterior humeral subluxation in the experimental group. This supports the hypothesis that posterior humeral subluxation is not merely a function of being in the supine position and was found to be different between patients with known posterior instability and a matched cohort of patients who

were treated operatively for conditions other than posterior instability.

Notes:

0840-0845

Clinical Validation Of The "On-Track" Vs. "Off-Track" Concept In Anterior Glenohumeral Instability

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Introduction: Bone loss is a well-described risk factor for failure with arthroscopic stabilization. The isolated importance of bone loss on both the glenoid and humeral side has been increasingly studied. A more recent evolution considers how both the glenoid and humeral bone loss interact to determine whether their combination results in an "on-track" or "off-track" lesion, which may be more predictive of recurrent instability than looking at either side individually. While the biomechanics of this concept have been elucidated, no study has tested this theory in a clinical population. The purpose of this study is to compare a series of arthroscopic Bankart reconstructions stratified by whether they are "on-track" or "off-track" with regard to bipolar bone loss and to compare their rates of recurrence and functional outcome scores.

Methods: Over a two year period, all isolated, primary Bankart reconstructions performed at a single facility by one of three fellowship trained Orthopaedic Sports Surgeons were included in this study. All patients had preoperative advanced imaging and had postoperative outcome measures including SANE and WOSI scores, as well as data return to work status. Glenoid bone loss, Hill-Sachs lesion size and location, as well as a radiographic measurement of the glenoid track were measured. Patients were stratified according to whether they sustained a subsequent recurrence of their instability, and these groups were analyzed according to their bone loss status, specifically whether they were "on-track" or "off-track".

Results: 57 shoulders met inclusion criteria. The average age was 25.5 years (range 20-42) at the time of surgery. There were 10 recurrences (18%). Patients in the recurrent group had WOSI and SANE scores that were roughly half as good as the group that did not recur (p=0.003 and p=0.002 respectively). Of the 49 on-track patients, 4 failed (8.2%). Conversely, of the 8 off-track patients, 6 failed (75%, p=0.0001). Six of the 10 (60%) of the patients who sustained a recurrence of their instability after arthroscopic stabilization were off-track at the time of their surgery. In contrast, in the 47 patients who remained stable at latest follow-up, only 2 (4.3%) were off-track (p=0.0001). Eight of 47 patients (17%) in the non-recurrent group had glenoid bone loss greater than 20%; two of 47 stable patients (4%) were off-track. The positive predictive value (PPV) of the off-track measurement was 75% which was significantly higher than the predictive value of glenoid bone loss >20% (PPV=43%, p=0.02).

Discussion: This is the first study to apply the on-track vs. off-track assessment of bipolar bone loss to a clinical population. In this study, being off-track was a significant predictor of recurrent instability after isolated Bankart reconstruction, correctly predicting failure in 75% of cases. This was superior to the predictive value of glenoid bone loss >20% alone, which correctly predicted failure 43% of the time. Recurrence correlated with worse functional outcomes scores. Bipolar bone loss as measured by the track method is quite accurate in predicting success and failure after arthroscopic Bankart reconstruction in a clinical population. This method of assessment is encouraged as a routine part of the preoperative evaluation of all patients under consideration for arthroscopic anterior stabilization.

Notes:

0845-0850

Glenoid Bone Loss In Posterior Shoulder Instability: Outcomes After Arthroscopic Stabilization

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Introduction: Glenoid bone loss is well-known to have detrimental effects on arthroscopic stabilization in patients with anterior shoulder instability. With a young athletic population having more recently reported increased rates of posterior instability, risk factors for failure of primary arthroscopic treatment should be evaluated. Posterior glenoid bone loss has recently been discussed on its existence; however, patient outcomes have not been correlated.

Methods: An IRB approved retrospective review was conducted at an active Military Treatment Facility (MTF) over a four-year period, between 1 June 2007 and 31 May 2011. Isolated, primary posterior instability cases which underwent arthroscopic posterior labral repair were identified. Preoperative imaging was used to assess the posterior glenoid using the standardized "perfect circle" technique employed in measurement of anterior instability. Patients were divided based on percentage bone loss. Patients were contacted and outcome scores were obtained including Single Assessment Numeric Evaluation (SANE) and Western Ontario Shoulder Instability (WOSI). Outcome scoring was compared to percentage bone loss.

Results: There were 43 consecutive cases of isolated, posterior shoulder instability that underwent primary arthroscopic stabilization. Functional outcomes scores were obtained in thirty-two patients (74%). There were 2 females and 30 males. The average age at the time of surgery was 30 (Range: 20-47). Average bone loss was 7%, with 6 of 32 (19%) demonstrating bone loss >10%. Increased bone loss was not a statistically significant predictor for a worse WOSI or SANE score. There was no association between bone loss and revision surgery, recurrence of symptoms, or the ability to return to full activity.

Discussion/Conclusion: Posterior glenohumeral instability traditionally comprises approximately 10% of total shoulder instability. Although posterior glenoid bone loss has been shown to be measurable using MRI, our patient outcome data suggests it does not carry the same implications, or risk of worsened outcome, in surgical management as its anterior counterpart.

Notes:

0900-0905

Pectoralis Major Rupture In Young Collegiate Athletes

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Introduction: Rupture of the pectoralis major muscle (PMM) is a rare event in young collegiate athletes. There has been a recent increase in the incidence of PMM ruptures in weightlifting athletes; however, little is known about the characteristics of these tears in the collegiate athlete population. Previous studies have analyzed PMM ruptures in older cohorts of average ages 30-40 years. Only isolated case reports have been reported in a young collegiate population where biomechanical movements involving the PMM are specific to their physically demanding training. Due to this sporadic reporting of the event in young collegiate athletes, it is challenging to determine risk factors for rupture and well-defined performance measures following surgical repair. Moreover, no studies have analyzed push-up performance as an outcome measure following PMM surgery. The objective of this study is to describe a series of PMM ruptures in young, physically-fit cadets at the United States Military Academy (USMA) and to determine the differences in the number of push-ups following surgical intervention.

Methods: We retrospectively reviewed PMM ruptures within the student population at the USMA, West Point, New York

from 2005-2014. Patients' records were used to collect information regarding patient demographics, past medical history, injury mechanism, physical exam findings, diagnostic imaging, treatment, and push-up performance on the biannual Army Physical Fitness Test (APFT) before injury and after surgical repair. Paired Student's t test was used to analyze statistical differences between the number of push-ups pre-injury and following surgical intervention. A Pearson's product-moment correlation coefficient was performed to determine if the difference in the number of push-ups post-operatively were correlated with return-time (duration of time interval between time of surgery and first performed APFT) participation in the APFT.

Results: During the years 2005-2014, twelve cases of PMM ruptures in USMA cadets were surgically repaired. The patients' ages ranged from 19 to 22 years, with a mean age of 20. All injuries were reported during sports activity with weightlifting as the most common mechanism (n=8, 67%). The most common rupture was at the PMM tendon insertion (n=5, 42%), followed by ruptures at the musculo-tendinous junction (n=4; 36%) and one bony avulsion. A bone trough technique was used in four repairs; a cortical button technique was used in four repairs; a suture anchor was used in one repair; and a modified Krakow suture of ruptured muscle to tendon in one repair. The mean number of APFT push-ups pre-injury was 74.56 (SD ± 12.00) with a trend towards lower number of push-ups following surgery (mean 68.22 ± 11.32, p=0.07). There was a moderate positive correlation (R= 0.68, p= 0.04) with respects to return-time and the change in the number of push-ups (post-operatively from numbers observed pre-injury).

Discussion and Conclusion: Young collegiate athletes with PMM ruptures demonstrate a trend towards lower number of APFT push-ups following surgical repair, with improvement in the number of push-ups as follow-up time approaches one year. Rupture type and location follow a pattern previously seen in young patients with PMM ruptures. The number of push-ups following PMM repair may provide an objective measurement of functional return-to-sport participation for young collegiate athletes.

Notes:

0905-0910

Acute Pectoralis Major Tears In Forward Deployed Active Duty U.S. Military Personnel: A Population At Risk?

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Introduction: As sport related activities and weight training broaden in popularity, the incidence of pectoralis major tears appears to be increasing. The purpose of our study is to report on the causes of a series of acute pectoralis major tears in active duty deployed military personnel; identify any patient specific risk factors and to confirm that in-theater surgical repair is possible in most cases.

Methods: Retrospective analysis of the medical records and imaging of 9 cases of acute pectoralis major tears evaluated and treated by the deployed military orthopedic surgeons at one expeditionary Medical Treatment Fascility (MTF) over a 4 month deployment cycle from December 2013 through March 2014 was performed.

Results: Nine male patients (5 USAF, USA 4) were diagnosed with pectoralis major tears; 7 complete tears at the tendinous insertion (Tietjen Type IIID), 1 complete tear at the musculotendinous junction (Tietjen Type IIIC) and 1 incomplete tear (Tietjen Type II) with a mean age of 32 years (23-52). All injuries occurred during bench press with a mean weight of 258 lbs (135-415 lbs), with the dominant upper extremity involved 56% of the time. Mean length of deployment was 230 days (120-365), with injury occurring an average of 77 days into the tour (3-198 days). Mean time from injury to surgical repair in the cohort was 18 days (10-43).

Discussion and Conclusion: Due to the alarming frequency with which pectoralis major ruptures were diagnosed and treated at one expeditionary military treatment facility over a short four-month deployment cycle; combat deployed active duty US military personnel likely represent a high-risk population for this injury. Surgical repair with a trough and transosseous repair technique is possible in the forward deployed setting and may be considered on a case-by-case basis.

Notes:

0910-0915

Acromioclavicular Ligament Reconstruction: Allograft Leads To Early Failure

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Background: Acromioclavicular joint injuries are a challenge to treat both operatively and non-operatively. There are a number of different techniques described for the reconstruction of these complex injuries. Over the last few years, there appears to be a trend in allograft usage among orthopaedic procedures. Its use has been reported to be as high as 40% in anterior cruciate ligament reconstruction patients. Being a relatively new surgical "implant" for orthopaedic surgeons to utiltize, it is difficult to determine appropriate use of allograft tendons in ligament reconstructions.

Purpose: To evaluate and compare the short term radiographic outcome of acromioclavicular (AC) ligament reconstruction using allograft and autograft.

Methods: A retrospective review was performed of a consecutive series of AC ligament reconstructions performed with coracoclavicular ligament and acromioclavicular capsular reconstruction using a free semitendinosis tendon graft (autograft or allograft). A fellowship trained shoulder surgeon analyzed the radiographs for maintenance of reduction. Reduction was defined as <5mm displacement of the coracoid-clavicular distance (CCD) compared to the uninjured side. Medical records were reviewed for operative details and functional outcome. Radiographic failure was defined as displacement greater than 5mm postoperatively.

Results: There were a total of 95 patients with an average age of 44.5 years of age that underwent coracoclavicular ligament and acromioclavicular capsular reconstruction. There were 62 (65%) patients that underwent reconstruction with autograft and 33 (35%) had allograft. 23 were distal clavicle fractures with a concomitant acromioclavicular joint separation. The overall failure rate was 28.4% (27/95) at an average of 6.8 months postoperatively. There was a significant increase in failure among the allograft group (42% vs 20% $p<0.05$). Other risks for failure were patients undergoing revision surgery, older age and severity of displacement preoperatively. Fracture was not a risk for failure in this group of patients.

Conclusion: Allograft tendon usage in acromioclavicular ligament reconstruction appears to be a risk factor for early failure in radiographic outcomes.

Notes:

0915-0920

Morphology Of The Acromioclavicular Joint And Association With Acromioclavicular Joint Injuries

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Introduction: Since the clavicle often dislocates or subluxates superiorly with injury to the acromioclavicular joint, having a distal clavicle that underrides the acromion may decrease the risk of these injuries. This study examines the effect of the angle of the acromioclavicular joint on the incidence and the degree of these injuries. An acromioclavicular joint angle that is overriding will have a greater likelihood of sustaining a displaced acromioclavicular joint injury and will have a higher degree of displacement.

Methods: Radiographs of 101 patients sustaining injuries to the acromioclavicular joint were assessed for the joint angle and degree of injury. These were compared to an age and sex-matched control cohort. An acromioclavicular joint angle of greater than 95 degrees was considered overriding, an angle of less than 85 degrees was considered underriding and the remainder were classified as neutral.

Results: There were 45 grade II, 35 grade III and 21 grade V acromioclavicular joint injuries. 77% of the injured patients had an acromioclavicular joint angle greater than 95 degrees, while only 65% of the uninjured patients had an angle greater than 95 degrees ($p=0.013$). There was no correlation with the degree of injury and acromioclavicular joint angle.

Discussion & Conclusions: There were a greater number of individuals with an acromioclavicular joint angle greater than

95 degrees in the injured group than in the control group. It appears that overriding acromioclavicular joint results in a greater risk for injury but does not affect the degree of injury.

Notes:

0920-0925

Medialized Clavicular Tunnel Position Predicts Failure After Anatomic Coracoclavicular Reconstruction

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MAJ Brian R. Waterman, MD
COL Mark P. Pallis, DO

Introduction: A recent clinical retrospective case series of 28 patients found that medialized conoid tunnel placement >25% of absolute clavicular length is correlated with early failure in anatomic coracoclavicular ligament reconstructions. Our purpose is to evaluate clinical and radiographic outcomes after anatomic CC ligament reconstructions among a large military cohort relative to absolute clavicular tunnel placement based on tunnel position to clavicular length ratio. This study will add to the current literature and validate previous findings.

Methods: The Surgery Scheduling System (S3) was queried for all procedures titled "Shoulder, AC joint Reconstruction or repair" as far back as the computer system would allow (year 2000). Patients with non-anatomic reconstructions were excluded. The electronic medical record and radiographic studies were reviewed for further analysis. Measurements were taken from the lateral border of the clavicle to the middle of each tunnel and divided by the clavicle length to determine a ratio. The conoid tunnel ratio was specifically looked at for failure due to position. These measurements were performed by a junior Orthopaedic Surgery resident and reviewed by a Sports fellowship trained attending surgeon. Radiographic failure was defined as >5mm displacement from immediate post-operative positioning. The initial query yielded 109 procedures. Of the 109 procedures non anatomic reconstructions were excluded, providing a data set of 40 anatomic coracoclavicular reconstructions.

Results: Of 40 anatomic coracoclavicular reconstructions, 27 tunnels had a ratio >.25, 9 tunnels were between .2 and .25, 4 tunnels were .25, yielding a 67% failure rate with this tunnel placement. The other 4 failures were in the tunnel ratio group of 25% the length of the clavicle was associated with failure, while any position lateral to this was not. Our study is consistent with the prior study with regards to medialized tunnel placement, however, a new finding with regards to maximum lateral position was noticed in our cohort. Failure was found to occur in all patients in whom the conoid tunnel was placed lateral to 20% of the total clavicle length. The optimal conoid tunnel placement seems to be between 20-25% of total clavicle length. All patients in our cohort with this ratio had no failures.

Conclusion: When determining the ideal tunnel positioning for anatomic coracoclavicular reconstruction, our study has shown that medialized tunnel placement >25% of total clavicular length is associated with an unacceptable rate of failure. Tunnel placement too lateral also is associated with failure. The optimal placement based on our result seems to be in the narrow range between .2 and .25 of the total clavicle length. This can be used as a guideline for orthopaedic surgeons performing anatomic coracoclavicular reconstruction for acromioclavicular joint separations.

Notes:

0925-0930

Initial Operative Versus Conservative Management In The Treatment Of Type V Acromioclavicular Dislocations

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MAJ Jason M. Cage, DO
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Introduction: Acromioclavicular (AC) joint injuries are common and constitute approximately 9% of all shoulder injuries. Traditionally Rockwood Types I and II are treated conserva-

tively, Type III dislocations are controversial, and Types IV, V, and VI AC dislocations are indicated for surgery. The basis for surgical recommendation for type V dislocations is limited. Little is known about non-operative treatment of Type V AC dislocations especially in active populations. The purpose of this study was to compare the outcomes between Type V AC dislocations treated initially with acute surgical intervention versus those treated conservatively.

Methods: A retrospective review was conducted using an automated search of electronic patient medical records from January 2007 through December 2012 for patients diagnosed with an AC dislocation in the Tripler Army Medical Center Department of Orthopedics. Patients were excluded who were not active military at the time of injury or who were tertiary referrals. Radiographs were reviewed and comparison was made to the contralateral shoulder. A Type V injury was defined as greater than 100% increase in the coracoclavicular (CC) distance compared to the contralateral side or greater than 2cm of displacement of the superior border of the clavicle unilaterally. Acute repair was defined as repair within 90 days without a trial of conservative therapy. Failure of conservative therapy was defined as being unable to return to full duty or requiring surgical intervention. A good outcome was defined as a return to full duty without limitations.

Results: 111 patients were identified with 60 patients having a bilateral shoulder films. Normal CC distances of the uninjured shoulder ranged from 4.3 mm to 18.66 mm with a mean of 9.09 mm and a standard deviation of 2.30 mm. 59 patients had a complete AC dislocation with the lateral end of the clavicle being displaced completely above the superior border of the acromion. 41 patients were Type V dislocations. 9 patients were tertiary referrals and were excluded. Acute surgical AC reconstruction was selected in 10 patients, initial conservative therapy was recommended for 22. In the conservative group: 11 patients (61%) returned to duty without surgery (average 97.8 days); 6 patients had delayed surgery and returned to full duty (average 131.3 days after surgery, 2 revisions); 2 refused surgery and changed careers; and 3 patients were lost to follow up. In the acute surgical group: 8 patients (88%) returned to full duty in an average of 190.6 days after surgery (mean time to surgery 28.29 days) with 4 of those requiring revision surgery; 1 patient was lost to follow up, and 1 patient failed to return to full duty. In the conservatively treated group, patients who failed conservative treatment and had a mean increase in CC distance of 129% (range 104%-166%) with a mean 20.2mm displacement (12.5-22.7mm). In the successfully treated group there was an average 150% increase in CC distance (range 102% - 217%) with a mean 19.34 mm displacement (12.73-24.22). There was no significance between the two groups for the increase in CC distance or mm of displacement (p= 0.32 and 0.69 respectively).

Conclusion: While numerous studies have evaluated the operative versus non-operative treatment of type III injuries in both a prospective and retrospective manner, no study to date has reported on the conservative treatment of type V AC dislocations. In this study we report on conservative treatment being successful in a majority of patients and that the average time to return to duty was not improved in an acute versus delayed surgical intervention. While more study is needed, this suggests that type V AC dislocations may be given a trial of conservative therapy. Secondarily we report on an increased range of the normal CC interspace (previously reported 1.1-1.3cm) and emphasize the need for a contralateral shoulder radiograph for accurate classification.

Notes:

Wednesday, December 17, 2014

General Session 7: Shoulder II
(Palomino Ballrooms 8-10)

Civilian Moderator: **Stephen S. Burkhart, MD**
Military Moderator: **MAJ Jeffrey Giuliani, MD**

1055-1100

Biceps Tenotomy Versus Tenodesis Of The Long Head Of The Biceps Brachii In Young, Active Duty Patients

CPT Jeremy McCallum, MD
CPT Shawn Gee, MD
CPT Jay B. Cook, MD
COL (Ret) Craig R. Bottoni, MD
COL John M. Tokish, MD
CDR Douglas J. Rowles, MD

Introduction: The treatment of intra-articular Biceps tendon pathology remains controversial. Tenotomy is simple but

may result in cosmetic deformity or functional deficits. For these reasons, many recommend tenodesis, especially in the younger, more active patient. There is no data, however, that compares outcomes from these procedures in a young population. The purpose of this study is to directly compare the outcomes of proximal biceps tendon pathology treated with either a tenotomy or tenodesis in a young active duty military population.

Methods: A retrospective, age matched case control study was performed at a single military medical center. All patients undergoing surgery for recurrent biceps tendinopathy by one of three fellowship trained orthopedic sports medicine surgeons were identified. Inclusion criteria consisted of: (1) Diagnosis of bicep pathology by MRI, physical exam, and arthroscopic examination (2) Age less than or equal to 40 (3) Tenotomy or tenodesis of the biceps tendon performed without any concomitant reconstructive procedures (5) Active duty status at the time of surgery. The patients were contacted and completed a detailed web-based assessment. Primary outcome measures included ASES, SANE, patient satisfaction, VR 12 scores as well as biceps specific questions about cramping, weakness, and deformity.

Results: During the study period, 113 patients underwent tenotomy and 154 underwent tenodesis, of whom, 26 tenotomy patients and 28 tenodesis patients met the inclusion criteria. The average age was 33 years (range: 23-40), and the follow up averaged 36 months. The average ASES score was 78.5 (range: 37 – 100) for tenodesis and 70.5 (range: 33 – 100) for tenotomy (p=0.26). The average SANE score was 61 (range: 7 –100) for tenodesis and 47 (range: 0 – 100) for tenotomy (p=0.26). The average patient satisfaction was 70 (range: 6 – 100) and 60 (range: 0 – 99) for tenodesis and tenotomy respectively (p=0.35). The average VR12 physical score for tenodesis 46.03 (range: 22.13 – 58.74) and tenotomy was 38.49 (range: 17.88 – 55.74) (p=0.035). There were no significant differences in the VR12 Mental Score, weakness, cramping, or cosmetic deformity between the two groups. Neither group noted a high rate of cosmetic deformity. Deformities, if any, were not concerning to patients in either group.

Discussion: Surgical treatment of biceps pathology with either tenotomy or tenodesis resulted in similar results in a population of young active duty patients with the exception of a 7.5 point statistically significant difference in the VR12 Physical Score. Concerns of cramping, weakness, and cosmesis were infrequent and occurred equally with both procedures. Neither treatment appears to be as effective in this patient population as in previous reports on older study cohorts.

Notes:

1100-1105

Clinical Outcomes Of SLAP Repair In The U.S. Military: Predictors For Failure Among 192 Patients

CPT William Arroyo, MD
COL Mark P. Pallis, DO
MAJ Brian R. Waterman, MD

Introduction: The current evidence suggests that arthroscopic repair is an effective treatment of type II SLAP lesions, although there may be a unacceptably high rate of failure and repoperation in the military population. The purpose of this study is to quantify the rate of surgical failure after SLAP repair procedure, as well as to identify demographic and surgical risk factors associated with poor outcomes.

Methods: A retrospective query was performed to identify all consecutive active duty servicemembers undergoing arthroscopic repair of type II SLAP lesions at a single institution between 2006 and 2012. All patients with less than 2-year clinical follow-up, non-military status, or rotator cuff repair were excluded. Demographic variables [age, gender, rank, military occupational specialty (MOS)], injury history, surgical variables (perioperative complications, concomitant/secondary procedures, revision) and occupational outcomes (medical discharge, return to duty, permanent activity limitations) were extracted. Rates of failure, defined as subsequent revision surgery or medical discharge with persistent shoulder complaints, were recorded from the electronic medical record and cross-referenced with the US Army Physical Disability Agency database.

Results: After the exclusion of 74 patients, a total of 192 patients with SLAP repair were isolated with an average follow-up of 50.0 months (SD, 17.0 months). Patients were predominately male (96%; n=184) and the mean age was

35.0 years (SD, 8.2 years; range 20-56). High-demand combat MOS was identified in 38% (n=72) of the patients, and enlisted servicemembers accounted for 86% (n=165). Postoperative return to duty occurred in 79.6% (n=153) and only 20% (n=39) were discharged with continuing shoulder disability. In this analysis, 20% (n=39) patients had a preoperative history of instability and 58% (n=112) reported history of trauma. Isolated SLAP repair was performed in 31% (n= 60), and concomitant procedures were performed in 69% (n=132), including the following: combined Bankart repair (n=42), posterior labrum repair (n=8), and panlabral repair (n=10). At final follow up, 37% (n=71) patients had activity-related shoulder pain, 7% (n=14) complained subjective stiffness, and 3% (n=6) experienced recurrent instability. Return to duty rates were highest in the combined Bankart repair group (88%), followed by combined subacromial decompression/ distal clavicle resection (87%), combined posterior labrum (75%), isolated SLAP repair (70%), and panlabral repair cohorts (70%). A total of 31 (16%) patients were classified as surgical failure and required revision SLAP repair or subpectoral biceps tenodesis. In the revision group to biceps tenodesis (76%) patients returned to active duty, as compared to revision SLAP repair with only 17%. A traumatic etiology and the presence of combined shoulder injuries were associated with a lower risk of medical discharge or revision surgery.

Conclusions: Our findings indicate that favorable outcomes can be anticipated in the majority of U.S. Army servicemembers after arthroscopic repair of type II SLAP tears, particularly with combined shoulder injuries. Revision surgery occurred in 16% of patients after primary SLAP repair, and secondary biceps tenodesis demonstrated improved functional outcomes over revision SLAP repair. Isolated treatment of type II SLAP lesions and/or atraumatic, overuse pathology were associated with higher rates of failure in this population. Judicious clinical evaluation and patient selection are paramount for reproducible success in the surgical treatment of type II SLAP tears.

Notes:

1105-1110

Clinical Comparison Of Intramedullary Cortical Button Fixation And Suture Anchor Fixation For Subpectoral Biceps Tenodesis

MAJ Kelly Kilcoyne, MD
Bashir A. Zikria, MD
Umasuthan Srikumaran, MD, MSc
Qais Naziri, MD

Introduction: The long head of the biceps is a common source of anterior shoulder pain. Biceps tenodesis has been performed in patients with anterior shoulder pain in conjunction with rotator cuff tears and also for failed SLAP repairs. While there are varying tenodesis techniques, subpectoral tenodesis has several advantages, including maintaining the length tension relationship of the biceps muscle, decreased risk of groove pain by removing the tendon out of the groove, and superior cosmesis. The purpose of this study was to clinically evaluate early outcomes and complication rates of two techniques for subpectoral biceps tenodesis; intramedullary cortical button fixation compared to suture anchor fixation technique.

Methods: The records of two fellowship trained Sports surgeons were reviewed to determine the number of patients who underwent subpectoral tenodesis. The majorities of cases were performed in conjunction with rotator cuff repairs and failed SLAP repairs. A total of 60 patients underwent open subpectoral biceps tenodesis including 30 with intracortical button and 30 with suture anchor fixation. Average follow up was 6 months (range, 3 to 14 months).Patient records were reviewed to determine ASES score and VAS pain scores pre- and postoperatively. Complications were determined as persistent pain at the tenodesis site, failure of fixation, cosmesis, deformity (popeye) and nerve and wound complications. The mean pre- and post-operative scores were compared among those receiving the same technique and then again between the two separate groups. Student t- tests were used to compare the means of each variable and a p value of <0.05 was considered to be statistical significant.

Results: There were zero failures of fixation in this study. All patients showed significant improvement between their preoperative and postoperative status with regard to ASES score and VAS pain, (all p values <0.001). There was no significant difference in post operative VAS score, ASES score, or complication rates between the two groups. Two patients in the intra cortical button group had transient post operative numb-

ness along the lateral antebrachial cutaneous nerve caused by a homan retractor placed medially during the procedure.

Conclusions: The use of a suture anchor and intracortical button are both safe and effective techniques for subpectoral tenodesis. Both techniques showed significant improvement in pain and functional outcomes in all patients, with minimal complications. There were no significant differences between the two groups. The authors recommend taking caution when placing medial retractor during exposure to minimize risk of transient sensory disturbance.

Notes:

1110-1115

Arthroscopic Transosseous Rotator Cuff Repair Is Cost Effective Compared To Anchored Technique

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Introduction: Current trends in arthroscopic rotator cuff repair have focused on restoration of and compression across the natural anatomic footprint, which historically reflects the repair obtained with the traditional, open transosseous technique. Recent advancements in instrumentation have accommodated an arthroscopic, anchorless transosseous repair, which reproduces the gold standard of open transosseous repair. Currently, no published literature exists directly comparing arthroscopic, anchorless, transosseous repair to standard arthroscopic anchored techniques.

Methods: We conducted a retrospective case-control analysis of 90 arthroscopic rotator cuff repairs performed by a single surgeon with minimum 1 year follow up. The control group included patients who underwent arthroscopic anchored repair including both single and double row constructs. The experimental group included patients who underwent arthroscopic anchorless, transosseous repair. We excluded patients with isolated partial thickness tears, revision cuff repair, and isolated repairs of the subscapularis. Baseline demographic data included age, sex, and shoulder dominance. Intraoperative data on the tear size, number of tendons involved and degree of retraction was recorded prospectively. All patients had full thickness tears of the supraspinatus and/or infraspinatus tendons. We collected visual analog pain (VAS), subjective shoulder value (SSV), and American Shoulder and Elbow Surgeons (ASES) scores. We recorded range of motion and postoperative complications. Statistical and cost analysis was performed.

Results: There were 30 patients in the control group and 30 patients in the experimental group who met all inclusion criteria and completed a minimum 1 year follow up. Baseline demographic data for age ($p=0.07$) and sex ($p=0.87$) did not differ between groups, although there was a trend toward older patients in the anchorless, transosseous group. Compared to the anchored group, the anchorless, transosseous group was found to have significantly larger tear size ($p<0.001$). At minimum 1 year follow up, there was significant ($p<.001$) postoperative improvement in both groups with respect to SSV, VAS, and ASES scores compared to preoperative scores. There was no difference between the two groups with respect to SSV ($p = 0.43$), pain score ($p = 0.42$), ASES score ($p=.21$) or range of motion in abduction, forward elevation, and external rotation ($p=0.25$, 0.70, 0.71 respectively). There were no infections, nerve injuries, or returns to the operating room in either group. Cost analysis suggested 30-80% implant savings per case for the anchorless, transosseous group depending on tear size.

Discussion and Conclusion: Arthroscopic transosseous rotator cuff repair achieves similar clinical and patient reported outcomes with 30-80% reduction in implant costs, compared to traditional anchored techniques. This case-control analysis demonstrates arthroscopic anchorless, transosseous rotator cuff repair is clinically equivalent and cost effective compared to traditional anchored rotator cuff repair.

Notes:

1115-1120

Does The Application Of Compression Stockings Decrease The Risk Of Cerebral Desaturation Events In Obese Patients Undergoing Shoulder Arthroscopy In The Beach Chair Position?

Maj Dane H. Salazar, MD
Alexander Tauchen, MD
Douglas A. Evans, MD
Nicholas G. Garbis, MD
Pietro M. Tonino, MD

Introduction: Shoulder arthroscopy in the upright, or beach chair position (BCP) has been associated with cerebral hypoperfusion. Evidence suggests this may be more common in obese patients. The purpose of this study was to determine if the use of thigh high compression stockings could decrease the incidence of cerebral desaturation events (CDEs) in patients with a body mass index (BMI) ≥ 30 who underwent shoulder arthroscopy in the BCP. The hypothesis was that the use of the stockings would decrease the incidence of CDEs in this patient population.

Methods: Between December 2013 and May 2014, 23 patients ≥18 years of age with BMI ≥ 30 undergoing shoulder arthroscopy in the BCP were monitored intraoperatively using near-infrared spectroscopy (NIRS) while wearing thigh-high compression stockings. Data obtained was compared to data from a previous cohort at our institution in which 24 patients with BMI ≥ 30 underwent elective shoulder arthroscopy in the BCP with the same monitoring but without wearing compression stockings. The incidence of CDEs was identified in each group.

Results: The incidence of CDEs in the group with compression stockings was 4% (1/23) compared to 18% (7/24) in the group without compression stockings (P = 0.048). There were no significant differences in mean age (53.0 years vs 53.3 years; P = 0.91), BMI (34.5 kg/m2 vs 36.2 kg/m2; P = 0.21), or various medical comorbidities between the group with compression stockings and the historical control group.

Discussion: The use of thigh high compression stockings may decrease the incidence of CDEs in obese patients undergoing shoulder arthroscopy in the BCP.

Notes:

1120-1125

Thirty-Day Morbidity, Mortality, And Length Of Hospital Stay After Elective Total Shoulder Arthroplasty

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COL Philip J. Belmont Jr., MD
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Andrew J. Schoenfeld, MD
Julia O. Bader, PhD

Introduction: Total shoulder arthroplasty (TSA) is an effective treatment for painful glenohumeral arthritis, but its morbidity has not been thoroughly documented.

Methods: The National Surgical Quality Improvement Program (NSQIP) database was queried to identify all patients undergoing primary TSA between 2006 and 2011, with extraction of selected patient-based or surgical variables and 30-day clinical course. Postoperative complications, mortality, and length of hospital stay were recorded. Odds ratios (OR) with 95% Confidence Intervals (95% CI) were derived from bivariate and multivariable analysis to express the association between risk factors and clinical outcomes and length of hospital stay.

Results: Among the 2004 patients identified, the average age was 69 years and 57% were female. Obesity was present in 46% and 48% had an American Society of Anesthesiologists (ASA) classification of ≥3. The 30-day mortality and total complication rates were 0.25% and 3.64%, respectively. Comorbid cardiac disease (OR 85.31; 95% CI 8.15, 892.84) and increasing chronological age (OR 1.19; 95% CI 1.06, 1.33) were independent predictors of mortality, while peripheral vascular disease was associated with statistically significant increase in any complication (OR 6.25; 95% CI 1.24, 31.40). Operative time >174 minutes was an independent predictor for developing a major local complication (OR 4.05; 95% CI 1.45, 11.30). Obesity was not associated with any specified complication after controlling for other variables. Mean length of stay after TSA was 2.2 days [Standard Deviation (SD) 1.7], and 91% of cases received hospital discharge in less than three days. Multivariable logistic regression analysis identified renal insufficiency (OR 11.35; 95% CI 1.68, 76.49; p=0.0002), increased age (OR 2.13; 95% CI 1.11, 4.07; p=0.011) longer operative time (OR 1.94; 95% CI 1.23, 3.04; p=0.0041), and ASA ≥3 (OR 1.86; 95% CI 1.27, 2.74; p=0.0016) as the most significant risk factors for length of

stay. Gender also influenced length of stay, with women were more likely to stay ≥4days [OR: 0.44 (95% CI: 0.29, 0.66, p<0.0001)].

Conclusions: While TSA has low short-term rates of perioperative complications and mortality, careful perioperative medical optimization and efficient surgical technique should be emphasized to decrease morbidity, mortality, and length of hospital stay.

Notes:

1140-1145

The Subjective Shoulder Value Correlates Well With The American Shoulder And Elbow Surgeons Score

MAJ Kelly Kilcoyne, MD
Umasuthan Srikumaran, MD
Meera R. Chappidi, BA
Casey Hannan, BS
Steve Petersen, MD, MSc
Edward McFarland, MD
Bashir A. Zikria, MD, MSc

Introduction: Assessing patient reported outcomes before and after surgery is important to evaluate the success of surgical procedures, to conduct value analyses, and to perform cost-effectiveness research. Numerous measures exist and vary with respect to their administrative burden and complexity. An ideal tool would be short, simple to complete, and correlate well with more extensive and detailed evaluations. The Subjective Shoulder Value (SSV) is single scale question regarding the patient's subjective evaluation of their shoulder (0-100, 100 being completely normal). The American Shoulder and Elbow Surgeons (ASES) standardized assessment score is an eleven question assessment tool with proven validity, reliability, internal consistency, and responsiveness.

Methods: We retrospectively reviewed 100 consecutive patients undergoing rotator cuff repair at one institution. We recorded the SSV and American Shoulder and Elbow Surgeons (ASES) scores preoperatively and at 1 year minimum follow up. We calculated the Pearson correlation statistic between the SSV and the ASES preoperatively and postoperatively.

Results: At minimum 1 year follow up, there was significant (p<.001) postoperative improvement in both the SSV and ASES scores compared to preoperative scores. The Pearson correlation statistic (r) between the SSV and the ASES score was 0.60 preoperatively and 0.74 postoperatively.

Conclusion: The SSV is an efficiently administered outcome measure and correlates well with the ASES score in patients undergoing rotator cuff surgery both preoperatively and postoperatively. The Subjective Shoulder Value correlates well with the American Shoulder and Elbow Surgeons Score in patients undergoing rotator cuff repair, allowing for efficient assessment of patient outcomes.

Notes:

1145-1150

Performance Variations In Knotted Suture Anchors Versus Knotless Suture Anchors

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Bryan Hanypsiak, MD
Lillian Simmons, BA
Walter R. Lowe, MD
Stephen S. Burkhart, MD

Introduction: The purpose of the study was to evaluate and compare maximum load to failure, 3 mm displacement (clinical failure), knot stack height, and timing of arthroscopic knotted suture anchors versus knotless suture anchors performed by 71 independent expert orthopaedic arthroscopists.

Methods: Each surgeon tied three of the same type of their preferred arthroscopic knot and half hitch locking mechanism using a 5.5 mm knotted anchor versus three 5.5 mm knotless anchors. A 10/20 pcf sawbones block was utilized. Each knotted anchor and knotless anchor was timed, the knot stack height was measured, and the constructs were mechanically tested for maximum load to failure and clinical failure.

Results: For the 213 knotted anchors tested, the average maximum load was 177N (standard deviation (STD), 93N). The average clinical failure load was 84N (STD, 33N). The average extension at maximum load was 12N (STD, 9N). The average time of the knotted anchors was 83 seconds per anchor (STD, 28 seconds). The average knot stack height among the 213 knots was 5.35 mm (STD, 0.97 mm). For the 213 knotless anchors tested, the average maximum load was 155N (STD, 19N). The average clinical failure load was 89N (STD, 33N). The average extension at maximum load was 6.34N (STD, 2.34N). The average knot stack height among the 213 knotless anchors was essentially zero. The average time of the knotless anchors was 41 seconds per anchor (STD, 14 seconds). Significant differences in knotted versus knotless anchors existed in maximum load to failure ($P = 0.013$) and extension at maximum load ($P < .001$); however, there were no difference in clinical failure load ($P = 0.427$). There were significant differences in knot stack height ($P < 0.001$) and time to complete the anchor ($P = < 0.001$).

Discussion and Conclusion: Knotless anchors and tied anchor performance were equivalent at clinical failure (3 mm extension). Knotless anchors were 5 times more consistent than tied anchors at maximum load. Knotless anchors were 2 times faster than tied anchors. Knotted anchors had a knot stack height of more than 5 mm versus knotless anchors.

Notes:

1150-1155

The West Point Knot: A Comparison to Conventional Arthroscopic Knots

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*2LT Justin Felix, BS
LTC Lanny Griffin, PhD
LTC(P) Chad A. Haley, MD
LTC Brett D. Owens, MD
Kenneth L. Cameron, PhD, MPH, ATC
COL Steven J. Svoboda, MD

Objectives: Numerous arthroscopic knots are available to surgeons and vary by the suture configuration (sliding versus static), knot complexity, and suture type (monofilament versus braided). The choice of which knot a surgeon uses is frequently based on training experience and empirical data. The West Point knot, an arthroscopic sliding knot, is frequently employed by arthroscopists but it has not undergone biomechanical evaluation. The purpose of this study was to compare knot security and loop security of the West Point knot to various combinations of commonly used arthroscopic knots tied with two different types of high-strength, nonabsorbable, braided suture.

Methods: The West Point knot was compared to three commonly used arthroscopic sliding knots (Roeder, Samsung Medical Center, and Weston knots) tied with a series of three Reversing Half-hitches on Alternating Posts (RHAP) and a static surgeon's knot. Two different high-strength nonabsorbable, braided sutures were used, and a minimum 6 knots were tied for each suture-knot combination. Each knot was tied on a standard 12.7 mm diameter post by hand, without instruments, to minimize abrasion and create loops of uniform circumference. Each loop was mounted on a Material Testing System (MTS) machine affixed with a 1kN load cell and a 2N preload was applied. Failure was defined as 3 mm of crosshead displacement or suture breakage during single-pull load testing.

Results: The surgeons knot tied with No. 2 Fiberwire provided a greater failure load than the surgeons knot tied with No. 2 Orthocord as well as all sliding knot configurations. Among the sliding knots, the West Point knot demonstrated the highest failure load compared to the Roeder, Samsung Medical Center, and Weston knots. Static and sliding knots tied with No. 2 Fiberwire demonstrated a larger failure load than the same knots tied with No. 2 Orthocord. Although, knots tied with No. 2 Fiberwire demonstrated a higher failure

load, this suture exhibited increased slippage compared to No. 2 Orthocord.

Conclusion: The study supports the use of the West Point knot as a reliable arthroscopic sliding knot with a favorable load to failure compared to other commonly used sliding knots.

Notes:

1155-1200

High-Tensile Strength Tape Versus High-Tensile Strength Suture: A Biomechanical Tissue Repair Study

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LT Jennifer L. Smith, MD
Kim Nguyen-Ta, BS, MS
LCDR Lucas S. McDonald, MD
LCDR Lance E. LeClere, MD

Introduction: There are multiple options of suture material, suture design, and repair technique for tendon and musculotendinous repairs. Recently, high-tensile strength tape has been introduced with reported advantages of higher load to failure when compared to high-tensile suture. Presently there is no quality data for a comparison of materials. This biomechanical human tissue study directly compares tape to suture in various models of tendon and musculotendinous repair. Given the larger surface area of suture to tissue contact, we hypothesized that high tensile-strength tape would perform better than high-tensile strength suture at securing human tissue across all testing scenarios.

Methods: Fifteen human cadaveric lower extremities were dissected. From each specimen, 2 quadriceps tendon segments, 4 patellar tendon segments, and 2 Achilles tendon segments were harvested. This provided matched sets of tissue and allowed for direct comparison testing. Using multiple suture techniques, one sample of each matched set was sutured with 2 mm high-tensile strength tape and the other with No. 2 high-tensile strength suture. A whip stitch was utilized in the quadriceps tendon, a simple stitch in the proximal patellar tendon sample, a Mason-Allen stitch in the distal patellar tendon sample, and a Krackow stitch in the Achilles tendon sample. Each sample was independently mounted on an electromechanical testing machine and loaded at a constant rate of 100 mm/min until failure. Failure was defined as suture pull-out, suture rupture, tissue rupture, tissue avulsion from the bony fragment, loss of suture or tape fixation in the device, and loss of bony fragment fixation in the device. The total load at failure (Newtons) and the location of failure were recorded. A power analysis was performed prior to testing and a sample size of thirteen sets per model was needed to demonstrate a difference of 40 N (alpha: 0.05, power: 0.80). We tested fifteen sets per model. A Wilcoxon signed rank test was used to analyze the data collected.

Results: The mean maximum load at failure in the quadriceps tendon (whip stitch) model was 709.34 N (SD 91.10 N) for the tape and 528.66 N (SD 73.63 N) for the suture ($p = 0.0010$). The mean maximum load at failure in the Achilles tendon (Krackow stitch) model was 427.58 N (SD 125.92 N) for the tape and 333.14 N (SD 68.59 N) for the suture ($p = 0.0146$). The mean maximum load at failure in the patellar tendon (simple stitch) model was 36.76 N (SD 24.95 N) for the tape and 29.34 N (SD 10.42 N) for the suture ($p = 0.2330$). The mean maximum load at failure in the patellar tendon (Mason-Allen stitch) model was 90.32 N (SD 46.95 N) for the tape and 93.79 N (SD 51.13 N) for the suture ($p = 0.5321$).

Discussion and Conclusion: We demonstrated that use of high-tensile strength tape in the quadriceps tendon (whip stitch) and the Achilles tendon (Krackow stitch) models had significantly higher load to failure by 180.68N and 94.44N. There was no significant difference in load to failure between high-tensile strength tape and high-tensile strength suture in the two patellar tendon models (simple stitch and Mason-Allen stitch). We conclude that in the repair of tendon and musculotendinous injuries, high-tensile strength tape performs more favorably than high-tensile strength suture, with a higher load to failure, when using a Krackow or whip stitch technique in tissues anatomically similar to the Achilles or quadriceps tendons, respectively.

Notes:

1200-1205

Arthroscopic Shoulder Simulator Training During Graduate Medical Education: Are Relative Performance Improvements Maintained At 1-Year Follow-Up

CPT John Dunn, MD
MAJ Brian R. Waterman, MD
MAJ Joseph T. Lanzi Jr., MD
MAJ Kevin D. Martin, DO
Kenneth L. Cameron, PhD, MPH, ATC
LTC Brett D. Owens, MD
COL Philip J. Belmont Jr., MD

Introduction: Mandated decreased resident work hours combined with a heightened emphasis on patient safety has propelled surgical simulation to the center of orthopaedic resident development. A resident arthroscopic simulation curriculum has been validated, demonstrating reduced surgical error and operative time. The purpose of this study was to determine if the gains made through an arthroscopic simulation curriculum could be maintained after the regular curriculum has ceased.

Methods: Eighteen orthopaedic surgery residents (PGY2-5) were randomized into two groups, simulator (SIM) and standard practice (SP). The SIM group received regimented arthroscopic education on the arthroscopic simulator which was compromised of four 15-minute sessions conducted by a single instructor over a 3-month period, while the SP group received no additional training. After completion of the educational sessions, one year elapsed in which neither group received any simulation training. At this point, both groups completed an in vivo shoulder arthroscopy which was taped. Two blinded, independent fellowship trained surgeons evaluated arthroscopic performance utilizing a 14-point shoulder arthroscopy checklist, total time elapsed, and the Arthroscopic Surgery Skill Evaluation Tool (ASSET), a validated metric for assessing technical ability during arthroscopy. American Council for Graduate Medical Education (ACGME) case logs were queried to identify competed arthroscopic cases. Scores between SIM and SP were compared using the student t-test. Multivariate analysis was conducted to correlate simulator performance with number of arthroscopic cases.

Results: There were no statistically significant differences by age, sex, median Post Graduate Year, average arthroscopy case load. All residents successfully completed the in vivo arthroscopy in less than 5 minutes without undue patient risk. Average score on anatomic checklist was similar between both study groups and further analysis by total ASSET scores and individual subdomains are currently under analysis.

Discussion: While simulation training has been shown to improve surgical skill in the short term, no study has evaluated the long-term benefit of surgical simulation. We hypothesize that there will be no difference between randomized groups at one year after the cessation of formal arthroscopic simulation education. Continued emphasis on a year-round simulation curriculum should be considered.

Notes:

Wednesday, December 17, 2014

General Session 9: Sports Lower Extremity
(Palomino Ballrooms 8-10)

Civilian Moderator: **Christopher Harner, MD**
Military Moderator: **COL Steven J. Svoboda, MD**

1450-1455

Anterior Cruciate Ligament Deficiency Does Not Affect Stress Radiograph Validity In Posterolateral Corner Injuries

LCDR Lucas S. McDonald, MD
LCDR Robert Waltz, MD
CDR Joseph Carney, MD
CDR Christopher Dewing, MD
CDR Joseph Lynch, MD
CDR Dean Asher, MD
LT Dustin Schuett, MD
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Introduction: To guide surgical decision-making, previous cadaveric studies developed radiographic guidelines quantifying lateral compartment opening in knees with fibular collateral ligament (FCL) and posterolateral corner (PLC) deficiencies. However, the effect of Anterior Cruciate Ligament (ACL) injury on lateral compartment opening was not

described. We hypothesized that ACL insufficiency causes an increase in lateral joint line opening during radiographic varus stress testing, falsely suggesting a PLC knee injury. The purpose of this study was to determine the effect of isolated ACL insufficiency on the radiographic varus stress test, and to provide reference data for the measured increase in varus gapping of a PLC injury with a known associated ACL injury.

Methods: Ten fresh frozen non-paired cadaveric lower extremities were fixed to a jig at the femoral diaphysis with the knee bent at 20 degrees. Both 12 Newton-meter (Nm) and clinician applied varus loads were applied at each sectioning interval, first with all knee ligaments intact followed by sequential sectioning of the ACL, FCL, popliteofibular ligament (PFL), and the Popliteus tendon. By measuring the shortest distance from the lateral femoral condyle and the corresponding lateral tibial plateau, three independent observers calculated lateral gapping using digital imaging at each load and knee state. Interobserver and intraobserver reliability was calculated. Statistical analysis was performed using a two-way repeated-measures analysis of variance with Scheffé adjusted P values.

Results: In the intact knee, mean lateral gapping was 6.99mm and 7.90mm for the 12-Nm moment and clinician applied varus loads respectively. Isolated sectioning of the ACL increased lateral gapping by 0.31mm for the 12-Nm load ($p=0.193$) and 0.52mm for the clinician applied load, which was statistically significant ($p=0.021$). The maximum increased lateral gapping for an isolated ACL deficient knee was 1.06mm with clinician-applied stress. No specimens with isolated ACL insufficiency gapped sufficiently to produce false positives for a lateral ligamentous injury based on previously established standards. The mean increase in gapping over the intact state for a combined ACL and FCL deficient knee was 1.48mm and 1.99mm for the 12-Nm and clinician applied loads respectively ($p<0.0001$) and increased to 1.94mm and 2.68mm with complete sectioning of the ACL and all PLC structures ($p<0.0001$). ACL deficiency contributed to 26% of the lateral gapping observed in a combined ACL/LCL injury and to 19% of the lateral gapping observed in a combined ACL/PLC injury. Interobserver and intraobserver reliability was high at 0.970 and 0.994 respectively.

Discussion and Conclusion: Anterior Cruciate Ligament deficiency contributes to lateral gapping on varus stress radiographs though it does not lead to false positives in stress radiographic testing for lateral ligament knee injuries. Reference data for the increase in lateral gapping due to varus stress in a knee with a PLC injury and associated ACL deficiency is reproducible within this study. We did not demonstrate the same magnitude of lateral gapping with sectioning of the posterolateral corner structures as previously reported in the literature. These findings draw into question the reproducibility of the varus stress radiography test among different testing sites, and should caution clinicians on making surgical decisions based on current standards for radiographic stress examination alone.

Notes:

1455-1500

Prospective Evaluation Of Acute ACL Reconstructions Using Patellar Tendon Autograft

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CDR Douglas J. Rowles, MD
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Introduction: There is a common belief that surgical reconstruction of an acutely torn anterior cruciate ligament (ACL) should be delayed for at least three weeks due to the high risk of post-operative motion loss (arthrofibrosis) and suboptimal clinical results. The null hypothesis of this study was that there is no difference in post-operative range of motion or stability compared to the contralateral knee following ACL reconstructions performed acutely using a patellar tendon autograft.

Methods: Patients (>18 yrs) who presented within 10 days of an ACL tear, irrespective of the condition or preoperative range of motion of the injured knee, were reconstructed using autograft patellar tendon. Previous knee surgery on the index extremity and a multi-ligamentous injury were exclusionary criteria. A standard surgical technique and postoperative rehabilitation were employed and were identical for all patients. Postoperative evaluations were performed by an

independent physical therapist, blinded to the operative side. Post-operative assessments included active range of motion measurements using a goniometer and KT-1000 testing.

Results: Twenty consecutive patients were enrolled who met the inclusion criteria. The average age was 26.4 years (range 19-40) and 17 were males. The time from injury to surgery averaged 4 days (range 1-8). Average follow up was 9 months and range of motion was regained at an average of 4.4 months (range 2-12). Two meniscal repairs and two microfractures were performed concomitantly. There was no loss of extension or flexion > 2° compared to the contralateral side in any patient at the latest evaluation. There was no difference greater than 1mm on KT-1000 testing.

Discussion and Conclusion: Excellent clinical results can be achieved following ACL reconstructions performed acutely after injury using autograft patellar tendon. Although we do not advocate that all reconstructions should be performed acutely, we found that early ACL reconstructions do not result in loss of motion or suboptimal clinical results as long as a rehabilitation protocol emphasizing extension and early range of motion is employed.

Notes:

1500-1505

Analysis Of ACL Reconstruction Outcomes In A Military Population At A Single Center

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Introduction: Anterior cruciate ligament rupture is a common knee injury in the active duty military population and is the most common surgically reconstructed ligament. It is unclear whether this surgery, and the post-operative rehabilitation, is successful in returning patients to full active duty.

Methods: We performed a retrospective chart review of patients that underwent an ACL reconstruction at a single military treatment facility and analyzed the charts for demographic data, surgical data and information regarding full duty status over 2 years after surgery.

Results: From January 2010 to April 2012, 105 primary ACL reconstructions were performed; the patients were 95% male, average age 26.7 years old (SD=5.8). In total, 90 (88%) of 102 patients successfully returned to full active duty after ACL reconstruction and 8 (8%) were medically separated from the military for issues related to the operative knee (3 patients did not have information regarding duty status). Of the 105, 59 patients had well documented follow-up and averaged 234.1 days (SD=79.9) of restricted duty and had an average of 25.7 PT visits (SD 9.5).

Conclusion: In general, ACL reconstruction was a successful procedure for returning military patients to full active duty at a single military treatment facility.

Notes:

1505-1510

ACL Graft Selection From The Patient's Perspective

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Purpose: To characterize the factors that affect the ACL graft selection from the patient's perspective and the role that the physician's advice plays in that decision. A more complete understanding of this issue will improve the ability of physicians to inform, counsel, and educate patients.

Methods: A one-time patient questionnaire was given to 214 consecutive patients immediately following their pre-operative surgical counseling, prior to undergoing ACL reconstruction. Patients self-reported demographic data, as well as the main reason for selecting the particular graft type, reasons for not

choosing another type of graft. They were asked to rank the importance of several commonly given reasons for graft selection based on their personal priorities.

Results: Our patients had an average age of 29 years, were predominantly male (87%) and enlisted. Graft types were hamstring autograft (52%), autograft patella tendon (15%) and allograft tendon (34%). Thirty-five percent of the overall group and 39% of the patients undergoing primary ACL reconstruction indicated that 'the potential to return to to their previous level of activity' was the most important reason for selecting a particular graft. The percentage of patients who indicated that their decision was primarily influenced by the advice of their physician (21%) was equal to the group who indicated that their primary influence was the advice of a family member or friend (21%). Twenty-seven percent specifically indicated that their physician's advice was not a factor in choosing the graft type, but rather relied on other sources.

Conclusion: From the perspective of the patient, the influence of the advice of the surgeon is one of many factors in the process of selecting a particular ACL graft. Notably the advice of the surgeon was not considered the predominant contributing factor as had been shown in previous literature. Multiple other factors and sources of information are influencing patients as they make these decisions.

Notes:

1510-1515

Risk Of Anterior Cruciate Ligament Injury On Synthetic Playing Surfaces In Athletes: A Systematic Review

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Objective: The effect of synthetic playing surfaces on the risk of injury in athletes is frequently debated in the orthopaedic literature. Biomechanical studies have identified increased frictional force at the shoe-surface interface, theoretically increasing the risk of injury relative to natural grass. This increase in frictional force is potentially relevant for the risk of anterior cruciate ligament rupture, where non-contact mechanisms are frequent. However, clinical studies examining this issue have shown mixed results. We hypothesized that the risk of anterior cruciate ligament rupture on synthetic playing surfaces would not be higher than that of natural grass playing surfaces.

Methods: A systematic search of OVID, EMBASE, the Cochrane Library of Systematic Reviews, and the PROSPERO International Prospective Register of Systematic Reviews was performed using the keywords anterior cruciate ligament, ACL, knee, injury, surface, artificial turf, natural turf, and grass both alone and in combination. The reference sections of all candidate papers were also searched to identify any missed studies, in order to maximize the available pool of articles under examination. Candidate articles were included if they reported the risk ratio of ACL rupture on natural grass versus synthetic playing surfaces, were Level III evidence or better, and included only ACL injuries sustained during organized athletic events. Data extraction for each article was recorded on a standardized worksheet, and included: demographic data of the study population; sports included in study; level of competition; playing surfaces utilized; ambient temperature; moisture level; quality of playing surface; concomitant injuries; and, mechanism of injury.

Results: A total of 10 studies with 968 ACL injuries met criteria for inclusion, all of which reported on soccer and football cohorts. Seven studies compared natural grass to 3rd generation artificial turf (synthetic turf with rubber infill), two compared natural grass to 1st generation artificial turf (AstroTurf), and one compared natural grass to 1st and 3rd generation turf. Three studies utilized the National Collegiate Athletic Association Injury Surveillance System, three utilized the National Football League Injury Surveillance System, and four set up their own injury monitoring system with participating teams. Five studies (768 ACL injuries) found an increased risk of ACL injury on artificial playing surfaces. All five of these articles were conducted in football cohorts, and included both earlier-generation surfaces (AstroTurf) and modern 3rd generation surfaces. Only one study in football players found a reduced risk of ACL injury on synthetic playing surfaces, and this was a relatively small cohort with only 15 ACL injuries. No soccer cohort found an increased risk of ACL injury on synthetic surfaces. For studies comparing 3rd generation turf to natural grass (793 ACL injuries), two

showed a significantly increased risk of ACL injury on turf, one showed significantly decreased risk on turf (as above), and the remaining five showed no difference.

Conclusions: Our systematic review supports an increased rate of ACL injury on synthetic playing surfaces in football, but there is no apparent increased risk in soccer. Further study is needed to clarify the reason for this apparent discrepancy.

Notes:

1520-1525

Surgical Techniques For The Reconstruction Of Medial Collateral Ligament And Posteromedial Corner Injuries Of The Knee: A Systematic Review

Jeffrey DeLong, BS
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Purpose: The purpose of this study was to systematically review reconstruction techniques of the medial collateral ligament (MCL) and associated medial structures of the knee.

Methods: A systematic search of Medline/PubMed Database (1966 to November 2013), reference list scanning and citation searches of included articles, and manual searches of high impact journals (2000 to July 2013) and conference proceedings (2009 to July 2013) were performed to identify publications describing MCL reconstruction techniques of the knee. Exclusion criteria included: (1) MCL primary repair techniques or advancement procedures, (2) lack of clear description of MCL reconstruction technique, (3) animal models, (4) non-relevant study design, (5) and foreign language articles without available interpretation. Clinical studies were descriptively analyzed and assessed for multiple outcomes of interest: level of evidence, concomitant ligamentous procedures, duration and extent of patient follow-up, laxity on radiographic and/or manual stress valgus testing, International Knee Documentation Committee (IKDC) objective form valgus stability subscore, Lysholm scores, and other patient-reported outcome measures. To further quantify the outcomes of individual reconstruction techniques, absolute or relative medial joint space widening on valgus stress testing with the knee flexed to 20 to 30 degrees, percentage of patients with relative medial joint space widening less than 3 mm on valgus stress, and percentage of patients with an IKDC valgus stability grade A (normal) or B (near normal).

Results: The online Pubmed/MEDLINE database search produced an overall total of 4600 publications. Following exclusion of duplicate and non-relevant articles, 372 abstracts were assessed for eligibility. Fourteen articles were published in Chinese medical journals and could not be further translated beyond the abstract. One article, published in a German medical journal was interpreted and included in the systematic review. Full-text articles were obtained for 128 articles and were evaluated for inclusion and exclusion criteria. An additional 31 publications were identified through secondary screening measures. After applying exclusion criteria, a total of 25 unique references with 28 described medial knee reconstruction techniques were included in the final systematic review.

Discussion and Conclusion: This systematic review demonstrated that numerous medial reconstruction techniques have been utilized in the treatment of isolated and combined medial knee injuries in the existent literature. Many variations exist among reconstruction techniques and may differ by graft choices, method of fixation, number of bundles, tensioning protocol, and degree of anatomic restoration of medial and posteromedial corner knee restraints. Further studies are required to better ascertain the comparative clinical outcomes with anatomic, non-anatomic, and tendon transfer techniques for medial knee reconstruction.

Notes:

1525-1530

Return To Duty Rates After Multiligamentous Knee Injury

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Introduction: The purpose of this study was to characterize injury patterns, treatment outcomes, and the return to duty (RTD) rate of active duty soldiers who sustained multiligamentous knee injuries (MLI) while deployed during Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF).

Methods: We retrospectively reviewed the medical records of 46 soldiers who had sustained 48 MLIs between 2003 and 2011. Injuries were characterized based upon mechanism, ligament injury pattern, the presence of associated arterial and vascular injuries, ipsilateral fractures, traumatic arthrotomy, and co-morbid injuries. Types of treatment (acute external fixator placement; operative vs non-operative; early vs. delayed; single vs. staged) were also identified. We then compared treatment outcomes including: pain, range of motion (ROM), instability, operative complications, RTD, and the disability rating of those unable to return to duty.

Results: Forty (83%) of the MLIs were the result of high-energy, combat-related events. The most common injury pattern (19%) was combined disruption of the anterior cruciate ligament, posterior cruciate ligament, posterolateral corner, and medial collateral ligament. Twenty one knees (44%) had an ipsilateral tibia fracture, 11 (23%) had an ipsilateral femur fracture, and 11 (23%) sustained a traumatic arthrotomy. There were 11 (18%) associated vascular injuries, 16 (33%) nerve injuries, and 11 extremities (18%) developed compartment syndrome. The most common method of treatment was delayed, single-stage operative reconstruction (48%). There were no significant differences in complication rates or outcomes between treatment types. The overall RTD rate was 40%. However, low-energy injury subjects were significantly more likely remain on active duty ($p=0.035$). High energy injury, nerve injury, vascular injury, compartment syndrome, traumatic arthrotomy, and poor ROM were all significant factors in preventing RTD ($p<0.05$). High energy injury was also a significant predictor of receiving a 'permanent disability' rating among those who were medically discharged from military service ($p<0.002$).

Conclusion: MLIs sustained in combat have a slightly higher incidence of ipsilateral extremity fracture, neurovascular injury, traumatic knee arthrotomy, and compartment syndrome than has been previously reported on MLIs in civilian settings. These associated ipsilateral injuries are the most important factors in predicting RTD. Active duty personnel that sustain non-combat related MLI are much more likely to be retained in the military.

Notes:

1530-1535

Adjunctive Tibial Tubercle Osteotomy For Patellofemoral Chondral Defects

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Introduction: There are several options for surgical treatment of patellofemoral chondral disease, including tibial tubercle osteotomy (TTO). Anteromedializing TTO has been shown to have favorable outcomes for chondral defects, especially those involving the lateral facet or distal patella and when combined with cartilage restoration procedures. There are few studies that provide clinical outcomes regarding TTO for treatment of patellofemoral chondral lesions in a young, active population, particularly high-demand, military service members.

Methods: After IRB approval, all TTOs (Current Procedural Terminology code 27418) performed between October 2006 and 2012 in the Military Health System (MHS) were isolated from the MHS Management Analysis and Reporting Tool (M2). Demographic data such as rank, age, sex, military occupational specialty, and branch of service were extracted, and an extensive review of the electronic medical record was conducted to survey outcome data such as complications, revision/secondary procedures, and initiation of a Medical Evaluation Board for persistent knee disability. Data such as BMI, tobacco use, and history of traumatic etiology for chondral defects were also collected. TTO indicated for patellofemoral

chondral defects were isolated, and exclusion criteria included non-military patients, less than 24-month follow-up, and/or the presence of a peri-articular osteotomy other than TTO. The U.S. Army Physical Disability Agency database was queried to confirm medical separation due chondral pathology. Univariate and multivariate analysis was performed in order to identify associations between patient-based or surgical variables and medical separation following TTO for chondral defects.

Results: After exclusion of 250 cases, a total of 138 TTOs were isolated for initial review. An additional 51 cases indicated for patellofemoral instability were separately analyzed, leaving 74 patients undergoing 87 TTOs for patellofemoral chondral defects in the final analysis. With an average follow-up of 40.7 months (range, 24-65), the cohort was comprised of 78% males, 74% enlisted, and 61% Army, with an average age of 32.3 years (range, 21-45) at the time of surgery. Thirty-four percent of patients had at least one prior procedure on the ipsilateral knee prior to TTO, with the most common procedure being diagnostic arthroscopy. Concomitant procedures were performed in 32%, with autologous chondrocyte implantation occurring most commonly (23%). There were 5 (6.4%) total complications including secondary fracture (3.8%), wound complications (2.6%), and nonunion (2.5%). Overall revision rate was 3.8% and the rate of knee related military discharge was 27% (n=21). Only 10% (n=8) of patients deployed after surgery. Tobacco use and bilateral TTO were associated with nearly two-fold higher risk of military discharge, whereas higher age, sex, BMI, branch of service, and absence of chondral restoration procedure were not associated with higher rate of clinical failure.

Discussion: At short- to mid-term follow-up, TTO remains a reliable option for a young, active patient population with patellofemoral chondral defects, especially in combination with chondral reparative techniques. Prior studies have shown 80% good to excellent subjective outcomes for the treatment of patellofemoral chondral lesions. In this study, 73% of service members who received a TTO returned to active duty service. Tobacco use and bilateral TTO were associated with increased rates of clinical failure. For those patients without tobacco use or bilateral procedures, service members can anticipate a 90% return to duty and low complication rate after TTO for patellofemoral chondral lesions.

Notes:

1535-1540

Epidemiology Of Chondromalacia Of The Patella In An Active Military Population

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Introduction: Chondral pathology of the patella is a common cause of knee pain in a physically-active military population, and it accounts for almost 25 percent of identified knee injuries in running athletes. Currently accepted predisposing factors include repetitive use, anatomic abnormalities, and trauma; however, no current study has evaluated the correlation between demographic and occupational risk factors with the overall incidence rate of chondromalacia of the patella in an high-demand, at-risk military population. We hypothesize that enlisted service members in the United States military will show higher incidence rates of chondromalacia of the patella due to their higher level of activity both on the battlefield and in training.

Methods: A retrospective study of all active U.S. military service members diagnosed with chondromalacia or a chondral defect of the patella (code 717.7 in the International Classification of Disease, 9th Edition) between 2006 and 2012 was performed using the Defense Medical Epidemiology Database. Demographic and occupational risk factors including age, sex, race, military rank, and branch of military service were individually categorized, and cumulative and subgroup incidence rates of chondromalacia of the patella were calculated using a multivariate Poisson regression model to establish statistically significant risk factors for development.

Results: During the study period, a total of 42,040 patients were diagnosed with patellar chondral defects among an at-risk military population of 9,723,449, resulting in an incidence rate of 4.32 cases per 1000 person-years. The annual incidence rate of chondromalacia of the patella remained consistent from 2006 to 2012. Elevated risk for developing chondral pathology of the patella was significantly correlated with older (40 years-old and greater) patient age, female sex, black race, enlisted military rank, and Army service.

Conclusion: Systematic evaluation of the epidemiology of chondromalacia of the patella, among an ideal at-risk population, identified increasing age, sex, race, military rank, and

branch of military service as important factors associated with the incidence of chondromalacia of the patella.

Notes:

1540-1545

Particulated Juvenile Articular Cartilage Allograft For Treatment Of Chondral Defects Of The Knee: Short-Term Survivorship With Functional Outcomes

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Introduction: Focal articular cartilage defects in a physically demanding military cohort are exceedingly common. However, the functional results after chondral restoration procedures are variably reported and may differ significantly by lesion size, location, and knee alignment. While more cost-effective than other cell-based alternatives and readily available as a single-staged option, the clinical outcomes after particulated juvenile cartilage allograft transplantation are not well established.

Methods: A retrospective analysis of active duty servicemembers undergoing surgical treatment with particulated juvenile articular cartilage allograft transplantation for chondral defects of the knee were isolated from the Military Health System Management Analysis and Reporting Tool prior to 2014. Demographic variables such as age, sex, and rank were extracted. Operative reports and the electronic health record [Armed Forces Health Longitudinal Technology Application (AHLTA), version 3.3] were reviewed to identify selected surgical variables, including the following: size, depth, and/or severity of chondral lesion; concomitant intra-articular pathology, associated or prior surgery, the rates of perioperative complications, secondary surgery (including revision), activity limitations, and initiation of medical discharge as confirmed by the U.S. Army Physical Disability Agency database. Military duty limitations, as recorded on a DA Form 3349 within the e-Profile electronic profiling system, were analyzed. If available, postoperative magnetic resonance imaging was also reviewed.

Results: After the exclusion of 3 individuals due to non-active duty status or inaccessible medical record, a total of 29 patients with 36 treated chondral defects (average size, 270 mm2, range 36-450 mm2) were isolated at an average follow-up of 16.2 months. The cohort was comprised of 96% males and mean patient age was 33.1 years (range, 22-45 years). All servicemembers were in the Army, and enlisted rank (93%) and non-combat arms MOS (68%) were most common. Location of chondral lesion included the patellofemoral articulation (patella 39%, trochlea 31%, bipolar lesions 8%) and medial or lateral femoral condyles (31%). Offloading or realignment osteotomy procedures were performed in 7 knees (23%). Of all patients, 15 servicemembers (52%) underwent knee-related medical discharge due to persisting pain and dysfunction, and one patient underwent conversion to total knee arthroplasty.

Conclusion: In this small patient cohort, articulated juvenile cartilage allograft transplantation for chondral defects of the knee did not reliably restore military servicemembers to full military function. At least one in two patients had persisting knee pain after chondral restoration procedure. Further large-scale series are warranted to better define the clinical success of this procedure and differentiate lesions optimal for its use.

Notes:

1545-1550

Biomechanical Strength Of Current Medial Patellofemoral Ligament Reconstruction Techniques

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Background: Current surgical techniques for medial patellofemoral ligament reconstruction (MPFL) may employ suspensory cortical fixation and a human gracilis allograft. We examine the biomechanical strength of suspensory cortical fixation and human gracilis allograft as it compares to the strength of the native MPFL.

Materials & Methods: Five different MPFL reconstruction techniques where analyzed using six matched pair human cadavers. Methods of fixation examined: suspensory cortical fixation in patella and femur (DTR), suspensory cortical fixation patella interference screw femur (TRP/ISF), interference screw patella suspensory cortical fixation femur (ISP/TRF), interference screw patella and femur (DIS), two suture anchors patella suspensory cortical fixation femur (SAP/TRF). The vector force was anatomic, directed laterally over the lateral femoral condyle while the knee was flexed 25°. Each method was examined six times; each reconstruction utilizing a new human gracilis allograft. The widths of all patellae were measured; consequently, the force necessary for 50% (subluxation) and 100% patellar displacement (dislocation) could be quantified. The peak force to fixation failure was examined for all methods. A native MPFL strength of 208N was used as a control. Failure was either 100% patellar displacement or fixation failure.

Results: Three forms of reconstruction required force >208N for 100% patellar displacement and fixation failure; DTR, TRP/ISF, and ISP/TRF. All methods of reconstruction required <208N for 50% subluxation. All methods of MPFL reconstruction demonstrated significantly different strengths for 50% and 100% displacement of the patella as well as peak force to failure (F = 8.4, F crit = 2.3 (results of ANOVA)). No reconstruction method failed as a result of the human gracilis allograft.

Conclusion: Three methods of reconstruction were stronger than the native MPFL; ISP/TRF being the strongest. Additionally, human gracilis allograft can withstand forces far greater than the native MPFL; therefore, suggesting human gracilis allograft as an acceptable tissue alternative for MPFL reconstruction.

Notes:

1600-1605

Survivorship Of Meniscal Allograft Transplantation In A High-Demand Patient Population

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COL Mark P. Pallis, DO

Introduction: Meniscal allograft transplantations (MAT) have traditionally been indicated for young patients with limited painful arthrosis after prior subtotal meniscectomy. However, recent estimates suggest that the short-term reoperation may occur in up to one-third of patients undergoing MAT, and secondary failure may develop in up to 20%. The purpose of this study was to determine the survivorship, complication rates, and functional outcomes of MAT in an active population, as well as identify any predictors of poor objective or subjective outcomes.

Methods: Using the Military Health System (MHS) were isolated from the MHS Management Analysis and Reporting Tool (M2), a cohort of all active-duty patients undergoing MAT (Current Procedural Terminology code 29868) in military treatment facilities between 2007 and 2013 was identified. Demographic parameters, surgical variables clinical outcomes were extracted from the electronic medical record, and the Defense Manpower Data Collection (DMDC) was queried to determine current military status and combat deployment history. Previous or concomitant procedures, perioperative

complications, reoperation rate, revision, and initiation of military discharge due to persistent knee disability were recorded for further analysis. Univariate and multivariate analysis was performed in order to identify associations between patient-based or surgical variables on selected endpoints.

Results: A total of 230 MATs were performed in 227 patients with 228 knees during the study period. The mean age was 27.2 years (range, 18-46; SD 5.5), and the cohort was predominately male (89%) and of enlisted military rank (87%). Approximately half (51%) of all patients had undergone other prior, non-meniscal procedures on the knee. Medial MATs were performed in 159 (69%) cases, and isolated MATs were performed in 137 operations (60%) as compared to 93 (40%) with other concomitant procedures (ACL reconstruction, n=60; chondral procedure, n=24; HTO, n=13; other, n=10). A total of 55 complications occurred in 46 (21.1%) patients, including a secondary tear or extrusion of the MAT (9%), surgical site infection (5%), and arthrofibrosis (4%). At an average clinical follow-up of 2.14 years, 10 (4.4%) patients required secondary meniscal debridement, while 1 (0.4%) patient required revision MAT and 2 (0.8%) patients underwent later total knee arthroplasty. Following MAT, only 14% successfully completed a combat deployment, and 92 (40.5%) patients separated from the military with medical disability at an average of 2.49 years postoperatively. No statistically significant differences were detected in rates of complication, secondary surgery, or deployment between medial and lateral MAT ($p>0.05$).

Conclusion: After MAT, overall survivorship from revision or knee arthroplasty was 98.7% in an active military population at short-term follow-up. Postoperative complications and secondary tear or extrusions of MAT occurred in 21% and 9%, respectively, and meniscal debridement was required in 4.4%. However, only one in seven servicemembers underwent combat deployment after MAT, and two in five patients required medical discharge. While these results reflect a comparatively lower rate of reoperation or revision, this investigation indicates that the majority of military servicemembers may be unable to return to full, pre-injury activity level following MAT.

Notes:

1605-1610

Epidemiology Of Isolated Meniscus Tears In Young Athletes

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Introduction: Meniscus tears are common in athletic populations; however, there are few studies of the epidemiology of meniscal tears in a stable knee, and particularly tears in young populations. The purpose of this study was to define the incidence of isolated meniscus tears and to determine demographic and athletic risk factors.

Methods: A longitudinal cohort study was performed to determine the incidence and characteristics of isolated meniscus tears at the United States Military Academy between 2005 and 2012. Injuries identified in the Cadet Illness and Injury Tracking System (CIITS) were confirmed by clinic, surgical, and radiographic data for inclusion. Cooper's classification was used to localize meniscus tears. Incidence rates (IR) per 1000 person-years and per 1000 athlete-exposures (AE) were determined for sport and level of competition. Demographic, injury characteristic and time loss data were also evaluated.

Results: There were 79 instances of meniscus tears in stable knees in a cohort of 9086 subjects from 2005-2012. Of these, 68 (86%) were in males and 11 (14%) in females. Right (40) and Left (39) knees were equally affected. The lateral meniscus (70%) was torn at a greater rate than medial meniscus (30%). Body mass index (BMI) of the meniscus injured population was 25.7 vs. 24.6 for the uninjured cohort (p less than .05). BMI was also greater in subjects with lateral (26.4) vs. medial (23.9) meniscus tears (p less than .05). The average time lost from activity was 102 days. Surgically managed injuries lost 112.7 days vs. 36.1 for non-operative cases (p less than .05). Of the operative cases, repairs lost 150.8 days vs. 101.0 for debridement (p less than .05). There was no significant difference in time lost from medial (90.9 days) vs. lateral (106.9 days) injuries. The greatest percentages of meniscus tears were found in football (19%), wrestling (13%) and rugby (9%) activities. Military combative training accounted for 5% of meniscus tears. The IR per 1000 AE for intercollegiate athletes was greatest in wrestling (0.157) and

rugby (0.150). This was mirrored in the intramural population with rates of 0.125 and 0.138 respectively. Rates per AE in football were lower at 0.045 and 0.062 for intercollegiate and intramural competition.

Discussion and Conclusion: Isolated meniscus tears are relatively common in young athletes and cause significant loss of time from athletic pursuits with meniscus repair causing greater loss than debridement. Lateral meniscus tears are more prevalent in this population. A significantly greater BMI was seen in those with vs. without isolated meniscus tear in this cohort, and between those with lateral vs. medial meniscus tear among the injured. Wrestling and rugby carry the greatest risk of meniscus injury per exposure at both the intercollegiate and intramural level of competition.

Notes:

1610-1615

Meniscal Repair In The Active Duty Population At A Military Medical Center

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Introduction: Meniscal injury is one of the most common knee injuries in the active duty military population. Maintaining the integrity of the meniscus is critical to reducing contact pressures on the tibiofemoral articulation and reducing the degenerative cascade leading to osteoarthritis. The purpose of this study is to analyze the outcomes of meniscal repair in a military population, focusing on the patient's ability to remain on active duty.

Methods: A retrospective review of all meniscal repairs performed on active duty Soldiers at a Military Medical Center from January 2002 to December 2012 was conducted. Data were collected from operative reports, eprofile and the electronic medical record (AHLTA). A multivariate logistic regression model was utilized for statistical analysis.

Results: Two hundred forty nine active duty Soldiers, mean age 28 (19-48) years underwent 249 meniscal repairs during the study period. There were 175 meniscus tears repaired with an all inside technique with an average of 3 sutures, 38 repairs with inside out technique with an average of 8 sutures, 33 combined inside out and all inside repairs with an average of 6 sutures, and 3 outside in repairs. There were 95 bucket handle tears repaired with an average 6 (2-16) sutures. One hundred twenty one meniscal repairs were performed concurrently with an anterior cruciate ligament reconstruction. Postoperatively, 39 patients were medically separated from the military at an average time of 29.8 months. Fifty five patients required a permanent duty restricting profile at an average time of 35 months, and 5 patients currently have a temporary duty restricting profile. One hundred two patients required no permanent profile after meniscal repair at final follow up, which averaged 5 (1.5-12.3) years. Forty eight (19%) patients were lost to follow up.

Discussion and Conclusion: In conclusion, meniscal repair in this active duty population allowed approximately 80% of patients to return to military duties; however, 25% of those Soldiers required a permanent duty restricting profile. Twenty percent of patients in this cohort required medical separation from the military after meniscal repair.

Notes:

1615-1620

Return To Play Following Concussion At A Military Service Academy

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Introduction: Mild traumatic brain injury (mTBI) and sport-related concussion (SRC) are significant health problems facing our athletes and active duty military members today. The

natural history of concussion is still poorly defined. The average recovery time for concussed athletes has been reported to be as soon as 2-3 days in NFL and college athletes and 5 to 7 days in High School athletes.

Methods: All concussions in cadets at a military service academy from October 2012 through May 2014 were retrospectively reviewed. Each concussion was evaluated initially within 1-72 hours post injury and followed weekly until return to play. A combination of symptoms scoring, postural stability, neurological assessment and computer based neuropsychological testing were used as return to play criteria. The return to play (or return to full duty) time was calculated for each patient.

Results: More than 300 consecutive concussion cases from cadets presenting to the concussion clinic at a military service academy were reviewed. The average return to play was 40.8 days post injury with the median of 27 days. This includes a 5 day return to play exercise challenge. If the days used for a graded return to play are not used in the calculations, the average return to baseline testing and resolution of symptoms is 35 days with the mean of 22 days. Nine percent of cases took greater than 100 days for return to play.

Conclusion: In a retrospective cohort of service academy student-athletes who were followed weekly, the mean time to return to play was 40.8 days with a median 27 days. This represents an increased duration when compared to several other studies in the literature.

Notes:

1620-1625

Geographic Variation In Injury Incidence Rate Reporting

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Objective: Injury incidence is a key area of study in orthopaedic sports medicine, providing valuable information to stakeholders and spurring important changes in rules and equipment to protect athlete safety. Incidence rates are commonly reported using a time-based unit such as injuries per 1000 player-hours or an event-based unit like injuries per 1000 athlete exposures. Unfortunately these units are not easily converted between each other unless very specific baseline data is known, making comparisons between studies and sports difficult or impossible. The objective of this study was to determine the variables that impact researchers' choice of injury incidence reporting units.

Methods: We manually searched all issues of The American Journal of Sports Medicine (AJSM) and British Journal of Sports Medicine (BJSM) between January 1, 2009 to December 31, 2013. These journals were selected due to their high impact factor ranking and relatively large number of published sports injury studies. In addition, we expected the majority of authors in AJSM to be American, while the majority authors in BJSM to be non-American, giving a reasonable distribution of authors' geographic location. To the best of our knowledge, neither journal requires authors to report injury rate/risk using a particular denominator. We limited our search to the last five years in order to reflect the current state of research in the field. Articles were included in this study if they were original research reporting the injury risk or rate in athletes, and only reported injuries sustained during organized sporting events (games or practice). Articles were excluded if they reported illnesses or did not give an overall injury risk or rate for their cohort. For purposes of this study, we did not consider referees/officials, cheerleaders, or students participating in school-based physical education classes as athletes. When multiple sports were examined in a single study, we recorded sport-type as "multiple." For articles written by authors from multiple geographic locations, we recorded only the geographic location of the senior author. Statistical analysis was performed using SPSS software. Confidence intervals were calculated based on Poisson distribution, and are represented graphically. P-values were calculated using Fischer exact testing.

Results: A total of 109 articles were identified which reported injury risk or rate. 50 of the articles came from AJSM, and 59 from BJSM. There was no significant difference in the number of articles between the two journals. American authors were significantly more likely to publish in AJSM versus BJSM ($p<0.0001$). Sports reported varied widely, with the majority of cohorts involved in soccer or football/rugby (56 of 109 studies). The majority of studies reported multiple injuries within their cohorts. Significantly more authors chose to describe injury incidence than injury

risk. There was no difference in the proportion of reports giving injury incidence versus risk between the two journals (p=0.65). Most studies reported only competition-based injuries. 33 of the 109 studies were conducted by American researchers, and 25 of these studies reported injury incidence (the remainder reported injury risk). 23 of these studies giving injury incidence utilized event-based incidence, primarily injuries per 1000 athletic exposures. In contrast, 45 of the 49 studies authored by non-American researchers utilized time-based incidence reports, usually injuries per 1000 player hours. This finding was statistically significant (p<0.0001). American researchers were significantly more likely to publish in AJSM than BJSM (p<0.0001), and so BJSM was significantly less likely to publish articles using event-based injury incidence reporting (p<0.0001).

Conclusions: Over the last five years, American researchers have chosen to report rates in terms of injuries per athletic exposure, while non-American researchers have preferred time-based rate reporting. The reasons for this geographic split are not clear, but standardization of reporting measures would be preferable in order to facilitate cross-sport comparisons of injury rates and meta-analyses of existing studies.

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1625-1630

Contemporary Epidemiology Of Lower Extremity Stress Fractures In The United States Military

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Introduction: Lower extremity stress fractures are a common problem in the military traditionally associated with new recruits. The purpose of this study is to identify important risk factors for their development, which may help reduce their high cost to the armed forces.

Methods: Using the Defense Medical Epidemiological Database (DMED), we extracted first-time occurrences of ICD-9-CM codes 733.93 (stress fracture of tibia/fibula), 733.94 (stress fracture of metatarsals), 733.95 (stress fracture of other bone), 733.96 (stress fracture of femoral neck) between 2003 and 2012. Unadjusted and adjusted Incidence rates expressed per 1000 person-years were further subcategorized by gender, race, age, rank, and branch of service, with the calculation of Incidence Rate Ratios (IRR). Multivariate data analysis was performed to obtain rate per 1,000 person-years as well as Adjusted Rate (adjusted for age group, gender, race, rank, and service) to isolate risk factors.

Results: Between 2003 and 2012, 85,836 lower extremity stress fractures occurred among an at-risk population of 14,038,625 servicemembers for an unadjusted IR of 6.11 per 1000 person-years. The annual adjusted IR for total lower extremity stress fractures ranged from 2.17 in 2010 to 3.29 in 2005 with the greatest change occurring between 2003 and 2004 with an increase of 25.5%. During this time frame, 41% of stress fractures of involved tibia/fibula (IR 2.49), 38% were unspecified (IR 2.35), 18% occurred in the metatarsals (IR 1.08), and 3% involved the femoral neck (IR 0.41). The highest prevalence of stress fractures by age group was in the 20-24 group contributing 34.1% of fractures, while the lowest occurred in the 35-39 group with 5%. However, after adjustment for population size, individuals >40 years-old had the highest incidence rate (IR 11.77), which was over ten-fold greater than that of the 20-24 group (IR 1.14). When compared with males, females had a significantly higher rate of total lower extremity stress fractures (IRR 3.33; 95% CI 3.27, 3.37), as well as those involving femoral neck, tibial, or metatarsal stress fractures. Servicemembers of White race had significantly higher incidence of all stress fractures when compared to those of Black race (IRR 1.63; 95% CI 1.60, 1.67). Most fractures (80.5%) also occurred in junior enlisted servicemembers (IR 1.77), with at least seven-fold greater incidence rate than any other rank groups. The Army had the highest incidence rate of total (4.65) and unspecified (1.73) lower extremity stress fractures, whereas the Marines had the highest incidence rate of femoral neck (1.68), tibial (1.73), and metatarsal stress fractures (1.56).

Discussion: Statistically significant risk factors for lower extremity stress fractures identified in this study were female sex, age >40, non-Black race, junior enlisted rank, and Army or Marine branch. Female gender had its greatest influence on femoral neck stress fractures, while junior enlisted status had its most profound effect on tibia/fibula and other stress fractures. Age between 20 and 34, male, Black race, senior

officer, and Navy or Air Force service were protective factors for stress fractures. This investigation elucidates several non-modifiable risk factors for stress fractures in the military and may inform prevention strategies to reduce this significant source of lower extremity disability.

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1630-1635

Epidemiology Of Injuries In Major League Baseball Catchers

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Introduction: Major League Baseball officials have recently implemented experimental rule changes in an attempt to alleviate collisions at home plate. Unfortunately, there is a paucity of literature on the rate, type, and severity of injury in catchers specifically, with no literature on collision injuries in catchers. The goal of this study is to more completely define injuries in MLB catchers. Hypothesis: While catchers risk potential serious injury, especially in collisions with base-runners at home plate, career ending or otherwise severe injuries remain a relatively rare occurrence. Study Design: Retrospective, data-base review

Methods: The authors analyzed the MLB Electronic Baseball Information System for the 2001-2010 seasons. Injuries in catchers were isolated, and categorized based on mechanism, collision versus non collision, and injury characteristics.

Results: From the 2001 - 2010 seasons there were a total of 134 injuries sustained by catchers. Twenty of these were collision injuries, and 114 were a result of a non collision mechanism. The mean time spent on the disabled list for all injuries was 50.8 days. Collision injuries resulted in less time, on average, spent on the DL when compared to non-collision injuries, 39.1 versus 52.8 days, but this difference was not significantly different. No collision injury was career ending, and non collision injuries more commonly resulted in greater than 100 days spent on the DL (p=.049).

Conclusion: While collision injuries in catchers are dramatic and seemingly potentially dangerous, they are relatively rare. There were no instances of a career ending, or otherwise catastrophic injury in a MLB catcher, resulting from a collision, in the ten seasons studied.

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