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Concussion in Athletes

ABSTRACT & COMMENTARY

Synopsis: Initial and follow-up assessments of post-traumatic amnesia are an essential part of the neurologic evaluation of the head-injured athlete.

Source: Cantu RC. *Journal of Athletic Training.* 2001;36(3):244-248.

In 1986, cantu proposed what has become the most widely used practical scheme for grading concussion severity in athletes based on duration of unconsciousness or post-traumatic amnesia (PTA).[1] In this current article, he proposes an evidence-based modification of the original Cantu guidelines using retrograde and especially anterograde PTA as a criterion to be used for grading of concussion severity.

PTA may be divided into either retrograde or anterograde amnesia. Retrograde amnesia is the partial or complete loss of the ability to recall events that occurred immediately prior to the concussion. Anterograde amnesia is a deficit in the ability to form new memory after the injury. Retrograde amnesia may be assessed on the field by asking questions related to score, mechanism of injury, and names of current and recent opponents. Anterograde amnesia may be assessed by repeating 4 words immediately and 2 minutes later, repeating 5 numbers forward and backward, and repeating months of the year backward. Sophisticated tests of sideline mental status testing are available and useful for assessment of concussion.[2]

The original Cantu scheme proposed 3 grades of concussion based on duration of unconsciousness or PTA, or both. The grade 1 concussion occurs without loss of consciousness with only a brief period of PTA, which by definition lasts less than 30 minutes. The grade 2 concussion is associated with unconsciousness lasting less than 5 minutes, and/or PTA lasting more than 30 minutes but less than 24 hours. A grade 3 concussion occurs with loss of consciousness longer than 5 minutes, and/or PTA lasting more than 24 hours.

The new, evidence-based modification of the original Cantu scheme also uses a 3-grade classification system for concussion.

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INSIDE

Grade 1 (mild) concussion includes: no loss of consciousness; and PTA or postconcussion signs or symptoms lasting less than 30 minutes. A grade 2 (moderate) concussion is associated with: loss of consciousness lasting less than 1 minute; and PTA or postconcussion symptoms lasting longer than 30 minutes but less than 24 hours. The grade 3 (severe) concussion includes: loss of consciousness lasting more than 1 minute or PTA lasting longer than 24 hours; and postconcussion signs or symptoms lasting longer than 7 days. For all 3 grades, PTA is retrograde and anterograde.

COMMENT BY DAVID H. PERRIN, PhD, ATC

At least 15 grading systems for concussion exist and use state of consciousness and magnitude of PTA for severity classification. There is not complete agreement among these systems, and Cantu points out that there is also not universal agreement that PTA is a better or more sensitive predictor of outcome after concussion than assessment of unconsciousness.

Cantu's modified guidelines are based on the fact that unconsciousness lasting longer than 5 minutes is almost never seen in athletic events and that most periods of unconsciousness last from seconds to a minute. Moreover, prospective studies over the past decade report a correlation between duration of postconcussive symptoms, PTA, and results of neuropsychological assessments. Cantu further explains that while not diminishing the importance of unconsciousness, "I find it illogical to grade a concussion that produces postconcussion symptoms lasting months or years without loss of consciousness as less severe than a concussion resulting in brief unconsciousness and resolution of all postconcussion symptoms within a few minutes or hours."

There is not universal agreement among the grading systems for concussion experienced during athletics. However, there is consensus that an athlete who has incurred an initial concussion has a greater chance of sustaining subsequent concussions. Moreover, there is agreement that an athlete should not be returned to play in the presence of PTA and any postconcussion symptoms at rest and with exertion.

This paper is 1 of 19 written by more than 30 international experts on neurological athletic mild head injury for a *Journal of Athletic Training* special issue on concussion in athletes. Physicians and other sports medicine clinicians involved in the care of athletes will find this issue invaluable for managing cases involving an athlete with concussion. ❖

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Sacral Stress Fractures: A Possible Cause for Low Back Pain in Athletes

ABSTRACT & COMMENTARY

Synopsis: Sacral stress fractures should be considered as a possible cause of low back pain in female athletes, especially in the face of menstrual and dietary irregularities.

Source: Johnson AW, et al. *Am J Sports Med*. 2001;29(4): 498-508.

Low back pain is a common complaint among many athletes. The pain may emanate from the low back or may be referred from another site. The purpose of this study is to report on several patients with an

uncommon site for a stress fracture. This article presents 5 Division 1 NCAA athletes and 3 other athletes age 19-45 years old with prolonged low back pain. All athletes complained of vague low back pain that failed to respond to routine NSAID agents. Plain radiographs, CT, MRI, bone scans, and bone density studies were ordered on most patients. Menstrual history and diet history were evaluated.

All patients were premenopausal and all bone density studies were above the fracture level. The average time until the athletes returned to their preinjury activity level was 8 months. The most likely identifiable risk factors were an increase in the activity level, inadequate caloric intake, and abnormal menstrual histories.

COMMENT BY JAMES R. SLAUTERBECK, MD

Both low back pain and stress fractures are common in athletes. In athletes with persistent low back pain failing routine nonoperative management, most physicians would consider looking for stress fractures in the pars intrarticulartis but might not consider the sacrum as a potential site. I wonder how many runners, on whom I have ordered a CT scan to rule out a spondylolysis, completed a full dietary and menstrual history, lab, and radiographic work-up only to result in the grab-bag diagnosis of mechanical low back pain, were sent back to running with a sacral stress fracture?

Low back pain can be either musculoskeletal or nonmusculoskeletal, ie, discogenic vs. gynecological. Stress fractures can be 1 of 2 types—insufficiency or fatigue. Fatigue stress fractures occur in normal bone and insufficiency fractures occur in osteopenic bone. Therefore, in the work-up for low back pain in running female athletes, one must obtain a good running, menstrual, and dietary history to determine the type of stress fracture.

Aggressive management of these athletes with fatigue stress fractures by obtaining proper history, performing a thorough exam, using consultation with a gynecologist, and aggressively treating the athlete with appropriate rest will return an athlete to full activity. If insufficiency fractures are present, one should consider aggressive medical management for the osteopenia by a qualified physician added to the above. I recommend an early bone scan or MRI in athletes after routine screening radiographs are negative followed by a CT for localization and definition of the fracture. Additionally, bone density studies are important to determine if insufficiency or fatigue stress fractures are present to help guide treatment. The long-term effects of amenorrhea, diet disorders, and osteopenia can lead to devastating osteoporosis later in life. Nutritional and psychological assessment and treatment can be life altering or saving in some cases. Isolated treatment of only the stress fracture in these elite athletes will be fraught with frustration between the coach, athletes, and physician.

Runner's chronic complaints often can lull the physician into a state of complacency, which can prolong successful treatment of overuse syndromes. Runners' sacral stress fractures are now on my radar screen for low back pain in athletes. ❖

Meniscal Tears in ACL-Deficient Knees

ABSTRACT & COMMENTARY

Synopsis: An analysis of meniscal tears in almost 500 patients with ACL-deficient knees demonstrated that tears of the medial meniscus were slightly more common than lateral meniscal tears. The most common tear pattern was a peripheral posterior horn tear.

Source: Smith JP III, Barrett GR. *Am J Sports Med*. 2001;29(4):415-419.

Meniscal tears occur commonly in patients with ACL injury. The incidence has been reported as high as 96% in chronic ACL-deficient knees. Lateral meniscal tears have been reported to be slightly more common than medial meniscal tears in the acute ACL-injured knee.[1] Smith and Barrett prospectively evaluated 1065 knees in 1021 patients. Approximately three fourths of these patients had ACL reconstruction within 6 weeks of injury, and the other one fourth had ACL reconstruction chronically. Meniscal tears were present in 45% of the knees. The study group included 303 males and 173 females. The average patient age was 25.4 years (range, 9-57). The tears were classified into zones based upon the system described by Cooper and colleagues.[2] Medial meniscal tears were present in 53% of cases, and lateral meniscal tears occurred in 47% of cases with meniscal tears. Peripheral tears were present in approximately three fourths of the medial meniscal tears but in slightly less than half of the lateral meniscal tears.

COMMENT BY MARK D. MILLER, MD

This is an interesting study of meniscal tear location in ACL-deficient knees. Smith and Barrett state that it is prospective, but there is no way to verify this statement. This paper does not challenge the commonly held tenant that lateral meniscal tears are more common in acute ACL-injured knees, because approximately one fourth of

the study group had chronic ACL deficiency and the acute group is not stratified to allow us to address this issue. What I found most interesting, and it agrees with what I see clinically, is the high incidence of peripheral meniscal tears. This is important because most (if not all) of these tears should be repaired. Repair of peripheral meniscal tears, especially with concurrent ACL reconstruction, represents the best opportunity for successful meniscal healing. Smith and Barrett attempt (unsuccessfully in my opinion) to explain their findings based upon a theory originally proposed by Hughston. This theory suggests that the semimembranosus muscle plays a role in peripheral medial meniscal tears. Another theory Smith and Barrett cite is based upon the role of the posterior horn of the medial meniscus serving as a "bumper" in the ACL-deficient knee. This theory makes more sense, as it is known to serve as a secondary stabilizer to anterior displacement of the tibia, and the extra force it must resist in the ACL-deficient knee may result in injury. Neither theory can be proven in this study, however, and the important thing to recognize is the high incidence of peripheral tears, not how they occur. ❖

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Revision ACL Surgery with Use of Bone-Patellar Tendon-Bone Autogenous Grafts

ABSTRACT & COMMENTARY

Synopsis: Although patients improved their pain and function outcome measures, there was a 24% graft failure rate. Using the ipsilateral patellar tendon a second time yielded an unacceptably high failure rate of more than 50%.

Source: Noyes FR, Barber-Westin SD. *J Bone Joint Surg.* 2001;83-A(8):1131-1143.

Primary acl reconstruction with patellar tendon grafts has been shown to be successful with the graft failure rate between 3 and 10%. Noyes and Barber-Westin prospectively evaluated revision-ACL reconstructions using patellar tendon grafts and retrospectively compared this to a similar study with allografts. In this study, 57 consecutive ACL revisions were prospectively followed with only 2 knees lost to follow-up. Initial graft failure was due to improper graft placement, associated ligamentous insufficiencies or traumatic reinjuries, all about equal in their incidence. Virgin patellar tendon from either the ipsilateral or the contralateral leg was used in all but 11 knees. In these 11 knees, a graft was obtained from the same knee in which the patellar tendon was previously harvested. About two thirds of the knees had a 2-incision, arthroscopic-assisted technique in order to change the orientation of the femoral tunnel and avoid the prior interference screw or collapse of the bony bridge between the tunnels. The other third had a single-incision arthroscopic technique performed. No knees required bone grafting for unusually large tibial or femoral defects. All knees prior to surgery have positive pivot shift tests and greater than 6 mm of side-to-side difference on KT 2000 testing.

Patients were postoperatively evaluated by KT 2000 arthrometry (by the same examiner for reliability), the Cincinnati knee rating system, weight-bearing radiographs, and assessment of the ability to return to sports and occupations. About half of the knees had some other major reconstructive procedure performed in addition to the ACL revision. This included reconstruction or tightening of the posterolateral ligamentous structures in 29%, or high tibial osteotomies for varus knees in about 20%, or 1 case of MCL replacement. Osteotomies were staged and done prior to the ACL revision surgery; whereas, the ligamentous reconstruction procedures were done at the same time. The postoperative rehabilitation progressed relatively slowly with a brace and protective weight bearing until 6 weeks, and continued for 12 weeks for those patients with posterolateral reconstructions. Running was not begun until 6 months, and full return to activities was not permitted until between 9 and 12 months.

Noyes and Barber-Westin found statistically significant improvements in the scores for pain, activities of daily living, sports participation, patient satisfaction, and the overall rating of the knee at a mean of 33 months (range, 2-6 years) postoperatively. Based on positive pivot shifts and a KT 2000 greater than 6 mm of translation compared to the opposite side, 13 knees (24%) had failed grafts. The posterolateral reconstruction was successful in all but 1 patient. This was performed with an advancement of the femoral attachment of the posterolateral structures in line with the LCL before staple fixation at the original attachment site. Those patients with the simultaneous ligamentous reconstruction procedures tended to have lower scores, perhaps reflecting a greater amount of surgery and the more severely damaged knees.

COMMENT BY DAVID R. DIDUCH, MS, MD

Noyes and Barber-Westin are to be congratulated on another excellent addition to the sports medicine litera-

ture. Their follow-up is impressive and their statistics and conclusions are sound. They offer an excellent benchmark from which we can counsel patients and base decisions. Their findings demonstrate that the revision ACL knee is far more difficult than the primary ACL knee. The failure rate of 24% is only part of this picture. The majority of these knees had associated chondral and meniscal damage that was in excess of that usually encountered with primary ACL injured knees. Although the meniscal healing rates with aggressive repair using inside-out, nonabsorbable sutures was quite good, the excessive intra-articular damage tended to lower the patients' return to sports and activities.

Additionally, this paper offers a comparison to a prior study performed by the same authors with revision ACL reconstructions using bone patellar tendon bone allografts.[1] The graft failure rate in that study was 33% of 75 consecutive knees. This is certainly higher than 24% and, as such, Noyes and Barber-Westin no longer recommend using allograft patellar tendon for revisions. Unfortunately, Noyes and Barber-Westin do not evaluate hamstring autogenous grafts as an alternative. They conclude that they recommend autogenous patellar tendon grafts not taken from the same knee as before, yet they do not have any control group in this cohort type study. It would be most interesting to see if hamstring techniques with the modern fixation methods would improve upon this failure rate and also reduce the morbidity associated with the operation. An important point in this paper is that using the same patellar tendon twice is not safe. Six of the 11 knees in which this was performed subsequently failed. This has been something reported sporadically in the literature and often entertained by sports medicine surgeons but frequently abandoned out of fear. This study dissuades the use of the same tendon even years after the prior harvest.

An additional strength of this paper is the excellent description of Noyes and Barber-Westin's decision making for reconstructing associated ligamentous deficiencies. Those knees that have a primary varus deformity of the tibia, or even double varus knee with associated deficiency of the LCL, do well with a high-tibial osteotomy, which they recommend staged prior to the ACL revision. However, the triple varus knee that has varus plus LCL laxity plus posterolateral corner laxity is appreciated to have increased lateral joint opening at 30° of flexion, a varus thrust, as well as increased external tibial rotation and hyperextension. These triple varus knees require a staged high tibial osteotomy plus a posterolateral ligament reconstruction or advancement at the time of the ACL revision surgery. A knee with a varus thrust and lateral laxity puts abnormal stress on an ACL graft as the lateral side of the knee gaps open all the way across to involve the intracondylar notch, thus stretching the graft. Noyes and Barber-Westin recommend an accessory extra-articular iliotibial band procedure for some knees that have excessive laxity of the secondary restraints but do not provide evidence in this particular paper to support its use. ❖

Reference

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Graft Choice for ACL Surgery in Women

ABSTRACT & COMMENTARY

Synopsis: From analysis of postoperative results, it appears that bone-patellar tendon-bone autografts for ACL reconstructions are a reasonable graft option for women.

Source: Ferrari JD, et al. *Arthroscopy*. 2001;17(6):588-596.

Ferrari and colleagues retrospectively reviewed the results of bone-patellar tendon-bone autografts done from 1987 to 1994 in 200 patients, comparing the results in men (137 patients) with the results in women (63 patients). Ferrari et al state that these results have been previously published, but prior publications did not attempt to compare men to women. The same surgeon performed all procedures, and although postoperative technique and rehabilitation schemes evolved during this period, the same protocols were used for procedures done on both men and women during the same time. No mention is made in the article as to whether the percent of reconstructions done in men vs. women have varied during the time period.

All 200 included in this study were evaluated by physical examination, KT 1000 testing, functional testing, radiographic evaluation, and outcome assessments including the Tegner, Lysholm, modified HSS, and Cincinnati rating scales, as well as the SF36 health survey, and a self-administered assessment questionnaire. Ferrari et al report that postoperatively no differences were noted in Lachman, anterior drawer, pivot shift, or functional testing in either group. However, males did have slightly lower KT 1000 scores (maximal manual side-to-

side differences of 0.76 mm in men vs 1.73 mm in women), but there were no differences in the percentage of patients with a side-to-side difference greater than 5 mm.

Women did score higher than men on SF36 testing for Role Physical and Body Pain General Health categories, but Ferrari et al had no preinjury scores for comparison and therefore used gender-matched controls. No marked differences were found in the other outcome assessments.

Therefore, Ferrari et al argue that since there are no significant differences between males and females reconstructed with bone-patellar tendon-bone autograft on examination of physical findings, arthrometric analysis, or outcome assessments, this graft selection is as appropriate for women as for men.

■ COMMENT BY LETHA Y. GRIFFIN, MD, PhD

With increasing numbers of women playing competitive sports, and with the incidence of ACL injuries greater for women than men in many sports requiring pivoting and jumping (eg, soccer and basketball), the question arises as to whether surgical procedures used traditionally to treat ACL injuries in men are also appropriate for women. Some have argued that since women have been reported to have an increased incidence of anterior knee pain, graft options other than bone-patellar tendon-bone autografts should be considered in this population.

Although Ferrari et al have nicely shown no major outcome differences in women compared with men following ACL reconstruction using bone-patellar tendon-bone autograft, they nonetheless do report a fairly substantial percentage of anterior knee symptoms following reconstruction in all patients. Thirty-eight percent of men and 29% of women had the inability to kneel longer than 10 minutes when evaluated 36-79 months following their reconstructions. Surprisingly, only 14% of women had pain on ascending or descending steps compared with 18% of men and only 3% of women compared with 6% of men had crepitance greater than grade 1. Unfortunately, since this is a retrospective study, no data are available on the preoperative assessment of Q-angle or patellofemoral symptoms in either men or women.

Studies such as this, which thoroughly evaluate physical findings, arthrometric data and outcome studies following ACL reconstruction in men and women are helpful for all of us to review before counseling patients regarding the risks and benefits of various graft choices for ACL reconstruction. ❖

Little League Baseball Injuries

ABSTRACT & COMMENTARY

Synopsis: Injuries that occur in youngsters participating in baseball are frequent but generally not severe.

Source: Mueller FO, et al. *The Physician and Sports Medicine.* 2001;29(7):41-48.

In the thorough style that is typical of this superb sports epidemiologist, Dr. Frederick Mueller and his colleagues present a statistical analysis of little league baseball injuries. Players between the ages of 5 and 12 were analyzed over a 10-year period from 1987 through 1996 during which an estimated 1,722,121 children participated each year. Data was obtained from analysis of compensated insurance claims filed with little league baseball. While some may view this means of collecting injury data as a limitation of the study, Mueller et al, after their careful review, state that, "these insurance claims data provide a valid and comprehensive picture of injury in little league baseball."

During the study, 29,038 injuries occurred with an injury rate of 1.69 injuries per 1000 participants per season. Approximately 25% of the injuries were considered severe, and 13 players died. Mueller et al present their data in easy to review tables. The tables detail injuries per player position resulting from ball-related trauma; sliding, running, or tagging; and colliding, falling, or being hit by the bat. A table detailing the mechanism of the 13 fatalities is also provided, as is a table relaying the incidence of each injury type (eg, fracture, dislocation, laceration, contusion) per body part.

Finally, Mueller et al have emphasized that data such as theirs are most helpful when analyzed to help develop injury prevention strategies, and, based on their data, they make recommendations along these lines.

■ COMMENT BY LETHA Y. GRIFFIN, MD, PhD

Mueller et al state that next to basketball, baseball is the most commonly played team sport in this country with approximately 8.6 million 6- to 17-year-olds participating each year. Hence, it is prudent to analyze not only the incidence of injury, but the type of injuries and the mechanisms of injury seen in those playing this sport. Surprisingly, of the 216 ball-related chest injuries reported in this study, none resulted in death. Ball-related chest trauma resulting in death from commotio cordis, an arrhythmia (generally ventricular fibrillation),

or sudden death from low impact, blunt trauma to the chest without apparent heart injury has been reported in young players and, in fact, is one reason why some have recommended chest protection and softer baseballs for younger players as well as the accessibility of automatic external defibrillators (AEDs) for use by medical personnel covering youth baseball and softball games.[1] However, Mueller et al state, following analysis of their data, ". . .there is no evidence that a vest will protect the batter as shown in this study—the number of chest injuries is small."

Mueller et al do feel that since sliding was associated with approximately 60% of the injuries to base runners, that safety bases as previously recommended by Janda and associates would reduce a significant number (approximately 3000) of these injuries.[2] Data presented in this article would be helpful not only as background information for coaches, players, and the families of the players, but also for those involved in little league baseball who are responsible for recommendations regarding injury prevention and safety equipment. ❖

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Current Concepts on SLAP Lesions

ABSTRACT & COMMENTARY

Synopsis: An update of current diagnosis, evaluation, and treatment of SLAP lesions (superior labral tears) is presented. This is a thorough review of the literature and current clinical practice.

Source: Musgrave DS, Rodosky MW. *Am J Orthop*. 2001;30(1):29-38.

Musgrave and rodosky introduce this review article with a historical review of labral lesions in the shoulder. Labral anatomy and biomechanics are also discussed. The diagnosis, physical exam, and specific tests are then presented. The history usually involves a clicking or popping in the shoulder, especially with overhead activities. There also may be a history of instability or biceps-related anterior shoulder pain. Several physical exam tests such as the O'Brien and Kibler tests are discussed, as well as biceps tendon tests. The Snyder test was omitted, but it can be equally helpful. Musgrave and Rodosky stress the importance of diagnosing concomitant injuries such as rotator cuff tears, instability, cartilage injuries, and impingement lesions such as acromioclavicular joint arthritis and acromial spurring. Plain radiographs, CT arthrogram, MRI, and MRI with a gadolinium arthrogram can all be helpful diagnostically, but arthroscopy is the gold standard for diagnosis. Treatment of the labral tear usually requires surgical debridement or fixation. Concomitant pathology should also be addressed at the time of surgery. Types I through VII SLAP lesions are all specifically discussed. The type of SLAP lesion, concomitant injuries, and the patient's symptoms dictates treatment.

■ COMMENT BY STEPHEN B. GUNTHER, MD

This article reviews the anatomy and biomechanics of the glenoid labrum and briefly mentions other labral lesions. There is a thorough discussion of history, physical examination, and imaging of SLAP lesions. This is an important discussion since the diagnosis of SLAP lesions can be difficult. Most of these lesions were treated with "benign neglect" in the past, but shoulder arthroscopy has introduced a new avenue for diagnosis and treatment of these lesions.

An educated physician is the best tool for diagnosing SLAP lesions. MRI enhanced with a gadolinium arthrogram is also helpful. Musgrave and Rodosky also present previous work describing anatomical labral variants. This is important to remember so that normal labral variants are not treated with debridement or repair. Surgical treatment depends on the type of SLAP lesion and other associated pathology as well as patient age, activity level, and degree of symptoms. Surgical fixation has progressed from large, absorbable tacks to smaller absorbable devices and suture anchors. Surgical outcomes have been very successful in short-term follow-up studies. ❖

CME Questions

22. The modified Cantu guidelines for grading of concussion are based primarily on which of the following?

a. A correlation between duration of postconcussive symptoms, PTA, and neuropsychological assessment
b. The presence of unconsciousness in mild, moderate, and severe concussions
c. The presence of PTA in moderate and severe concussions
d. The incidence of unconsciousness lasting longer than 5 minutes

23. Low back pain in female athletes may be secondary to:

a. osteopenia of the lumbar spine.
b. polycystic ovarian disease.
c. sacral stress fractures.
d. spondylolysis.
e. All of the above

24. Most meniscal tears in ACL-deficient knees:

a. occur in the central portion of the meniscus.
b. occur in the anterior horn of the meniscus.
c. occur in the periphery of the meniscus.
d. occur as radial tears.

25. Which ACL reconstruction technique had the highest graft failure rate?

a. Primary ACL reconstruction with patellotendon graft
b. Revision ACL reconstruction with patellotendon autograft
c. Revision ACL reconstruction with patellotendon allograft
d. Revision ACL reconstruction with patellotendon graft taken from the same knee the graft was previously taken

26. Bone-patellar tendon-bone autograft for ACL reconstructions:

a. appears to be appropriate for both men and women.
b. is associated with a higher incidence of reinjury in women.
c. is only an appropriate graft material for athletes younger than 30 years of age.
d. is associated with a higher incidence of patellofemoral symptoms in women.

In Future Issues: Thermal Capsulorrhaphy for Internal Impingement in Pitchers