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Strength of Bioabsorbable 'All-Inside' Meniscal Repair Devices

ABSTRACT & COMMENTARY

Synopsis: *In an independent study of various commercially available meniscal repair devices, none of these products were as strong as vertical mattress sutures.*

Source: Barber FA, Herbert MA. Meniscal repair devices. *Arthroscopy* 2000;16(6):613-618.

Although newer bioabsorbable "all-inside" meniscal repair devices are enormously popular, surgeons must keep in mind that the mechanical strength of all of these products are weaker than conventional "inside-out" meniscal repair. Additionally, one must be careful about accepting manufacturer's claims on face value. This study used a porcine meniscal model to determine the initial holding strength of various constructs. Mechanical testing was accomplished using similar parameters from other published studies and repeat testing yielded an accuracy with approximately 5% error. The results reported that a double-vertical mattress suture (top and bottom) using 2-0 nonabsorbable suture was at least twice as strong as any "all-inside" device. The strengths of the meniscal repair devices, according to this study, basically fall into two groups. The first group, about half as strong as the double-vertical suture, and two-thirds as strong as a single vertical suture, includes the BioStinger (Linvatec) and the T-Fix (Smith and Nephew Endoscopy) devices. The second group of devices, approximately one-third as strong as the double vertical sutures and two-fifths as strong as the single vertical suture, included the remaining devices (Meniscal Arrow [Bionx], Clearfix Screw [Innovasive Devices/Mitek], SDsorb Stable [Surgical Dynamics], Mitek repair system [Mitek], and the Biomet staple [Biomet]).

COMMENT BY MARK D. MILLER, MD

What I found to be the most remarkable point of this study is that

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INSIDE

Barber and Hebert's findings are in stark contrast to "Final, Significant, and Valid Results" published in an advertisement in the *American Journal of Sports Medicine* the month prior to this article (August). In that advertisement, Bionx proposed that the Meniscus Arrow was stronger than vertical suture, the BioStinger, the Clearfix Screw, The Mitek system, and SD Sorb staples, in that order. On careful examination, they compared their device to PDS and not nonabsorbable suture, but this still does not explain the discrepancy.

What is clear is that a word of caution with the use of these devices is appropriate. Perhaps less aggressive rehabilitation may be necessary when using these devices. Perhaps these devices should not be used for large, complex tears. Perhaps these devices are appropriate only for repairs in conjunction with ACL reconstruction when the healing environment is optimal. There is a paucity of objective clinical studies to support these devices, so surgeons are left with only advertisers' information on which to base their decisions. Additionally, numerous reports of breakage, synovitis, migration, and other problems with these devices should temper their use. I remain primarily a meniscal "sewer" using vertical mattress sutures and an inside-out technique. In fact, I prefer zero nonabsorbable sutures over 2-0 because I have experienced episodes of suture breakage using 2-0 sutures. Sure, "all-inside" devices are quicker, easier, and do not require an incision. . .but do they consistently work? Fundamental to these issues is the question of how strong is strong enough. Long-term clinical studies may provide the answer to that question, but in the interim, I am reminded of a line from an old television sitcom: "Danger, Will Robinson!" ❖

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Atraumatic Osteonecrosis of the Knee

ABSTRACT & COMMENTARY

Synopsis: *This large series with long-term follow-up documented the effectiveness of magnetic resonance imaging as a screening tool and prognosticator for atraumatic osteonecrosis of the knee, and the efficacy of core decompression as a treatment modality.*

Source: Mont MA, et al. Atraumatic osteonecrosis of the knee. *J Bone Joint Surg Am* 2000;82:1279-1290.

Atraumatic osteonecrosis of the knee is a disorder affecting younger patients who generally have comorbidities. This is in contrast to spontaneous osteonecrosis of the knee that generally affects older patients, especially females, often in their 60s and 70s. The latter is more focal and limited in extent to the subchondral region of usually just one femoral condyle. Atraumatic osteonecrosis, on the other hand, is more diffuse, frequently involving both femoral condyles as well as the tibia, and often presenting with multiple joint involvement and bilaterality. Atraumatic osteonecrosis of the knee has a strong correlation with autoimmune diseases and steroid use. However, the literature is lacking in good, long-term studies that help with prognosis and treatment alternatives.

Mont and associates provide a review of their experience with 248 knees in 136 patients who were treated over a 24-year period at Johns Hopkins. The patient population was limited to those younger than 55 years of age to avoid overlap with the spontaneous osteonecrosis population. Seventy-four percent had a comorbid disease that affected the immune system, most commonly Lupus. Ninety percent had a history of corticosteroid use. Diagnostically, bone scan missed lesions 30% of the time, leading Mont et al to recom-

mend MRI as the screening modality of choice for the involved joint and any other symptomatic joint.

Initially, treatment involved three months of conservative measures including protected weight-bearing and anti-inflammatory medication. Those patients who failed to improve underwent core decompression with a 79% clinical success rate. This was sustained to a mean of seven years. For those with recurrent symptoms, repeat core decompression was effective in 60%. Arthroscopic debridement was combined with repeat core decompression if patients developed more localized joint line tenderness or mechanical symptoms. Only 20% of the patients treated nonoperatively had clinical success. Furthermore, knee replacements faired terribly in this population with only 71% success at nine years, and an unacceptably high rate of loosening. This poor outcome was the same whether the patients were treated first with core decompression prior to replacement.

Prognostically, Mont et al found that size of the lesion and location in the epiphysis—as opposed to the metaphysis—was the most prognostic for poor outcome. Lesions larger than 250° (the combined necrotic angle on the AP and lateral view of the magnetic resonance imaging [MRI]) had a worse prognosis. Based on the positive response to core decompression and the very poor response to nonoperative treatment, Mont et al now recommend immediate core decompression upon patient presentation rather than waiting for three months of nonoperative treatment.

COMMENT BY DAVID R. DIDUCH, MS, MD

This is an exceedingly well-written paper with a large number of patients with sufficient long-term follow-up. This will soon be referenced widely because it gives us excellent data on which to base treatment recommendations. Although the sports medicine physician may not think of atraumatic osteonecrosis as a common problem in their patient population, we frequently are the ones ordering a MRI and determining the course of treatment, and we frequently are involved in joint restorative procedures about the knee. This article clearly points out the difference between atraumatic osteonecrosis and spontaneous osteonecrosis. They clearly define the epiphyseal location and large lesions as high risk factors for poor outcome. They also present an excellent case for core decompression to alter the natural history in positive fashion. It is important to note that this was maintained over the long term. Their core decompression technique involves radiographic-guided decompression from an extra-articular starting location. The ACL tibial guide and cannulated reamers can be helpful in this regard.

There are many take-home lessons in this paper. Upon presentation, we should have a high suspicion for other joint involvement and use MRI as a screening tool liberally. This is because core decompression appears to offer the ability to alter the natural history of this problem. It would also appear that nonoperative treatment of symptomatic lesions has a poor prognosis. It would also appear that repeat core decompression with arthroscopic debridement can be successful even if the initial treatment did not relieve symptoms. Finally, we are to be cautioned regarding recommending knee replacement in this patient population. They have a very high rate of both aseptic and septic loosening. This is due to their frequent autoimmune disease comorbidity, poor bone stock, and associated corticosteroid use. Cemented knee replacements with long stems are probably ideal. ❖

MRI and Knee Dislocations

ABSTRACT & COMMENTARY

Synopsis: *The dislocated knee is a complex injury with multiple ligamentous tears and associated injuries. Examination under anesthesia is the most accurate manner to define functional integrity of ligamentous injuries in a dislocated knee, but the role of magnetic resonance imaging is still being defined.*

Source: Lonner JH, et al. Comparison of magnetic resonance imaging with operative findings in acute traumatic dislocations of the adult knee. *J Orthop Trauma* 2000;14(3):183-186.

Knee dislocations are injuries that have great interest for both sports medicine and trauma orthopaedic surgeons. These injuries are complex, require careful evaluation and management, and can have significant complications. In one series, more than 20% of patients eventually diagnosed with a dislocated knee were found to have a reduced tibio-femoral joint at the time of presentation, thus other studies have been considered for optimal diagnosis and management. Lonner and colleagues describe their experience with knee dislocations in an attempt to identify the accuracy of magnetic resonance imaging (MRI) in the evaluation of soft tissue injuries as compared to clinical examination under anesthesia (EUA). Lonner et al used a retrospective analysis of 48 patients between 1986 and 1996 in which a cohort of 10 patients undergoing

preoperative MRI, EUA, and operative exploration was identified.

The researchers found clinical examination to be the critical step in evaluating the functional integrity of ligamentous injuries in a knee dislocation. EUA neared 100% accuracy in functional evaluation; however, EUA was uncertain in two of five patients with a posterolateral corner injury requiring open exploration for definitive evaluation. However, it is unclear if the surgeons were blinded from the MRI and possibly the preoperative information influenced the results of the EUA. MRI accuracy ranged from 80-100%, with diagnosis of the lateral meniscus, MCL, and PCL at 100%. The accuracy of diagnosis of the posterolateral corner was 90%. Lonner et al concluded that MRI is useful for defining the presence of ligamentous injuries in knee dislocations. However, clinical examination was more accurate. Lonner et al noted that all injuries underwent operative exploration between one and two weeks postinjury; hence, they felt that an MRI was most useful for orthopaedic surgeons inexperienced in treating acute knee dislocations. Nonetheless, Lonner et al note that MRI may be helpful in the operative management of the acutely dislocated knee, particularly if an autograft is being considered for surgical reconstruction.

COMMENT BY ROBERT C. SCHENCK, Jr., MD, TOM DeCOSTER, MD, & DAN WASCHER, MD

This retrospective review is useful for the practicing sports medicine specialist as it clearly identifies the key point in decision making for the evaluation and treatment of knee dislocations, namely examination under anesthesia. Knee dislocations present in a variety of ligamentous combinations and energy mechanisms (high—motor vehicular trauma, and low—sporting injuries). In our experience, identifying what ligaments are torn is much more useful than identifying the joint position (ie., anterior, posterior, etc.) of the tibiofemoral joint. As in any ligamentous evaluation of the knee, examination under anesthesia is imperative preoperatively and should be part of any arthroscopic or open surgical reconstruction. We agree with Lonner et al on the importance of EUA in the diagnosis and surgical decision making in the dislocated knee.

However, we still find MRI useful under several situations in the evaluation and treatment of the dislocated knee. We agree that the radiographic study is not the best way to functionally evaluate ligamentous injuries. MRI frequently complements what is found at the time of EUA, and as reported by Reddy et al and Yu et al, determination of midsubstance vs. avulsion injuries of the ligaments can only be determined with preoperative MRI or surgical exploration.[1,2] In our experience, we find that MRI is very important for preoperative decision making by more accurately defining:

- site and morphology of ligament injury (avulsions vs midsubstance tears);
- timing of surgical reconstruction by identifying avulsions that are best operated on early (3-5 days);
- meniscal tears or chondral injuries (which may be more readily treated with an arthroscopic approach;
- associated injuries, especially the condition of potential autograft tissues (patellar tendon, hamstrings) which may be considered for reconstruction/augmentation;
- collateral injuries, facilitating the surgical dissection by localizing the area of collateral ligament injury (proximal vs distal vs midsubstance).

Open ligament repair is the standard of treatment in knee dislocations.[3] However, several researchers delay surgical repair with range of motion followed by arthroscopic simultaneous bicruciate reconstructions.[4,5] In such plans, MRI could identify an avulsion injury that would be best treated with early, open repair. In summary, EUA is the key to functional evaluation of knee ligaments; nonetheless, MR imaging has other benefits in the evaluation and treatment of the dislocated knee and still can be recommended. In contrast to Lonner et al, we believe MRI can play an integral supplemental role in effective evaluation of patients with knee dislocations in 2000. ❖

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Tensioning the PCL Graft

ABSTRACT & COMMENTARY

Synopsis: *The posterior cruciate ligament graft should be pretensioned and fixed with an anterior load placed on the knee at 90° knee flexion.*

Source: Harner CD, et al. The effect of knee flexion angle and application of an anterior tibial load at the time of graft fixation on the biomechanics of a posterior cruciate ligament reconstructed knee. *Am J Sports Med* 2000;28(4):460-465.

This is a basic science cadaver study using a well-documented robotic/universal force moment sensor to test the biomechanics of the posterior cruciate ligament (PCL). This study addresses the effect of knee flexion angle and the application of an anterior tibia load applied to the knee during PCL reconstruction.

Ten fresh frozen cadavers aged 36-65 were tested. The intact knee, PCL deficient knee, and PCL reconstructed knee were compared. Testing was performed at full extension, 60°, 90°, and 120°. The PCL reconstructions were performed arthroscopically using 11 mm achilles allograft tendons.

The results demonstrated that if the PCL graft fixation was performed at full extension and a 134 N posterior load applied to the knee, then the resulting tibia translations were significantly decreased from normal at 30°, 60°, 90°, and 120°. Additionally, significantly increased in situ forces were reported at full extension, 60° and 120°. When the PCL fixation was performed at 90° with a concomitant anterior tibia force and the same 134 N posterior loads applied to the knee, the resulting tibia translation at all recorded flexion angles was not different than the normal knee. The in situ forces were similar to the intact knee at full extension, 60°, and 120°.

COMMENT BY JAMES R. SLAUTERBECK, MD

Controversies exist on what knee flexion angle one should pretension and fix the graft. PCL surgery is a complicated procedure and many different techniques are available to assist the surgeon. Many studies reflect patient satisfaction after PCL reconstruction but objective measurements demonstrate persistent laxity. This study addresses where and how to pretension and fix the PCL graft. Proper knee placement and pretensioning procedures may lead to knees that are more stable post-operatively.

The PCL is the primary restraint to posterior tibia translation at 90° of knee flexion, and the ACL is the primary restraint to anterior tibia translation at 30°. If the ACL graft is pretensioned and graft fixation performed at 30° it would stand to reason that the PCL should be pretensioned and fixed at 90°.

It is not commonly discussed where to set the tibia when pretensioning. If the tibia is not reduced at the time of graft fixation, the knee will have excessive AP excursion. If the graft is tensioned in full extension where the posterior capsule is the primary restraint to posterior tibia translation, the graft could be overly tensioned. Over-tensioning could lead to early graft failure from excessive forces or decrease the knee range of motion. If the knee is placed at 90° of flexion where the PCL is the primary restraint to posterior tibia translation, one could gently set the knee tension against the ACL and remove the posterior translation within the knee. Pretensioning in this position will remove any tunnel-bone plug graft friction and stretch the collagen crimp at the position where the graft is most functional to resist posterior tibia translation.

This study shows that with the knee positioned at 90° of knee flexion and a gentle anterior drawer placed on the knee the kinematics of the knee are restored to nearly normal. However, at full extension excessive graft forces and decreased tibia translations are noted. The increased forces and decreased tibia translation essentially over-constrains the knee and could lead to premature rupture or even DJD from the increased forces in the knee. This is another nice study from a respected biomechanical lab, which helps to answer some clinically pertinent questions. ❖

Posterior Shoulder Instability

ABSTRACT & COMMENTARY

Synopsis: *Posterior shoulder instability is an uncommon problem requiring careful patient selection and attention to correction of anatomic labral and capsular abnormalities.*

Source: Antoniou J, et al. Capsulolabral augmentation for the management of posteroinferior instability of the shoulder. *J Bone Joint Surg Am* 2000;82(9):1220-1230.

This prospective evaluation of capsulolabral augmentation for posteroinferior instability of the shoulder evaluated 41 patients undergoing an arthro-

scopic posterior capsular shift. All patients presented with a positive jerk test and failed a six-month period of rehabilitation. In an attempt to produce a true outcome study, Antoniou and colleagues used a pre- and postoperative SF-36, the Simple Shoulder Test, and a treatment outcome questionnaire. One of four types of surgical findings of the posterior capsular labral complex were noted in more than 83% of patients, and almost an equal number presented with a history of trauma. Surgery included repair or augmentation of the posterior capsulolabral complex to restore the depth of the glenoid cavity. In addition, plication with arthroscopic sutures was performed to tighten the redundant posteroinferior capsule and to close the rotator interval in patients with generalized ligamentous laxity.

Antoniou et al noted improvement in mean scores of the simple shoulder test, but only two of eight of the SF-36 parameters improved significantly at a minimum one-year follow-up. However, those patients on worker's compensation insurance had no improvement for any of the parameters on SF-36 evaluation. Physical exam findings improved in all patients with regards to stability, but subjectively only 35 of 41 patients described improved stability of the shoulder. Interestingly, 28 of 41 patients complained of residual stiffness, whereas the mean score on flexibility examination had not changed significantly compared to preoperative evaluation.

COMMENT BY ROBERT C. SCHENCK, Jr., MD

This interesting study looks at the rare and often overlooked shoulder instability pattern of posteroinferior instability. Doug Harryman, now deceased, had tremendous insight and ingenuity in problems about the shoulder throughout his orthopaedic career. This paper is no different. As with most clinical orthopaedic studies, this paper contrasts the objective findings of a surgical procedure with that of patient satisfaction and outcomes. Using the SF-36 and the Simple Shoulder Test, Antoniou et al note the discrepancies between good objective findings (stable shoulder, good range of motion, minimal pain) and patient satisfaction. All patients with worker's compensation insurance claims had no improvement on SF-36 parameters despite objective findings otherwise. As noted by other investigators, the SF-36 is frequently difficult to administer despite its universal usage. Furthermore, the ability of the SF-36 to differentiate outcomes with orthopaedic procedures has been questioned.

The described surgical technique is all-arthroscopic and requires an experienced sports surgeon to perform such a plication. They conclude that posteroinferior instability is associated with well-defined lesions of the glenolabral complex that are amenable to repair, thereby restoring the depth of the glenolabral cavity. In addition, capsular plication is necessary to address the redundant capsular laxity. Although Antoniou et al did not detail their complications, such a procedure requires cadaveric lab experience or fellowship training to minimize pitfalls. The final question remaining involves patient selection with posteroinferior instability. In the 19 patients receiving worker's compensation, only six returned to work. Although the follow-up was only 28 months (range, 12-69 months), Antoniou et al describe a successful arthroscopic technique with good objective findings postoperatively. However, insurance companies reading no improvement on the SF-36 outcome measure may interpret it otherwise, especially in the area of worker's compensation claims. ❖

Is Infection Risk Linked to Exercise?

ABSTRACT & COMMENTARY

Synopsis: *Excessive, strenuous exercise appears to increase infection risk, while moderate exercise appears protective.*

Source: Nieman DC. Is infection risk linked to exercise workload? *Med Sci Sports Exerc* 2000;32(7):S406-S411.

A common perception is that elite athletes subject to prolonged and intense exertion have decreased resistance to upper respiratory tract infections (URTI). Much of the data regarding this association are anecdotal and obtained from surveys. The reverse association has also been suggested—that is, a recent URTI can result in a sudden deterioration of athletic performance. In fact, following a viral infection, a clinical syndrome of decreased athletic performance, lethargy, easy fatigability, and myalgia termed the "post-viral fatigue syndrome" has been described. However, the majority of endurance athletes, as Nieman stresses, do not experience URTIs after competitive events, and in fact, regular moderate exercise is said to confer resistance against infection.

There appears to be a link between exercise workload and infection with the risk of URTI increasing during periods of excessive, intense exercise. Changes in the immune system occur after heavy, but not necessarily moderate, exercise. These include increased neutrophils and decreased lymphocytes in the blood, increased blood granulocyte and monocyte phagocytosis, but

decreased nasal neutrophil phagocytosis, increased plasma concentration of inflammatory cytokines, and decreased nasal and salivary IgA concentrations. These and other changes imply that the immune system is stressed following prolonged endurance exercise. The stress to the immune system can be further accentuated by lack of sleep, severe mental stress, malnutrition, or weight loss. Therefore, to decrease the risk of infection, athletes (since most will not alter their intense vigorous training schedules) should decrease the confounding factors just listed.

There is also some evidence that nutritional supplements, including vitamin C, glutamine, and carbohydrates may decrease the negative effects on the immune system from intense exercise. For example, Neiman notes that ". . .carbohydrate compared with placebo supplementation during prolonged exercise is associated with higher plasma glucose levels, an attenuated rise in plasma stress hormone concentrations (in particular, cortisol), and reduced stress to the immune system. . ." Such data would imply that athletes might benefit from carbohydrate sports drinks before, during, and after intense exercise bouts. Levels of glutamine, a nonessential amino acid and fuel for lymphocytes and monocytes, appear to decrease with prolonged exercise. Therefore, some feel that a decrease in glutamine could impair immunity by altering the proliferation rates of lymphocytes, but this theory has not been scientifically substantiated. Further research to more clearly define the association of exercise and immunity, as well as factors influencing this relationship, is warranted.

COMMENT BY LETHA Y. GRIFFIN, MD, PhD

Research in the area of decreased immunity in athletes has been stimulated by the observation that athletes appear to experience a higher number of URTIs during periods of intense activity. However, research data regarding this alteration of immune function in athletes is conflicting. Although the numbers of circulating immune cells do not seem to vary with exercise, the cell function may, as might immunoglobulin concentration. However, no conclusive evidence has been gathered to date.

Nonetheless, the take-home message in this article and others in this special supplement of *Medicine and Science in Sports and Exercise* is that there is some relationship between exercise and immunity. Although the data are somewhat conflicting, it does appear that regular fitness exercise enhances the immune system, whereas overexertion, especially if combined with other stresses such as not eating or sleeping properly, can decrease the immune response. The cause of this suggested decrease in immunity is not well understood. ❖

Evaluation of Lower Extremity Overuse Injury Potential in Runners

ABSTRACT & COMMENTARY

Synopsis: *Low-impact forces, a rapid rate of pronation, and greater hamstring flexibility may be related to a reduced risk of overuse injury in runners.*

Source: Hreljac A, et al. Evaluation of lower extremity overuse injury potential in runners. *Med Sci Sports Exerc* 2000;32(9):1635-1641.

This paper compared several anatomical features and biomechanical stride characteristics between runners with history of lower extremity injury and a matched group of runners free from history of injury. Two groups of 20 runners (8 female and 12 male in each) provided data pertaining to training distance, intensity, running surface, shoes worn, changes in training, and stretching habits. The injured group had sustained an overuse injury below the knee but subjects were pain-free at the time of the study and had returned to training for at least three months. Specific diagnoses were not obtained for the injured group. The anatomical data collected included height, weight, longitudinal arch height, footprint index, and hamstring and ankle flexibility. The biomechanical variables included contact time, vertical force impact peak, maximal vertical loading rate, maximum active force peak, maximum push-off force, Achilles tendon angle at touchdown, maximal angle of pronation, total change in Achilles tendon angle, and maximal pronation velocity.

No significant differences were found between groups in average running pace, weekly distance, or any of the other training variables. The statistical analysis for the anatomical and biomechanical data compared the average of right and left side values between groups. The only anatomical difference found between the groups was in flexibility as measured with the sit and reach test. The injured subjects were approximately 6.5° less flexible than the uninjured subjects. The only biomechanical variables that were different between groups were the vertical force impact peak and the maximal vertical loading rate. Hreljac and associates noted a trend toward more rapid pronation and greater touchdown supination.

COMMENT BY DAVID H. PERRIN, PhD, ATC

Hreljac et al should be applauded for examining the anatomical and biomechanical factors that may lead to lower extremity injury in runners. Only with this knowledge can clinicians implement preventive strategies founded on experimental rather than anecdotal evidence. Little scientific evidence exists that decreased flexibility leads to an increased rate of injury in runners. Many have speculated that this relationship does exist, and the findings of this study would seem to lend credence to this speculation. It is interesting to note that the injured and uninjured subjects reported no differences in stretching habits. One might speculate that perhaps the differences in flexibility were a result of problems with technique, rather than frequency or duration of stretching.

The primary biomechanical differences between the two groups were excessive impact forces and rates of loading, which were greater in the injured than uninjured group. It seems logical that repeated excessive loading could lead to lower extremity injury. The trend toward more rapid pronation in the uninjured group is also interesting. Pronation is thought by many to be a protective mechanism during running, assuming it is not excessive.

The limitations of the study include the small sample size, and the absence of specific diagnoses of injury. Although a statistical power analysis was not reported, the failure to find statistically significant differences in maximal pronation velocity between the two groups might be due to the sample size. Further research should examine the potential risk factors for injury in runners with larger numbers of subjects and with prospective research designs. Specific injury diagnosis would also enable determination of a cause and effect relationship between anatomical and biomechanical characteristics and type of lower extremity overuse injury. ❖

CME Questions

24. During a PCL reconstruction with allograft Achilles tendon, the graft should be pretensioned and fixed at what knee flexion angle and with what type of externally applied tibia load?
a. At full extension and with a posterior applied tibia load
b. At full extension and with a anterior applied tibia load
c. At 90° knee flexion and with a posterior applied tibia load
d. At 90° knee flexion and with a anterior applied tibia load

25. The primary biomechanical variables associated with lower extremity injury in runners include which of the following?
a. Limitations in pronation
b. Maximum pushoff force
c. Changes in Achilles tendon angle
d. Magnitude and rate of impact loading

26. Outcomes of surgery used for posterior inferior instability are adversely affected by:
a. range of motion.
b. SF-36 ratings.
c. strength.
d. on the job injury.

27. Athletes should be cautioned that, during periods of intense training, they may be more subject to URTIs. To decrease their susceptibility, they should:
a. only exercise during the morning hours.
b. eat only a vegetarian diet but take extra vitamins E and K.
c. get ample rest and eat nutritiously.
d. not travel.

28. Atraumatic osteonecrosis is characterized by all of the following *except*:
a. Focal, limited involvement of just one femoral condyle
b. Diffuse involvement of both the femur and tibia
c. Good long term response to core decompression
d. High rate of loosening with joint replacement
e. Strong correlation with autoimmune diseases

29. Functional integrity of a ligament injury in a dislocated knee is best evaluated by:
a. arthroscopy.
b. MRI.
c. examination under anesthesia.
d. arthrography.

30. Pull-out strengths of absorbable all-inside meniscal repair devices:
a. are stronger than vertical mattress nonabsorbable sutures.
b. are as strong as vertical mattress nonabsorbable sutures.
c. are weaker than vertical mattress nonabsorbable sutures.
d. are basically all the same.

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