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Injectable Corticosteroids

ABSTRACT & COMMENTARY

Synopsis: *Injectable corticosteroids are frequently used to decrease musculoskeletal inflammation. While frequently beneficial, this technique is not without potential risks.*

Source: Noerdlinger MA, Fadale PD. The role of injectable corticosteroids in orthopedics. *Orthopedics*. 2001;24(4):400-405.

In this article, noerdlinger and fadale discuss the mode of action of corticosteroids, the type of injectable corticosteroids available, the indications and complications following steroid injections, as well as present their technique for instilling corticosteroids into commonly injected sites. The article contains an excellent chart describing the various injectable corticosteroids giving their generic name, trade name, equivalent dose, and recommended doses for the injections of small and large joints. There is also a second chart that details the pathway of inflammatory mediators and indicates the site of action of the corticosteroids. Corticosteroids, derivatives of cholesterol, inhibit phospholipase A2, thus preventing development of arachidonic acid from membrane phospholipid. Arachidonic acid is the precursor of prostaglandins, thromboxanes, and leukotrienes—the mediators of inflammation.

In their discussion on the indications for injecting steroids into tendons, ligaments, tendon sheaths, bursas, and joints, Noerdlinger and Fadale state their purpose as trying "to separate science from fiction," listing references for some of the areas where controversy still lingers over the use of injectable corticosteroids. For example, Noerdlinger and Fadale write that "the literature is inconclusive regarding the effect of steroid injections with tendonitis." They cite studies substantiating benefit and others reporting no difference from placebos following steroid injections in rotator cuff tendonitis.[1,2] They further state that the literature is equivocal in regard to the benefit of injectable corticosteroids for lateral epicondylitis. They cite work done previously where, in a blinded study, there was no difference in outcome between oral nonsteroidal anti-inflammatory drugs (NSAIDs) and steroid injections for this overuse syndrome.[3]

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INSIDE

In addition, Noerdlinger and Fadale also emphasize that steroid injections for those with symptomatic arthritis can significantly decrease the pain by decreasing inflammation; however, there are no long-term benefits from such injections.

COMMENT BY LETHA Y. GRIFFIN, MD, PhD

Noerdlinger and Fadale stress the dilemma often faced by those treating inflammation of the musculoskeletal system—that is, when do the potential risks of injectable corticosteroids outweigh the benefits? Noerdlinger and Fadale stress the risks of corticosteroids on articular cartilage (primarily potential cellular degeneration) are dose-dependent and believe that "if high concentrations of corticosteroids are avoided the harmful effects . . . can be avoided." However, they do not clearly define "high concentrations." Noerdlinger and Fadale do stress that it is not only the dose but also the time course over which the drug is delivered that influences the development of potential complications, and suggest that low dose, short-term, or intermitted injectable corticosteroids do not significantly affect collagen synthesis and strength. Surprisingly, they recommend injecting corticosteroids into tendons without sheaths, although they caution that the steroid should not be injected as a bolus but instead should be "peppered" into the tendon—ie, small amounts should be injected throughout an area through a single skin puncture site. Most orthopedists would be extremely hesitant to follow this advice over concern for potential tendon rupture. Actually, in their section on injection technique for the Achilles tendon, Noerdlinger and Fadale do caution against injection corticosteroids into the substance of this tendon.

Noerdlinger and Fadale only briefly mention the potential development of avascular necrosis following injection of corticosteroids and do not provide the reader with any reference for further information on this feared, yet rarely reported, complication from corticosteroids. Additionally, the article would also have been greatly enhanced if Noerdlinger and Fadale had chosen to include diagrams to compliment their text on injection techniques. Not withstanding the above comments, this article is a nice review on the use of injectable corticosteroids in the treatment of musculoskeletal inflammation. ❖

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ACL Reconstruction: Patellar Tendon vs. Hamstring Graft

ABSTRACT & COMMENTARY

Synopsis: *Patients who had patellar tendon graft ACL reconstructions had statistically significant better results than patients who had 2-strand hamstring graft ACL reconstructions with or without extra-articular procedures. The extra-articular procedure provided no additional benefit.*

Source: Anderson AF, et al. ACL reconstruction. A prospective randomized study of 3 methods. *Am J Sports Med*. 2001;29(3):272-279.

The debate regarding the optimum graft choice for ACL reconstruction continues to rage. Several

recent papers have suggested that hamstring grafts may not be as efficacious as patellar tendon grafts, at least in certain circumstances. The current paper lends further support to patellar tendon advocates, but these results must be carefully scrutinized.

A total of 105 patients with isolated ACL tears were randomized into 3 groups: 1) ACL bone-patellar tendon-bone (BPTB) graft; 2) ACL semitendonosus and gracilis tendon graft with extra-articular iliotibial band tenodesis; 3) ACL semitendinosus and gracilis tendon graft alone. All patients were thoroughly studied pre- and postoperatively with complete International Knee Documentation Committee (IKDC) and Hospital for Special Surgery (HSS) evaluation to include KT-1000, Cybex, and radiographic examination. Although precise details of the procedures are not given in the article, isometry was used to select femoral tunnel location, the patellar tendon grafts were secured distally with 2 staples, and the hamstring grafts were left attached distally and were only 2-strand grafts. Anderson and colleagues obtained follow-up for 102 of the 105 patients at a minimum of 24 months and an average of 35.4 months postoperatively. There was no significant difference in the incidence of patellofemoral crepitus between the groups, although group 3 (hamstring alone) did have the lowest incidence (10% vs 35-40% in the other 2 groups). The mean max-manual KT-1000 side-to-side difference of 2.1 ± 2.0 mm in group 1 was statistically better than the difference in group 3 (3.1 ± 2.3 mm), but not group 2 (2.6 ± 2.2 mm). "Normal" or "nearly normal" results on IKDC evaluation were obtained in 34/35 patients in group 1, 23/34 patients in group 2, and 26/33 patients in group 3. Subjective results and all other objective measures were similar in all groups.

COMMENT BY MARK D. MILLER, MD

Although it is tempting to apply these results to our current practice and drastically reduce the number of hamstring ACL reconstructions we do, this study does not definitively solve this problem. The fact that a 2-incision doubled hamstring construct was used in this study (and is no longer used in clinical practice) completely challenges the results. It is clear that an extra-articular procedure adds little to the results, and this has been shown in other studies as well. Note that the patellofemoral crepitus was markedly higher in the BPTB group. Although Anderson et al suggest that this difference was not statistically significant, it must have closely approached significance, and additional subjects may have made it so. Anterior knee pain was not specifically sought out in this study, and this information would have been helpful. These 2 issues are critical, and yet they are not well addressed in this paper. In fact, on face value alone, this paper challenges 2 commonly held axioms: 1) BPTB and hamstring tendon ACL reconstructions yield similar clinical results; and 2) The incidence of anterior knee pain is higher in patients with BPTB ACL reconstructions. Anderson et al conclude that: 1) BPTB ACL reconstructions result in significantly better objective clinical results; and 2) the incidence of "crepitus" (and by inference anterior knee pain) is similar in both groups. I do not believe that these results can be applied to current clinical practice, however, because: 1) current techniques are markedly different (4 strand grafts with improved fixation); and 2) the incidence of anterior knee pain was not thoroughly investigated. ❖

ACL Reconstruction with Open Growth Plates

ABSTRACT & COMMENTARY

Synopsis: *A tensioned soft tissue graft across wide open growth plates resulted in severe angulation and growth disturbance apparently due to the compressive effect across the physis.*

Source: Edwards BT, et al. The effect of placing a tensioned graft across open growth plates. *J Bone Joint Surg.* 2001; 83-A(5):725-734.

Most of the literature regarding acl reconstruction in skeletally immature patients focuses on individuals with less than 1 year of growth remaining. It is clear that these patients do well with conventional ACL reconstruction techniques for the most part. However, there really are no good clinical series with athletes having more than 2 or 3 years of growth remaining who undergo ACL reconstruction. Edwards and colleagues at LSU addressed that specific scenario with a dog model. They used 12 10-week-old beagles and performed ACL reconstruction in open fashion with a fascia lata soft tissue graft placed through transphyseal 4 mm drill-holes. These tunnels were basically in the same position as conventional endoscopic ACL reconstruction tunnels. The graft was fixed at both ends with a bicortical screw used as a post placed well away from each physis. The grafts were tensioned to 80 N before fixation to restore stability and to determine the effect of a tensioned graft across the growth plates.

One animal was lost due to infection. The others were sacrificed at 4 months postoperatively and evaluated

radiographically and by gross dissection with careful measurements of the length of both medial and lateral sides of the femur and the tibia. Finally, histological sections of the growth plates were compared.

Findings were notable for severe growth disturbance. The femurs all went into valgus, procurvatum, and were shortened. The tibiae went into varus but were not shortened, suggesting that the varus angulation was more due to overgrowth laterally to compensate for the valgus deformity of the femur. Histological sections revealed that the growth plates were thinner peripherally in the femur on the lateral side where they were compressed by the tensioned graft as it passed toward the lateral aspect of the femur. In similar fashion, the growth plates were thinner than controls in the central portion of the tibia where the tunnel passed creating compression at the physis. Interestingly, no osseous bar formation was observed in any specimen. Thus, the tensioned graft with the resulting compression of the growth plate resulted in inhibition of growth without the presence of an osseous bar. This is termed the Heuter-Volkmann principle.

COMMENT BY DAVID R. DIDUCH, MS, MD

This study by Edwards et al substantially increases our understanding of the risks of ACL reconstruction in skeletally immature athletes. Previously, most of the attention regarding this issue has been directed toward potential osseous bar formation with transphyseal tunnels. As such, conventional recommendations have been to use a soft-tissue graft rather than bone-tendon-bone to prevent osseous bar formation. This may still be true. However, this study demonstrates that the osseous bar is really only part of the risk. A much bigger concern is that tensioning the graft across the growth plates inhibits growth directly. This Heuter-Volkmann principle was readily demonstrated in these skeletally immature dogs by the femurs going into dramatic valgus and procurvatum with shortening over just a 10-week time frame. The tibia appeared to overgrow laterally rather than shorten medially to compensate for the femoral valgus. This is apparently due to the fact that the femoral tunnel travels obliquely in the lateral direction creating compression across the lateral aspect of the physis, whereas the tibial tunnel is much more central.

Edwards et al conclude that they cannot recommend transphyseal reconstruction of the ACL for individuals with significant growth remaining. So what are we to do? Other studies have clearly documented the risks of leaving a young patient with an unstable knee in terms of potential meniscal and chondral injury. There have also been studies clearly demonstrating the decrease in function of these unstable knees. The existing recommendation that is popularly held to use smaller tunnels with soft-tissue grafts with fixation distant to the growth plates needs to be reexamined in light of this study. Others have also recommended nonanatomical reconstruction such as bringing the graft under the roof of the notch with fixation on the side of the femur without a tunnel. While this avoids potential damage from tunnel drilling, it still does not eliminate the fact that tension is across the growth plate and could create the same procurvatum and valgus deformity. This would need to be specifically examined to be confirmed but seems likely in light of these findings. Probably the next step would be to examine the effect of various tensions across the growth plate to see if tension somewhere less than 80 N would still provide graft stability without the same growth arrest. This should continue to be an active area of research because the problem is yet to be solved. ❖

ACL Avulsion Injuries

ABSTRACT & COMMENTARY

Synopsis: *Proper treatment of tibial spine avulsions appeared to restore both stability and proprioception, although problems exist with the study methodology.*

Source: Ahmad CS, et al. Anterior cruciate ligament function after tibial eminence fracture in skeletally mature patients. *Am J Sports Med*. 2001;29(3):339-345.

Tibial spine avulsions of the acl insertion are far more common in adolescents than in adults. It is well accepted that surgical fixation of avulsions in skeletally immature patients yields good results. However, fixation of avulsions in adults is less predictable because of potential intrinsic stretch of the ligament in addition to the bony injury. Ahmad and colleagues analyzed 10 skeletally mature patients with ACL avulsions and compared them to 10 patients with ACL reconstructions and 10 patients with ACL deficient knees who had physical therapy only. We are not told how these other 2 groups of patients were selected or the length of follow-up from surgery or injury. The avulsion group was analyzed at an average of 5 years. All patients were assessed for laxity with KT-2000 arthrometry, outcome with the Lysholm questionnaire, and for proprioception using a modification of a method referenced only once before.

Ahmad and colleagues found that proprioception was

restored equally with both the ACL reconstructed and the repaired avulsion groups. There were no significant differences in laxity between these 2 groups either. However, the ACL-deficient group was significantly more lax and had inferior proprioception. They conclude that repair of tibial spine avulsions in adults can restore stability and proprioception.

COMMENT BY DAVID R. DIDUCH, MS, MD

ACL avulsion injuries of sufficient bone to repair occur quite rarely in adults. This paper supports repair of the avulsed ligament and goes against the concept of stretch within the ligament preventing a stable knee. Ahmad et al also make a case for restored proprioception. However, there are serious methodological problems with this study that makes me question their conclusions.

Most importantly, this is a retrospective study of a small group of patients with no power analysis provided to determine proper sample size. Actually, the group of 10 patients with avulsions includes 2 patients who were left completely untreated (and displaced). I have no idea why they were included in the paper at all. For the remaining 8 patients, 3 were minimally displaced and treated with a cast, while only 5 were treated surgically with varied techniques, both open and arthroscopically, by different surgeons. Essentially, this paper looks at these 5 patients with a mixed group of repair techniques and compares them to reconstructed and deficient knees that were selected by unknown means. I cannot imagine that a group of 5 comes anywhere close to sufficient power to generate statistical significance. In addition, the Lysholm scores are only provided for the avulsion group and not for the other groups for comparison. Lastly, the proprioception testing method is an adaptation of a method only referenced once before, and validation of the method or its modification is not provided.

The fact that only 5 patients with surgical treatment of these avulsions were collected over 5 years at a major teaching hospital in New York should tell us that this is a carefully selected group in terms of indications with an uncommon injury. For patients with adequate bone for stable fixation, the results probably are good. However, for patients with comminuted or small-avulsed fragments, I would be cautious to attempt a repair. Reconstruction is a more established and predictable option. Unfortunately, this paper does not provide a strong enough case to prove that ligament stretch will not compromise the results of repair. ❖

PCL Avulsions: Arthroscopic Fixation

ABSTRACT & COMMENTARY

Synopsis: *A retrospective, nonrandomized study of arthroscopically assisted PCL-avulsion reattachments in 13 patients (14 knees) are described. Simultaneous posterolateral and posteromedial portals were used to insert ligament sutures (23 gauge wire or multiple sutures) or screw fixation. Better ligament recovery was noted in patients treated in the acute phase.*

Source: Kim SJ, et al. Arthroscopically assisted treatment of avulsion fractures of the posterior cruciate ligament from the tibia. *J Bone Joint Surg Am*. 2001;83-A(5):698-708.

This study documents that the functional outcome associated with operative treatment of posterior cruciate ligament (PCL) avulsions from the tibia can occur with relatively reliable success if treated early and with anatomic reduction. The use of arthroscopic techniques was varied and depended upon the avulsion fracture size. Screw fixation with a retrograde placement of cannulated screws was performed for bony fragments > 20 mm in size. For medium-sized fragments (10-20 mm fragment size), 23 gauge wire was passed arthroscopically through the substance of the PCL and then passed through tunnels anteriorly and twisted on an anterior bony tibial bridge. For small fragments < 10 mm in size, various techniques using multiple sutures of PDS or Ethibond were used in combination with an Endobutton device. Stiffness was noted in 3 knees that were treated with postoperative immobilization due to articular fractures about the knee. In 11 patients treated acutely with reattachment, all showed no or trace posterior instability. Those 2 patients treated in a delayed fashion had residual grade I posterior instability.

COMMENT BY ROBERT C. SCHENCK Jr., MD

Controversy exists over clinical decision making for PCL reconstructions regarding optimal technique (arthroscopic, tibial inlay, 2-tailed femoral reconstruction), as well as when to start range of motion. With PCL avulsions, in contrast, the evidence for early fixation is fairly straightforward. PCL avulsions from the tibia surprisingly have little or no intrasubstance damage, and reattaching the avulsed ligament anatomically creates a near normal ligament.[1] Arthroscopically or open (straight posterior, or posteromedial), the tibial attachment of the PCL can be somewhat easily accessed.[2] Cer-

tainly, Kim and colleagues have developed a useful technique for the medium-sized fragments with wire fixation. However, passing the wire anteriorly after placing the suture through the ligament, I would suspect, could be technically demanding on the first attempt at this procedure. Furthermore, as an arthroscopist, it is important to reduce the avulsed segment anatomically, and in my opinion, one should be prepared to openly reduce the fragment if anatomic reduction or fixation is not obtained. ❖

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2. Schenck RC. Management of PCL injuries in knee dislocations. *Op Tech in SM*. 1998;1(2):43-147.

Trunk Training Exercises

ABSTRACT & COMMENTARY

Synopsis: *Trunk flexion exercises are more effective than trunk extension exercises.*

Source: Konrad P, et al. Neuromuscular evaluation of trunk-training exercises. *Journal of Athletic Training*. 2001;36(2): 109-118.

Konrad and colleagues examined activation of the trunk flexor and extensor muscles during 12 exercises using surface electromyography in 10 healthy subjects. Twelve trunk training exercises were performed in randomized order, including 5 for trunk and hip flexion, 2 for trunk lateral flexion, and 5 for trunk and hip extension.

The trunk flexion exercises while supine included: a straight curl-up (fingertips touch the temples, arms held in a fixed lateral position, head and shoulders lifted from 0-30° flexion, hip and knees at 90° flexion with legs supported and feet not fixed); a cross curl-up (same as straight curl-up except 1 leg across the other, one foot on the floor and contralateral elbow is moved to opposite knee); a hyperextended curl-up (same as straight curl-up with support placing low back in -20° extension and trunk flexion to 90° with feet not fixed); a sit-up (same as straight curl-up except knees at 90° flexion, feet not fixed on the floor, and flexion from 0-90°); and a vertical hip lift (knees flexed between 70-90°, arms fixed overhead, hip lifted until lumbar spine is lifted from the floor).

The lateral flexion exercises included lateral flexion with fixed legs while side-lying (foot of upper crossed over lower leg and fixed with lateral flexion until trunk is lifted from the floor to 30°) and a lateral hip lift (leaning on flexed elbow, hips elevated from the floor to neutral position).

The trunk extension exercises included: diagonal hip and shoulder extension (from quadrupled position, contralateral hip extension and shoulder flexion to horizontal position); kneeling back extension (from flexed chest-leg contact position, isolated back extension from 0-35°); trunk extension with fixed legs (prone with lower extremity to hips fixed and trunk lowered from 0-90° flexion); bridging (from supine position, trunk and arms resting on floor and knees flexed to 90°, hip extended to neutral position); and hip extension with fixed trunk (fixed upper body on table in prone position, from 90° hip and knee flexion with extension of legs to horizontal position).

Each subject performed 12 different static maximal voluntary contractions (MVC) from which %MVC was determined for each of the trunk training exercises. The muscles assessed included the trapezius (pars transversus), erector spinae (thoracic and lumbar parts), gluteus maximus, semitendinosus, semimembranosus, rectus abdominis, obliquus externus abdominis, and rectus femoris.

Konrad et al found good isolation of the abdominal muscles with the pure trunk flexion exercises, and that the EMG activity increased slightly with additional prestretch or rotation. High activation of the external oblique occurred with the lateral flexion exercises. The double supported back extension exercises (eg, diagonal hip and shoulder extension and bridging) elicited only moderate activity in the extensor muscles. The erector-spinae muscle activity was more effectively increased during prone-lying upper body vs. lower body movements.

COMMENT BY DAVID H. PERRIN, PhD, ATC

The trunk provides the core from which many physically demanding movements originate. For this reason, adequate strength of the trunk musculature is essential for optimal performance. Additionally, well-balanced strength of the trunk extensor and flexor muscles is important for proper posture and prevention of back pain and dysfunction. Konrad et al confirmed the effectiveness of pure trunk flexion exercises for activation of the abdominal muscles. However, the trunk extension exercises produced comparatively low-mean EMG activity, with load and activation levels that may be insufficient to produce a training stimulus.

Athletes tend to devote considerable emphasis to training of the abdominal musculature, often in the complete absence of strengthening exercises for the trunk extensors. This training strategy can lead to muscle imbalances between these agonist and antagonist muscles. Proper supervision of training and rehabilitation programs is essential to ensure that strengthening exercises are applied to all trunk and upper and lower extremity agonist and antagonist muscle groups.

The finding that these commonly used trunk extension exercises produced only moderate EMG activity of the erector spinae muscles is troublesome. Further research is needed to devise and validate additional exercises for strengthening and rehabilitation of the trunk extensor musculature. ❖

Marfan Syndrome & Sports

ABSTRACT & COMMENTARY

Synopsis: *A heightened awareness of the major and minor manifestations of Marfan syndrome is needed for prompt recognition of this autosomal dominant connective tissue disorder.*

Source: Salim M, Alpert B. Sports and Marfan syndrome: Awareness and early diagnosis can prevent sudden death. *Physician and Sports Medicine*. 2001;29(5):80-90.

Salim and alpert present an excellent review of Marfan syndrome (MFS), stressing the importance of awareness of this autosomal dominant disorder of connective tissue when evaluating athletes. The article has excellent charts: one enumerating "the clinical clues" of MFS and another listing by organ system the major and minor criteria that are needed to make the diagnosis. The revised Gent diagnostic criteria require major involvement in 2 organ systems with some involvement in a third organ system if the patient has no family history of MFS. With a positive family history of MFS, the index case needs one major criterion and the involvement of another organ system. The diagnosis can also be made if there is found a mutation known to cause MFS, a major criterion in one system, and involvement in a second organ system.

Salim and Alpert suggest including questions regarding a family history of MFS on history forms used for athlete screening exams, as well as evaluating athletes carefully during the physical examination for such major criteria as:

- medial displacement of the medial malleolus causing pes planus;
- pectus excavatum;
- arm-span-to-height ratio greater than 1.05;
- arachnodactyly;
- the ability for the distal phalanx of the flexed thumb to extend beyond the ulnar surface of the hand;
- the ability of the thumb to overlap the little finger when wrapped around the contralateral wrist;
- ectopia lentis;
- mitral valve prolapse (a mid-systolic click);
- scoliosis;
- a murmur of aortic regurgitation (diastolic murmur) or mitral regurgitation (late systolic murmur).

Salim and Alpert recommend that if an athlete is identified as having MFS, the athlete first needs a thorough evaluation by a specialist familiar with all of its manifestations. Even if deemed cardiovascularly stable, it is generally recommended that the athlete participate in sports with only minimal physical demands.

COMMENT BY LETHA Y. GRIFFIN, MD, PhD

MFS is not rare (2 to 3 per 10,000), and since the physique associated with this syndrome (long arms) is an advantage in many sports (eg, volleyball and basketball), MFS can be found in successful athletes. Perhaps one of the most famous examples is that of Flo Hyman, who died tragically from a ruptured aortic aneurysm as a complication of this disease.

One must also remember that MFS is a progressive disorder and hence manifestations in various organ systems may develop over time. For this reason, those identified with the syndrome need to be monitored regularly. As once stated, "we look for what we know . . ." Therefore, those involved in the care of athletes need to have a heightened awareness of this syndrome. ❖

CME Questions

9. Based on surface electromyography, which method of exercise was best for trunk muscles?

a. Trunk and hip extension
b. Lateral trunk bending
c. Hip and spine isometrics
d. Trunk and hip flexion

10. Injectable corticosteroids can be used to decrease inflammation in all but which one of the following conditions?

a. Rotator cuff tendonitis
b. Prepatella bursitis
c. Degenerative arthritis of the knee
d. Lateral epicondylitis of the elbow
e. Acute tear of the anterior cruciate ligament

11. PCL avulsion injuries are best treated with:
a. two-tailed reconstructions in the femur.
b. patellar tendon autograft in transtibial tunnel.
c. acute management with reattachment of an avulsion.
d. tibial inlay reconstruction with allograft.

12. According to Anderson et al, which technique for ACL reconstruction yields the best objective results at average 3-year follow-up?
a. Bone-patellar tendon-bone autograft
b. Semitendinosus gracilis autograft
c. Bone-patellar tendon autograft with extra-articular augmentation
d. Semitendinosus gracilis autograft with extra-articular augmentation
e. Extra-articular augmentation alone

13. Knees with repaired ACL avulsions demonstrated laxity and proprioception that were:
a. equal to ACL-deficient knees.
b. superior to ACL-deficient knees.
c. inferior to ACL-reconstructed knees.
d. superior to ACL-reconstructed knees.

14. Traits associated with Marfan's syndrome include:
a. arm-span-to-height ratio greater than 1.05.
b. an enlarged thyroid gland.
c. a long slender neck.
d. excessive thoracic kyphosis.

In Future Issues:

Risk Factors for Stress Fractures