The rapid growth of organized sports for children and adolescents in recent years is unprecedented. This growth began in North America and Europe and is now evident throughout the world. Because of a variety of social and cultural changes, many children in many of the "developed countries" will receive the majority of their exercise and physical activity in the organized sports setting. This development represents both an opportunity and a danger.

The opportunity that presents itself in such a circumstance is that with careful and systematic evaluation of the physical and psychological character of each child and better understanding of the mechanical, metabolic, and psychological demands of each sport or fitness activity, sports medicine specialists might be able to match child to sport in such a way as to maximize sports safety and the child's enjoyment of sport.24 The danger of organized sport dominance, however, is that children may be exposed to inappropriate or excessive training by inexperienced or unqualified adult supervisors. This can result in sports settings and experiences that increase the risk of injury, both from acute trauma and repetitive overuse mechanisms, as well as undermine the enjoyment of the children in their sports.

I fear we are closer to the latter scenario than the former at this time. We are all aware of the steady stream of sports injuries we are seeing in this age group, many of them preventable. In addition, a recent survey sponsored by the Sporting Goods Manufacturers Association found a 75% dropout rate from organized youth sports by age 15. The most frequently cited reason was that they were not fun or the child was not learning anything.6

Certainly, the potential for benefits or risks from organized sports training varies from sport to sport and from community to community. Even within certain communities, one organized sports program, such as a youth soccer

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program, might be done with careful and safe supervision and effective and positive coaching attitudes, with resultant enjoyment to both adult and child participants. In the same community another youth sports program, such as ice hockey or gymnastics, may demonstrate the worst of repressive coaching, unsafe playing and training techniques, and a hostile environment for learning and safety.

One of our greatest concerns in recent years is the great variability of sports training that is available to children and adolescents engaged in organized individual or team sports. We are frequently asked by parents to give our opinion regarding the amount of training their son or daughter should be receiving in sports as varied as classical dance, martial arts, or Pop Warner football. Clearly, one of the unanswered questions in this area of sports is "How much is enough and how much is too much?" in the training of these children. This question is part of a larger question concerning the changes in physical fitness of children, certainly in our own country and perhaps across the world. Are many children getting too little physical activity to attain or maintain physical fitness, while some in organized sports are getting too much or too specialized types of physical activity?

The debate over whether our children are less fit than previous generations rages on and certainly actor Arnold Schwarzenegger added a poignancy to this debate when he was chairman of the President's Council on Physical Fitness and Sports several years ago. He contended quite vociferously that children's physical fitness had declined to an unsafe and unhealthy level in this country. Critics of this stance argue that there is no scientific evidence of a decline in the physical fitness of our children and adolescents. These critics might very logically do so, because it is well known that there have not been ongoing and systematic, or even comparable physical fitness examinations administered over the past 40 years to comparable groups of children spanning these generations.

Although we do not have direct evidence that our children are less fit than previous generations, a variety of indirect evidence (including statistics on changing body composition) strongly suggests that most of our children are getting inadequate levels of physical activity. A national survey of children and youth fitness compared body composition of girls and boys in New York state over a 20-year span and found a 22% increase in average obesity levels in children over this period.34-35 This growing level of obesity could be caused by increased caloric intake or decreased physical activity by the children studied. Related studies done on smaller subgroups of children, both longitudinally and in a cross-section fashion, have suggested that decreased physical activity is the more probable culprit in this situation.4

In the organized sports setting, particularly the pyramidal sports training programs of "elite child athletes," there is, by contrast, evidence that many of these children are being systematically over-trained and exposed to excessive levels of specialized physical activity that can result in increased risk of injury and declining levels of performance, and may even affect physical growth and maturation.

There has been surprisingly little study of the relationship of volume or intensity of training to the potential for either enhancement or deterioration of performance or the risk of injury in this age group. To our knowledge, there has not yet been a longitudinal study monitoring changes in performance with changed volume or intensity of training in young athletes in either team or individual sports. Too often, adult formulas for training volume and progression have been applied to this age group. This approach is particularly hazardous
because the response to cardiovascular and musculoskeletal training in children or adolescents is most probably quite different than adult training. Concern is heightened by variability in training response and the still very real questions as to whether techniques of training progression and even measurement of training effect commonly used in the adult can be safely or accurately used in the child. As noted in other articles in this issue, the response of children and adolescents to aerobic training, as measured by the VO\textsubscript{2}\text{max}, is subject to variability, error, or frank lack of response. Similarly, anaerobic assessment of training progression in this age group is subject to error.\textsuperscript{8}

In our experience, coaches at this level all too often have used an extremely empiric approach to the volume or progression of training for their young charges. The aphorism "Sometimes we learn how much is enough by observing how much was too much" has proven all too often to be the parameters for training in this age group.

We recently had the experience of assessing an 11-year-old age group swimmer for an overuse injury. This girl had been training at a local swim club in the range of 5000 to 7000 yards a day of water training 6 days a week. She went to a 3-day "development program" in which she was made to swim 11,000 yards a day for each of the 3 days, with a resultant overuse injury that required 4 months of therapy for recovery. All too often youth coaches are using the upper limit at which injury is reached as a gauge for level of training and making no attempt to correlate the volume or progression of training with performance. As we learned from the training of adult marathoners in the mid to late 1970s, overtraining will predictably result in injury and in no way guarantees improved performance. Unfortunately, most coaches at this level seem to have little understanding of risk factors for overuse injury and, in particular, the potential for injury with increased rate of progression of training.

Although to our knowledge there has been little, if any, attempt to correlate volume or progression of training with performance, there have been several recent studies which give us some clues as to the relationship of volume of training to potential for injury. In 1991, Goldstein and colleagues reported on their use of MR imaging to study back injuries in young gymnasts.\textsuperscript{11} They noted an increased risk of injury with increased levels and duration of training and suggested that girls who trained more than 16 hours a week in gymnastics had a significantly increased risk of back injury.

A second study that gives us some insight into volume of training relates to overhand pitching in youth baseball. This study, done in Japan on a large number of young overhand throwers, found that those pitchers who delivered more than 300 skilled throws a week had, once again, a significantly increased risk of elbow injury.\textsuperscript{16} This contrasts with the present directives of many youth baseball leagues to limit pitching (to six innings a week) and obviously gives a much more exact guideline for volume of training. The six innings a week guideline can result in a very different number of throws by pitchers of different skill and accuracy, not to mention the potential for dramatically increased numbers of throws done in an informal setting in the backyard or in a more formal setting in team practices.

A similar question that we have been asked repeatedly over the years relates to the age at which a young girl can begin pointe work in ballet. Concerns have been expressed about the potential for physeal injury to the bones of the foot and ankle with too early a progression into the full pointe position. Also, the child who lacks sufficient strength to perform pointe techniques may be at increased risk of injury. In an attempt to answer this question, we performed
studies on three cohorts of girls. The first group of girls had been up on pointe for at least 1 year and were judged to be satisfactory candidates for participation in pointe work by their dance teachers. The second group of girls of the same age had been judged empirically by their dance teachers as not ready for pointe. The final group consisted of age-matched controls. To our surprise, we found that strength about the foot and ankle in these three groups was not significantly different. We did find, however, that the children who were judged to be appropriate for pointe work had a significantly increased range of plantar flexion at the ankle that enabled them to attain a linear mechanical axis through the tibia and ankle and down through the forefoot when on pointe. Additional study has suggested that it takes at least 3 years of advanced training to reach this stage and that most of these qualified children have reached 10 years of age.

I believe this is presently one of the most important issues in pediatric and adolescent sports medicine. There must be better studies relating the volume and progression of training in this age group to the potential for injury. Similarly, our coaching colleagues must study the relationship of volume and techniques of training to performance in child athletes (Fig. 1).

**KNEE INJURIES**

Knee injuries remain one of the most troublesome areas of either acute trauma or overuse injury in this young athletic population. In a great number of cases, knee injuries are caused by overuse or repetitive stress. Common injuries include patellar tendinitis (jumper's knee), iliotibial band syndrome, patellofemoral pain, and patellar instability. Early diagnosis and appropriate management are crucial to preventing long-term complications.

*Figure 1.* This 10-year-old girl was enrolled in a summer dance program for 4 weeks with 6 hours per day of training, 6 days a week. She had been dancing 3 hours per session, three times per week, previously. She complained of right ankle pain and was found to be tender about the entire circumference of the distal tibial physis. Plain radiographs were nondiagnostic. MR imaging of the ankle showed evidence of physeal injury on sagittal (A) and coronal (B) images.
of clinical centers that deal with young athletes there appears to be a serious increase in the occurrence and, possibly, the rate of anterior cruciate ligament (ACL) injury in this age group. In addition, there appears to be a particular propensity for ACL injuries in girls participating in sports such as soccer, basketball, and lacrosse.

The debate on this observation has ranged far and wide. Some observers have refuted the concept in its entirety and simply have suggested observer error, hypothesizing that these injuries have always occurred at the same rate. We simply have not been making the diagnosis in the past or we are simply seeing increased numbers of these injuries reflecting an increased participation by girls in organized sports. Other observers accept the hypothesis that there is both an increased occurrence and an increased rate of occurrence of this injury and have attempted to dissect out changes in host or environmental factors that may be contributing to this occurrence. The search for anatomic factors, such as a narrowed intercondylar notch of the femur has been pursued. Others have suggested that hormonal changes occurring at this age and stage in the young female athlete may result in periodic changes in the relative strength of ligamentous structures during times of participation.

It also has been suggested that owing to declining levels of general physical activity, the ligamentous structures in these children and adolescents, both girls and boys, may be relatively weaker and, in particular, may be inadequate to meet the demands of cutting and twisting field sports. We hypothesize that if the great-grandmothers of these girls, who were working in vigorous physical activities on farms in Kansas or Nebraska, were to participate in soccer or basketball, the rate of injury to their ACLs would be lower than their great-grandchildren owing to the protective effect of mechanical work stress and subsequent ligament strength increase in this earlier generation.

There are no studies now that can aid us in determining whether it is simply an increase in occurrence or an increase in rate of injury that we are seeing. Additionally, it is doubtful that we will get a real answer to this question in the near future because the epidemiology of children's sports injuries in this country is in such a primitive state. Nonetheless, addressing host or environmental factors that may be contributing to this catastrophic trend is extremely important.

Suggestions for increased levels of general and specific physical activity in an attempt to strengthen ligaments certainly would seem to merit consideration. In particular, introducing systematic and progressive strength training of the lower extremities for both girls and boys who participate in the sports at risk would appear to be indicated.

Attention to playing technique may also merit consideration. Henning and coworkers noted a significant decrease in catastrophic knee injuries in girls playing basketball compared with matched controls when a two-step cutting technique was instituted in their training.

The use of protective equipment to prevent these catastrophic knee injuries remains extremely controversial. Studies of protective knee braces have yielded contrasting results. Some studies have found a trend toward the prevention of collateral ligament knee injuries with bracing but have suggested that the presently available knee braces, by pre-loading the cruciate ligaments, may actually increase their risk of injury. Field studies to date have been inconclusive.

Unfortunately, some of the individuals participating in this controversy have raised a pragmatic question of the relative cost of outfitting youth sport
teams with another type of expensive protective device. This argument seems to us to be particularly specious. The same observers would not think of arguing against protective head or face wear in contact sports such as football or hockey, given the very real advances that have been made in prevention of injuries to the head and face with these devices in these sports. Nonetheless, the cost factor has been raised in the prevention of knee injuries using mechanical devices to protect the knee, despite the fact that this is one of the most devastating and costly injuries in this age group.

Although the development of an effective prophylactic knee brace appears to still elude the bio-engineers addressing this problem, it by no means should be concluded that the development of a protective device of this type is impossible. Whereas our present technology has not yet met this biomechanical need, the increased emphasis upon preventive medicine at all governmental levels should stimulate further research on this important problem. Such research has been dramatically underfunded in the past and has been left to be supported by various bracing companies or private foundations.

An associated controversy to that of ACL injury, one that has received less attention, is that of the present management of tibial eminence fractures. There has been a traditional tendency in pediatric orthopaedics to treat these injuries with closed techniques on the assumption that maneuvering the knee into full extension would mechanically reduce the fragment as it came in contact with the femoral condyles. Our own experience in studying this injury would suggest that this approach is excessively sanguine and naive.

In recent years we have taken to arthroscoping all tibial eminence fractures in which there is evidence of ACL instability as evidenced by Lachman testing. We no longer grade the severity of these injuries on radiographic criteria such as the size of the bony fragment or its location at the moment in time when a plain radiograph was obtained.

We now perform arthroscopy on tibial eminence fractures with significant Lachman instability. This approach has been quite revealing. In almost every case in which there has been a positive Lachman test, the tibial eminence and its attached ACL complex have been mechanically unstable in any position, including extension. In addition, most of these fragments have been too small to be reduced into place by putting the knee in extension. In fact, in our experience, placing the knee in extension inevitably results in a displacement of the fragment out of its bed. By contrast, placing the knee in 30 deg to 40 deg of flexion and performing a posterior translation maneuver to the tibia allows for relatively easy reduction of the fragment in its bed. This observation should come, of course, as no surprise. Studies of ACL mechanics have shown that both bundles of the anterior cruciate are at their lowest level of tension when the knee is flexed 30 deg to 40 deg.

In recent years we have assessed all cases of tibial eminence fractures with careful physical examination. In those with a positive Lachman test suggesting instability of the anterior cruciate tibial eminence complex we have proceeded to arthroscopy. When the knee is flexed 30 deg to 40 deg and the tibia is translated posteriorly, these fragments can usually be replaced in their beds, but sometimes only after either the medial or lateral meniscus has been removed from its blocking position over the fracture bed.

In the past, we have used varied internal fixation techniques, including sutures through the bed into the epiphysis or crossed K-wires (Fig. 2). More recently we have used cannulated miniscrews for internal fixation with success (Fig. 3A–B). Following the exact anatomic reduction of this fragment in its bed,
**Figure 2.** Tibial eminence fracture reduced and fixed with intra-articular Kirschner wires under arthroscopic control.

**Figure 3.** Tibial eminence fracture reduced and fixed with minicannulated Lag screws under arthroscopic control seen on anteroposterior (A) and lateral (B) radiographs postoperatively.
internal fixation and positioning in a position of minimal tension on the reduced fracture, usually that of 30 deg to 40 deg of flexion, we have immobilized the knee in this position for a period of 6 weeks and followed this then by systematic physical therapy to restore the range of motion and strength of the extremity.

We have been very pleased with the results in these cases and continue to use this technique with confidence for this injury. We believe it is a logical approach to a serious derangement. This injury is both an articular fracture and an injury to a major ligament complex of the knee. Failure to anatomically correct either of these derangements has been shown to have a poor natural history, particularly in younger individuals. When one carefully reviews the individual articles in the literature on this injury, it is evident that few of the subjects in follow-up examination have had a careful, long-term assessment of ligamentous stability. In a number of the studies, however, in which closed reduction or even earlier open reduction techniques were employed lack of full extension or some residual laxity still was evident. Now that there is technology available to exactly study such intra-articular injuries and to perform anatomic and secure reductions of these fractures, responsible surgeons caring for this injury should use these techniques or send the child to someone skilled in these techniques for this injury.

Osteochondritis Dissecans

Osteochondritis dissecans is a lesion of the articular surface of unknown cause that consists of a layer or area of necrotic subchondral bone that appears to be the primary pathology. The articular cartilage attached to this subchondral bone remains variable. Mechanical disruption of the joint occurs when the fragment remains necrotic and does not heal to adjacent bone and the articular cartilage becomes fractured from its adjacent articular cartilage with displacement or loosening of the fracture. The incidence of this condition is not known in the general population with any certainty.

A number of experienced physicians and surgeons dealing with athletically active young people have suggested recently that the occurrence of osteochondritis dissecans in young people is higher than the general population and appears to be increasing with the increased intensity of training in some of these sports. Once again, given the abysmal status of the epidemiology of injury, particularly sports injury, of children and adolescents in this country, we can have no certain conclusions about this increase in incidence. Osteochondritis dissecans is a condition that often is underdiagnosed and inadequately treated. Perhaps drawing upon older literature that dealt with smaller lesions or lesions in less active individuals, there has been a clinical impression that the majority of osteochondrotic lesions will go on to spontaneous healing. Often, this is believed to occur with some decrease in physical activity, and therefore, aggressive intervention is rarely indicated. This has not been our experience. Osteochondritis dissecans of the elbow, ankle, or knee, particularly in the athletically active girl or boy, can be a catastrophic injury if it is left untreated and allowed to progress to mechanical disruption.

Any child involved in repetitive training sports activities who complains of persistent chronic joint pain should receive careful evaluation for the possibility of osteochondritis dissecans. Delay in diagnosis has often resulted from the failure to obtain satisfactory plain radiographic views, such as the tunnel view at the knee, or the failure to progress to more advanced imaging techniques,
such as computed tomography scan or MR imaging in joints such as the elbow or ankle (Fig. 4A–B). In other cases, satisfactory early diagnosis had been made, but treatment has been insufficiently aggressive. Over the years, we have come to hate this condition because it can be so difficult to heal, particularly if it is a large lesion in a mechanically important site in the joint involved. Anything that can be done to hasten the stabilization and revascularization of the necrotic fragment should be instituted.

It certainly can be appropriate in certain cases, particularly in younger patients with smaller lesions and if there is early diagnosis, to attempt nonoperative management. If activity limitation alone is tried, this child must be monitored carefully and equivalent imaging techniques must be obtained 2 to 3 months later for assessment. The first report on this condition that noted its relatively high rate of occurrence in this age group was by Green and Banks in 1953.12 These authors pointed out the seriousness of this condition and noted that the physician must make every effort to get the lesion healed. Their conservative intervention for this condition consisted of immobilization, sometimes cast immobilization for as long as 6 to 9 months. Needless to say, with our present knowledge of the physiology and biomechanics of joint function, particularly in children, this duration might indeed be considered excessive and radical treatment.

In recent years, operative techniques, particularly arthroscopic techniques, have been used in an attempt to increase both the rate of healing and the percentage of these conditions that do heal. Guhl14 first introduced the concept of transarticular drilling or puncturing of the lesion. This process consisted of a series of small holes going across the articular cartilage through the necrotic fragment and into the subjacent viable bone in an attempt to locate sites of

Figure 4. This 15-year-old female soccer player presented with a painful effusion of her right knee. Lateral radiographs of the knee (A) suggested a trochlear lesion. Sagittal MR imaging demonstrates osteochondritis dissecans of the trochlear groove with an unstable but undisplaced fragment (B). Multiple transarticular drillings and fixation with bio-absorbable pins resulted in complete healing of the fragment.
healing channels that, it is hoped, revascularize and revitalize the dead bone of
the fragment by the process of creeping substitution. We have used this tech-
nique for over 15 years; our definite clinical impression is that increases in both
speed and healing incidence are due to this process. We do not hesitate to use
this in large mechanically important lesions, even if the physis is open.

Recently, newer techniques for internal fixation of these fragments now
have been introduced, often used in conjunction with arthroscopic technique.
These include bio-absorbable pins as well as cannulated compression screws.
These newer techniques obviously are particularly useful in cases where the
articular cartilage is fractured from its adjacent articular cartilage and the piece
becomes loosened or even displaced from its bed.

We have used bio-absorbable pins with great success in acute osteochondral
or even chondral fractures in this age group. These pins have provided satisfac-
tory fixation to the point where the fragment has been united with its adjacent
viable bone and, needless to say, an internal fixation device has not been
necessary. Newer apparatuses including cannulated Herbert screws or cannu-
lated minifragment compression screws are now available. We have used both
of these devices in recent years with success and continue to use them in
unstable fragments (Fig. 5). These internal fixation devices are used in
conjunction with multiple transarticular puncturings of these lesions. In several
cases with large fragments involving a great portion of the articular surface of
one or both condyles internal fixation with metallic devices is used even in cases
where the fragment had not yet become overtly unstable. In these cases, the
concern was that transarticular drilling and the formation of healing channels
alone might be inadequate because of the size of the lesion.

Figure 5. This 16-year-old male soccer
player presented with a large osteochon-
dritis fragment that had displaced and was
free in the joint. This fragment was re-
duced and fixed with an intra-articular can-
nulated Lag screw.
The rationale for the attempt to conserve the integrity and viability of articular cartilage in this condition follows closely on the heels of recent observations of the importance of the meniscal cartilage to the long-term function and health of joints, particularly the knee joint. In summary, osteochondritis dissecans in young athletes is a matter of grave concern, particularly if the lesion is large or in a mechanically important site in the joint, such as the condyle of the femur or the capitellum of the elbow. Every effort must be made to make an early diagnosis of this condition and to get it to heal as quickly as possible. In the event that nonoperative techniques such as activity limitation or immobilization have not resulted in healing by comparable imaging techniques, early operative intervention and stabilization as well as revascularization techniques should be employed.

Lateral Retinacular Release

Lateral retinacular release has become a controversial operative procedure in recent years when used for management of derangements at the extensor mechanism in adolescents and young adults, particularly when it is performed under arthroscopic control.

This procedure was first described as an open procedure and received attention as one of the less invasive proximal quadriceps realignment procedures that might be useful in anterior knee pain or in cases of lateral femoral compression syndrome and lateral subluxation of the patella. Certainly, release of the lateral retinaculum, including the extensive release proximally of the vastus lateralis, has been a time-honored component of proximal extensor mechanism realignments. It was used in certain circumstances of less extensive derangements because of the relatively low morbidity and the ability to begin an early range of motion and strengthening following the procedure, insofar as there are no proximal tethering or medial plications done in association with it.

This procedure reached a level of extensive popularity along with the widespread use of arthroscopy for assessment and treatment of knee derangements. Undoubtedly, because of the procedure’s ease of performance and ready accessibility under arthroscopic control, it may well have been overused, especially in circumstances with no clear lateral tethering of the extensor retinaculum.

In recent years, it has become the height of political correctness in orthopaedic circles, particularly pediatric orthopaedic circles, to deny that one uses lateral release for extensor mechanism derangements. Some observers have questioned whether there is any role whatsoever for release of the lateral retinaculum in the management of extensor mechanism derangements in this age group.

We reported our early, relatively favorable results with lateral retinacular release using an open technique and an extensive dissection subcutaneously and proximally. We also have described our results using this release under arthroscopic control in conjunction with a vigorous postoperative exercise management program. This program supplements the lateral release with a strengthening of the medial structures of the knee and stretching the lateral structures. Over the ensuing years and to the present, we continue to use this intervention successfully in selected cases. As with many other orthopaedic surgical procedures, careful selection of candidates is imperative for the success of this procedure. Undoubtedly, the widespread use and abuse of this intervention in association with arthroscopy for a variety of different extensor mechanism disorders has contributed to its disrepute at this time. This is unfortunate, in our opinion.
A number of observers, including ourselves, have reported on the highly effective treatment for anterior knee pain in children and adolescents using physical therapy regimens, including exercises, mechanical devices, and even taping. In our experience, more than 90% of anterior knee pain in this age group can be managed successfully with these nonoperative techniques. In cases that involve not only anterior knee pain but also diagnosable lateral subluxation of the patella or excessive lateral compression syndrome, however, these exercise techniques often can be successfully supplemented by lateral retinacular release. We presently stress the importance of three different criteria for the diagnosis of lateral patellar subluxation. Details of the history, including episodes of transient catching, slipping, or giving way of the patella, particularly upon going down stairs or in turning are very important. Specifics of the physical examination that identifies the presence of a lateral luxating patella with a tight lateral retinaculum also are extremely important. In addition, the relative constitutional laxity of the patient should be recorded by assessment of upper extremity and lower extremity criteria for ligamentous laxity. In general, the tighter children and adolescents will have more of a potential for true patellar subluxation. This is not always the case, however. Children showing evidence of generalized ligamentous laxity by thumb testing or even lower extremity parameters may still have a tight lateral retinaculum. Often, there is confusion between the parameters of ligamentous laxity and joint-related flexibility, which is primarily a function of muscle-tendon characteristics. These parameters may be altered in the face of a rapid growth spurt in a given individual. Although there is some crossover between laxity and flexibility, there is by no means a one-to-one relationship. Therefore, we certainly have found appropriate candidates based on history and physical findings who otherwise show evidence of generalized joint laxity.

The second set of criteria for appropriate candidates for lateral retinacular release include radiographic criteria and, in particular, as Fulkerson has so appropriately pointed out, the evidence of patellar tilt on skyline radiographs. Although in the past we paid little attention to radiographic characteristics in anterior knee assessment in this age group, we have become increasingly impressed with their contribution, albeit that radiographic criteria only represent a portion of the diagnostic puzzle in this situation.

Finally, in recent years we have made increased use of arthroscopic assessment of passive, or even active, patellofemoral tracking at the time of arthroscopy. We normally expect congruous seating of the patella in the trochlear groove at 30 deg of passive knee flexion in this age group. Our criteria for lateral retinacular release is satisfied by candidates for arthroscopic lateral release who have an appropriate history and physical examination and have met radiographic criteria. These candidates also must demonstrate persistent lateral tracking of the patella as the knee is put into a range of full flexion to 90 deg under direct arthroscopic observation (Fig. 6).

We carefully emphasize to the patients and their parents before, during, and after such intervention that this lateral retinacular release must be viewed as a component of the exercise process. Lateral retinacular release that is not followed by a careful and systematic progressive strengthening of the medial structures of the quadriceps and adductors along with a systematic and physical-therapy-directed stretching program of the lateral iliobial band, quadriceps, and hamstrings, will most likely not be successful in addressing lateral subluxing patella or lateral compression pain syndrome.
Peripelvic Avulsion Injuries of the Muscle-Tendon Units

The article by Paletta and Andrish elsewhere in this issue provides an excellent summary of the occurrence, diagnosis, and management of peripelvic avulsions of muscle-tendon units about the pelvis. We certainly agree with their recommendations for diagnosis and management.

We do believe, however, that another important consideration for these injuries is the study of interventions to help prevent this type of injury. Over the years, as we have encountered these injuries, we have attempted to determine in each case the constitutional laxity of the adolescents sustaining these injuries and the relative tightness of the peripelvic musculature. The great majority of these cases are constitutionally tighter individuals who have just completed their adolescent growth spurt. Evaluation of the opposite, uninjured extremity usually demonstrates significant tightnesses and contractures of the peripelvic musculature.

A great deal of attention has been devoted in recent years to prevention of sports injuries and also to enhancement of sports performance through stretch-
ing exercises. Despite the great amount of lecturing on this topic and didacticism, there are remarkably few studies that demonstrate a relationship between stretching and a reduction in injury occurrence or enhancement of athletic performance. Studies have been done that show a correlation between certain conditions such as anterior knee pain and relative tightnesses or contractures about the joints of the lower extremity. These often have been cross-sectional studies and have failed to show that an intervention of stretching exercises actually reduces the occurrence of injury, particularly using longitudinal study techniques.

Nonetheless, we believe that in this particular subgroup of athletes, the intervention of prophylactic stretching exercises at this stage of their growth and development, particularly when they are engaged in the ballistic sports at risk such as soccer, track and field, or jumping sports would very likely help prevent these types of injuries. Once again, we call upon our sports medicine colleagues who are dealing with athletes in these age groups to study this type of intervention. Now that the use of the preparticipation evaluation has become widespread and, in some states, mandated we should more easily be able to identify the athlete at risk and institute appropriate preventive techniques.

Low Back Pain

Sports medicine physicians who actually deal with young athletes, including assessing them and treating them for their injuries, are well aware that the pattern of injuries in this subgroup of individuals is quite different from low back pain in children and adolescents in general and certainly different from low back pain in the general adult population. The great majority of these young athletes will have back pain that appears to be associated with derangements of the posterior elements, particularly the pars interarticularis.

One of the traditional controversies in orthopaedics has been whether spondylolysis is a congenital or acquired lesion. This debate has ranged through both medicine and law and is often heavily debated in the realms of workmen’s compensation.

There is now ample evidence that although there may be certain genetic predispositions, particularly in certain populations or in situations such as spina bifida occulta where there may be a genetic predisposition to attain a lesion at this site, the great majority of these lesions, particularly in athletic individuals, are acquired.

Data from a variety of sources are available on the rate of occurrence in the general population of this condition. A number of recent studies of athletic individuals have shown a much higher rate of occurrence in young athletes, particularly in those engaged in sports involving repetitive flexion and extension or rotation of the lumbar spine.

This stress fracture of the pars appears to go through the same sequence seen in any stress fracture in the body. This fracture begins as a stress reaction in which there is still bony integrity of the structure, but the catabolic processes progressively exceed the anabolic processes of healing owing to repetitive mechanical stress at the site. Complete mechanical disruption through the bone finally may occur.

The confusion and controversy regarding the appropriate level of diagnosis and intervention for this condition remain puzzling. Very few physicians would make the diagnosis of a probable tibial stress fracture in an athlete with shin
pain but withhold treatment until the tibial stress fracture had completely displaced and broken through. Certainly, then, it strikes us as particularly bizarre that some individuals suggest no active treatment or intervention for a spondylolysis stress fracture until it is evident by plain radiographs.

It has been our experience that early accurate diagnosis of this condition is imperative if complete fracture and persistent nonunion are to be avoided (Fig. 7). Fortunately, this diagnosis has been made easier in recent years by the development of the SPECT bone scan. Impending stress fracture should be suspected in a child with an appropriate history such as participation in a sport with repetitive flexion or extension of the lumbar spine, particularly one who gives a history of extension techniques causing pain of the low back, and who has pain on provocative hyperextension testing. It behooves the physician to proceed on the assumption that a stress fracture of the pars is present until proven otherwise.

The additional problem with this particular stress fracture is that once it does occur and mechanically breaks through, it is a distraction environment, nonconducive to bony healing, analogous to the distraction stress fracture of the femoral neck.

There now are reports in the literature of established spondylolysis stress fractures that have been able to be healed with interventions such as activity limitation, postural exercises involving antilordosis, or antilordotic bracing techniques. It would be much simpler to institute any or all of these three treatment techniques prior to the frank development of a radiographically evident lesion.

The natural history of this adolescent onset spondylolysis and its relation-
ship to back pain also has been controversial. Some authorities on adult back pain have suggested that the presence of degenerative spondylolysis in the adult back does not necessarily imply that the spondylolysis causes back pain. This may be true, given the sequential degenerative processes that occur in the adult spine, usually beginning in the anterior elements and then secondarily involving the posterior elements. This, of course, is not the case in spondylitic lesion in the adolescent athlete in which the structural elements of the lumbar spine are still intact without degeneration. Following the development of a stress fracture through the pars, the associated and often debilitating back pain clearly is because of this lesion.

In our opinion, the logic for prevention of bony disruption at this site, if possible, is hard to negate. With early detection before bony lysis has occurred, this condition can be reversed and these conditions can heal rapidly (Fig. 8). We prefer an antilordotic brace that allows the young athlete to continue participation in their sport at a modified level. The brace enables the athlete to maintain cardiovascular and musculoskeletal fitness safely while the conditions for healing are reversed in favor of the anabolic bone formation processes.

The issues we have raised above are only a few of the unanswered questions in pediatric and adolescent sports medicine. Every article in this volume contains issues that should be resolved or studied in a more comprehensive fashion if we are to attain our objectives of healthful and safe sports for our children.

Figure 8. This 18-year-old football player with low back pain was assessed with plain radiographs, routine bone scan, and MR imaging of the lumbar spine, all of which were nondiagnostic. Coronal (A) and oblique (B) images with SPECT bone scan clearly demonstrate bilateral stress fracture in the pars interarticularis at L5.
matching of child competitors by physiologic norms of development rather than by age or weight, and the prevention of overuse injuries by careful attention to the volume and rate of training progression should be addressed. Techniques for prevention of head and neck injuries by strengthening of the tissues at risk, and the appropriate interpretation and implementation of safety rules, and protective equipment should be examined. Prevention of injuries about the shoulder and elbow in the young athletes, particularly the swimming and throwing athletes, by careful attention to volume of training and maintenance of muscle-tendon balances is a priority. The early detection and appropriate treatment for the young female athlete at risk for the female athlete triad and detection of nutritional risk factors for overuse or acute injury in general are also concerns. Finally, we must discover the patterns and types of sports that can best maximize health and minimize risk in the child with asthma, diabetes, or muscle disease.

The practice of sports medicine, particularly for children and adolescents, is a truly fascinating area. At every turn, there are more questions than answers regarding the health and safety of our children; pursuit of these questions requires an army of investigators. Every one of us must be involved in the careful and unbiased study of the best and safest ways to promote sports participation by our children.

References


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