OBJECTIVE. The purpose of our study was to evaluate the knees of asymptomatic high-level collegiate basketball players before the beginning of the basketball season to gain an understanding of nonclinical findings in this patient population.

SUBJECTS AND METHODS. Bilateral knee MR imaging examinations of 17 varsity basketball players (12 men and five women) were performed before basketball season began. All of the subjects were imaged on a 1.5-T magnet. The MR imaging studies were reviewed by two musculoskeletal radiologists. Structures analyzed were the menisci, ligaments, cartilage, plicae, and bone marrow. The presence of a joint effusion was also noted.

RESULTS. Fourteen (41%) of the 34 knees had bone marrow edema, eight (24%) showed signal in the patellar tendon, and 14 (41%) had abnormal cartilage signal or a focal abnormality. Twelve (35%) of the 34 knees showed a joint effusion. Two knees (6%) showed abnormal signal along the infrapatellar plica. Four knees (12%) were noted to have a discoid meniscus.

CONCLUSION. An MR examination of the knees of high-level collegiate basketball players may show changes unique to this population. The changes seen on MR imaging in these athletes may be asymptomatic abnormalities. For instance, changes suggestive of patellar tendinopathy were identified in these asymptomatic subjects.

MR imaging has proven useful for evaluating the knee for internal derangement. This imaging modality is accurate for evaluating meniscal abnormalities [1–3] as well as for assessing the integrity of the anterior cruciate ligament [4, 5], examining articular cartilage [6, 7], and diagnosing bone marrow edema [8].

This study was prompted by requests to evaluate several of our division I college basketball players for knee problems before the rigorous college basketball season began. At the time of these MR imaging studies, abnormalities were noted within the knee joint that did not prove to be symptomatic to the player. This finding prompted us to evaluate the knees of all the basketball players to assess changes that could be misinterpreted as abnormal if a player presented for imaging during the season. Our study evaluates the spectrum of MR imaging findings in bilateral knees in asymptomatic high-level collegiate basketball players to provide a baseline for interpretation.

Subjects and Methods

Both knees of 17 varsity college basketball players (12 men and five women) were imaged \((n = 34)\) during the course of their preseason physical examination. Internal review board approval for this study was obtained. The athletes were questioned about any relevant prior injury or surgery. All subjects were imaged on a 1.5-T magnet (Signa; General Electric Medical Systems, Milwaukee, WI) using a send–receive knee coil. Our routine knee protocol was performed: fast spin-echo T2-weighted images \((TR/TE_{eff}, 3500/65)\) were obtained with fat suppression in the axial, coronal, and sagittal orientations and spin-echo proton density fat-suppressed images \((TR/TE, 2000/20)\) were obtained in the sagittal plane to evaluate the menisci. A matrix of 256 × 192 with 2 excitations, a slice thickness of 4 mm with an interslice gap of 0.4 mm, and a field of view of 16 cm were used. The MR studies were reviewed independently by two musculoskeletal radiologists, forming a consensus opinion; the reviewers evaluated the appearance of patellar tendon, menisci, cruciate and collateral ligaments, cartilage, joint effusions, plicae, and bone contusion patterns.

Criteria for characterizing a tendon as abnormal were an alteration in thickness compared with the remainder of the tendon and abnormal signal within the tendon. Because of the potential effect of the magic angle on the patellar tendon, changes suggestive of patellar tendinopathy included an alteration in size as well as an abnormal signal. The meniscus was considered discoid if the ratio of body segments to the anterior and posterior horns.
was less than 1:2 on sagittal imaging and if the pro-
tuberant meniscus extended deep within the joint, which was best seen on coronal imaging [9, 10]. If abnormal signal within the substance of the menis-
cus interrupted the articular surface or if abnormal morphology was present on the proton density im-
ages, a tear was diagnosed. Ligaments were as-
pected as abnormal if they were discontinuous, abnormal in size, or contained increased signal intensity on T2-weighted images. A plica was consid-
ered abnormal if it had increased signal on T2-
weighted imaging or showed a subjective increase in thickness. Bone marrow was considered abnor-
mal if high signal was identified on fat-suppressed fast spin-echo images. Cartilage was considered abnormal if it had high signal, focal or diffuse, or showed full-thickness defects on the fat-suppressed T2-weighted images in any imaging plane.

Results

Clinically, none of the subjects complained of symptoms related to the knee. Of the 34 knees imaged, 25 knees (74%) had one or more abnormalities. Eight knees (24%) had abnormal thickness (relative to the remainder of the tendon) and abnormal signal in the pa-
tellar tendon (Fig. 1). Four (12%) of the 34 knees had discoid menisci, which was defined as a disproportionate ratio of body segments to anterior and posterior horn (in this case, 1:1; normal, ≈ 1:2); this finding was bilateral in two players (Fig. 2). Eight (24%) of the 34 knees had abnormal signal in the cartilage (trochlea, n = 4; patella, n = 4), and six (18%) had focal cartilage defects (Fig. 3). One player had under-
gone arthroscopic débridement of a lateral femoral condyle cartilage defect 18 months before the study. The cartilage defect was seen on MR imaging and corresponded to the area that had been débrided arthroscopically (Fig. 4). Twelve (35%) of the 34 knees had small joint effusions, and 14 (41%) had bone mar-
row edema (Fig. 5). Bone marrow edema was seen in the medial femoral condyle in seven knees, the lateral femoral condyle in two, the lateral tibial plateau in two, and the patella in three. Bone marrow edema was identified bi-
laterally, but not symmetrically. In most cases, the pattern of bone marrow edema was neither subarticular nor adjacent to ligament attach-
ments. None of the players had tears in the cru-
ciate or collateral ligaments, although one player was found to have an anterior cruciate ligament cyst. The players with focal cartilage abnormalities (six knees [18%]) included the player with a history of débridement. No inter-
val change was noted in the appearance of his cartilage (the prior examination was available for comparison). Three of the subjects with fo-
cal cartilage abnormalities showed focal de-
facts at the apex of the patella, and three showed signal change at the apex of the patella without a full-thickness defect. One player showed abnormal high signal in both knees along the infrapatellar plica (Fig. 6). None of the players showed meniscal abnormalities. Discoid meniscus was noted but is not neces-
sarily considered pathologic. These menisci are prone to tears, but no tears in the discoid meniscus were found in this series.

Discussion

MR imaging is sensitive and specific for identifying injuries to the meniscus, anterior cruciate ligament, collateral ligaments, and tendons [1–5]. MR imaging performed using a marrow-sensitive technique is both sensi-
tive and specific for the detection of bone con-
tusions and occult fractures [8].

Little has been reported about the MR im-
aging findings in the asymptomatic knee of the

Dedicated athlete [11–16]. Krampla et al. [17] examined the knees of marathon runners and identified no abnormal marrow signal after the runners had completed a marathon. One possi-
ble explanation for the lack of edema in the pa-
tients in their series could be the selected popula-
tion. Trained runners such as maratho-
ners have appropriate shoes or orthotics that

can properly distribute stress across the joint.

The knee absorbs a large amount of force during a game of basketball, especially at the

competitive collegiate level. During the course of a basketball season, a player’s knees are sub-
ject to repetitive trauma. Consequently, a high percentage of athletes have areas of signal abnormality in the bones, cartilage, and ten-
dons. It is probably more accurate to say that the athletes are presumably asymptomatic.

The players in our study were fully functional because none missed practices or games as a

result of knee complaints. However, our MR

findings suggest that the players might be

asymptomatic. Whether these athletes are truly

asymptomatic is impossible to determine
given the tremendous incentive to deny symp-
toms at this level of play. The abnormalities

Fig. 1.—20-year-old male college basketball player with patellar tendon abnormality. Sagittal fast spin-echo T2-
weighted MR image (TR/TE_{eff}, 3500/65) obtained with fat suppression shows thickening of patellar tendon with fo-
cus of high signal within substance of tendon (arrow). Findings resemble jumper’s knee, although patient was asymp-
tomatic.

Fig. 2.—19-year-old male college basketball player with discoid me-
iscus. Coronal fat-suppressed fast spin-echo MR image (TR/TE_{eff}, 3500/65) reveals discoid meniscus. Ar-
rows show meniscus extending more toward notch than expected for normal-sized meniscus. Finding was bilateral in this patient.
found in our study suggest that playing basketball at a high level for most of their lives might lead to some structural abnormalities within the knee. Possible expected abnormalities include injuries to the meniscus, cartilage, ligaments, and tendons, especially the patellar tendon. Bone contusions may also occur either in isolation or as a result of meniscal or ligamentous abnormalities.

In our study, players denied having any pain in the knee, but 74% of the players had at least one abnormal finding that was presumably asymptomatic. Although our sample of female basketball players was small, the imaging findings were seen in both sexes.

No meniscal abnormality was identified in our study population. This finding differs from that of a prior study of football players, which reported meniscal abnormalities in 59% [12]. This difference is perhaps an effect of the type of movements a basketball player makes compared with the repetitive trauma sustained by football players including a higher incidence of twisting injuries. A discoid meniscus was identified in 12% of the knees in our series. This incidence of discoid meniscus is higher in our subjects than that seen in the ordinary population and likely reflects the small number of subjects in our study.

Signal abnormalities were identified in the cartilage, but the players denied any symptoms referable to cartilage or the joint line. As a primary shock absorber in the knee, cartilage would be a likely area for developing abnormalities. It would be interesting to note the changes in the cartilage after a subject has played a full season of competitive basketball.

![Fig. 3](image1.jpg) — 20-year-old male college basketball player with cartilage defect. Axial fast spin-echo T2-weighted MR image (TR/TEeff, 3500/65) obtained with fat suppression shows focal area of cartilage abnormality at apex of cartilage in patella (large arrow). Smaller defect (small arrow) can be seen along medial facet.

![Fig. 4](image2.jpg) — 21-year-old male college basketball player with cartilage defect. Sagittal fast spin-echo fat-suppressed MR image (TR/TEeff, 3500/65) shows focal cartilage abnormality (arrows) corresponding to known arthroscopically debrided area.

![Fig. 5](image3.jpg) — 19-year-old male college basketball player with bone marrow edema. Axial fast spin-echo T2-weighted MR image (TR/TEeff, 3500/65) shows area of high signal in medial portion of patella (arrows).

![Fig. 6](image4.jpg) — 22-year-old male college basketball player with infrapatellar plica signal. Sagittal fast spin-echo fat-suppressed MR image (TR/TEeff, 3500/65) shows abnormal signal along infrapatellar plica (arrows).
We plan to study these athletes immediately after the season as part of another project.

The findings in the patellar tendon are not surprising. Jumper’s knee is so named because of the frequency with which this entity, patellar tendinopathy, is seen in basketball players. Abnormal thickness and signal were identified in eight (24%) of the 34 knees. This finding is common in basketball players and could represent healed patellar tendinopathy. However, the appearance is also suggestive of symptomatic patellar tendinopathy. The findings of patellar tendinopathy in the players who are asymptomatic raise the question as to whether these findings should alert the trainer to treating the tendinopathy before it becomes symptomatic to decrease potentially lost playing time if the player becomes symptomatic. Jumper’s knee can be a debilitating injury. At a minimum, trainers and team physicians should monitor athletes with tendinopathy more closely. Perhaps early identification can lead to early treatment.

The significance of the abnormal high signal along the infrapatellar plica noted bilaterally in one of the players is not clear. These findings might result from chronic stress or represent a variant of Hoffa’s disease. Abnormal high signal along the infrapatellar plica was shown in one of our subjects.

One of the most surprising findings was the number of areas with bone marrow edema. Fourteen (41%) of the 34 knees showed bone marrow edema in at least one location. One possible explanation for this finding is that shock or microtrauma is being transmitted through the meniscus, dissipated by the cartilage, and eventually absorbed into the bone, resulting in a microfracture or contusions. The continuous repetitive jumping and running in this sport may explain the presence of edema. The changes described by Zanetti et al. [18] represent a variant of Hoffa’s disease. Abnormal cartilage signal or a focal abnormality of cartilage was also seen in 41%. Signal along the infrapatellar plica was noted in two knees, and four knees (12%) were noted to have discoid meniscus. Joint effusions were identified in 35% of the knees imaged. Knowing what is “normal” for a competitive elite basketball player is important. Erroneously diagnosing bone contusions or cartilage abnormalities, for example, as abnormal conditions could lead to decreased playing time or inappropriate therapy. Being uninformed about the significance of the findings of bone contusions or cartilage abnormalities, for example, could lead to aggressive therapies that may decrease the athlete’s playing time. This treatment strategy could be detrimental to an athlete on scholarship with professional-level playing potential. The long-term effects of these findings are not known. The findings of patellar tendinopathies might be potentially significant. Long-term evaluation and evaluation during the season might clarify the significance of our findings. A potential benefit of imaging players before the season is the detection of asymptomatic jumper’s knee. Early treatment of this entity may lead to a better long-term outcome for the player.

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References

Major and Helms