Original Article / Özgün Araştırma

Bipartite Patella: Magnetic Resonance Imaging

Bipartita Patella: Manyetik Rezonans Görüntüleme Bulguları

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Abstract

Objective: Bipartite patella is accepted as a normal anatomic variant of patella, and is identified incidentally on knee radiographs taken for other reasons. The aim of this study was to characterize the magnetic resonance imaging (MRI) features of bipartite patella without bone marrow edema.

Materials and Methods: In total, 1.000 patients were evaluated retrospectively. Imaging was performed on 1.5T MRI unit using extremity coil. A standardized knee protocol was used. The obtained images were thereafter analyzed by two experienced radiologists in consensus.

Results: Of the 18 patients, six were female and twelve were male. The mean age of the group was 42.1±23.5 years. The bipartite fragments were located in the superolateral aspect of the patella. In 16 knees, only one fragment was recognized. The average transverse diameter of the patellar fragment was 11.6±8.1 mm. In the axial plane, the average distance between the fragment and the main patella was 1.67±1.1 mm. Continuity of the patellar cartilage on the fragment was observed in all patients. The mean fragment cartilage thickness was 1.9±1 mm and the patellar cartilage thickness was 3.8±2.3 mm. Cartilage signal was present in ten knees, fluid signal was present in six knees, and fibrous signal was present in four knees in the synchondrosis region.

Conclusion: A defining feature of bipartite patella without accompanying edema in the bone marrow is a thinner-than-
normal cartilage covering the fragments, and an overall cartilage signal over the area of the synchondrosis.

Keywords
Patella, anatomic variation, magnetic resonance imaging

Öz

Amaç: Bipartita patella insidental radyolojik bulgu olarak saptanır. Bu çalışmanın amacı kemik iliği ödemi bulunmayan bipartita patellalı olguların manyetik rezonans görüntüleme (MRG) bulgularını tanımlamaktır.

Gereç ve Yöntemler: Toplamda 1,000 hasta retrospektif olarak değerlendirildi. Görüntüleme her hasta için diz koili kullanılarak standart diz protokolünde 1.5T MRG cihazında yapıldı. Görüntüler iki radyoloğun ortak görüşünde değerlendirildi.

Bulgular: On sekiz hastanın altısı kadın, on ikisi erkekti. Ortalama yaş 42,1±23,5 yıldı. Bipartita fragmanların tamamı patellanın süperolateralinde yerleşimli idi. Fragmanın ortalama transvers çapı 11,6±8,1 mm idi. Aksiyal planda fragman ile komşu patella arasında ortalama mesafe 1,67±1,1 mm idi. Fragman üzerinde patellar kartilajın devamlılığı tüm hastalarda izlendi. Ortalama fragman kartilaj kalınlığı 1,9±1 mm ve patellar kartilaj kalınlığı 3,8±2,3 mm idi. Sinkondroz bölgesinde 10 dizde kartilaj sinyali, 6 dizde sıvı sinyali ve 4 dizde fibröz sinyal saptandı.

Sonuç: Kemik iliği ödemi bulunmayan bipartita patella olgularının önemli özelliği, fragmanı kaplayan normalden ince kartilaj ve genellikle sinkondrosis bölgesinde saptanan kartilaj sinyalidir.

Anahtar Kelimeler
Patella, anatomik varyasyon, manyetik rezonans görüntüleme

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Introduction

The patella is the largest sesamoid bone in the human body. It generally develops from a single ossification center at 2-3 years of age (1,2). Two or more ossification centers may be seen at a rate of 15% (2-4). A secondary center of ossification generally appears between the ages of 10 and 12, and fuses with the patella during adolescence (1-5); however, bipartite patella develops in cases where the secondary ossification center fail to fuse (2-4,6). Most bipartite patellae are asymptomatic and observed only as an incidental finding when the knee is radiographed for other reasons (2,4,7). In majority of cases, it is possible to see highly corticated fragments next to the superolateral patella in radiographs of the anteroposterior projection (Figure 1). The bipartite fragment and its relationship with the patella is better observed on tangential patellar radiography (2,8). Radiographs may not provide adequate diagnosis in cases of trauma or pain; for this reason, magnetic resonance imaging (MRI) is also performed to identify bone marrow edema, internal derangement or fracture in this region (2-4). There are very few reports in the English language literature regarding the MRI features of bipartite patella (3,4). In the current study, the aim was to analyze the MRI features in 18 patients with bipartite patella.

Materials and Methods

Patients: Patients, who had undergone a knee MRI for any indication between March 2013 and December 2014, were evaluated retrospectively. Patients younger than 18 years of age and those with acute knee trauma (in the bipartite fragment and patella that cause bone marrow edema) were excluded from the study. Thus, a total of 1.000 patients were included in the study and bipartite patella was detected in 18 of these patients.

Magnetic Resonance Imaging: Imaging (Optima, GE Medical Systems, Milwaukee, Wisconsin, USA) was performed on 1.5T MRI unit using extremity coil. A standardized MRI examination protocol was used and the following five sequences were performed for each patient.

*Sagittal T1-weighted fast spin echo (FSE) [repetition time (TR), echo time (TE), field of view (FOV), (TR=508 ms, TE=10.34 ms, thickness: 4 mm, matrix: 288x224, FOV=18 cm)],

*Sagittal fat-suppressed proton density (PD)-weighted FSE (TR=2520 ms, TE=38.24 ms, thickness: 4 mm, matrix: 256x192, FOV=18 cm),

*Coronal T1-weighted FSE (TR=645 ms, TE=15.46 ms, thickness: 4 mm, matrix: 288x224, FOV=20 cm)

*Coronal fat-suppressed PD-weighted FSE (TR=2323 ms, TE=45.48 ms, thickness: 4 mm, matrix: 288x224, FOV=20 cm)

*Axial fat-suppressed PD-weighted FSE (TR=2742 ms, TE=39.8 ms, thickness: 3 mm, matrix: 288x224, FOV=18 cm)

Image Interpretation: All patients were examined for the features of the bipartite patella. Bipartite patella was defined as a visible accessory fragment/fragments, in one of the typically reported locations (inferior pole, lateral margin and superolateral location) (3). The number and locations of the patellar fragments were evaluated on the coronal plane.

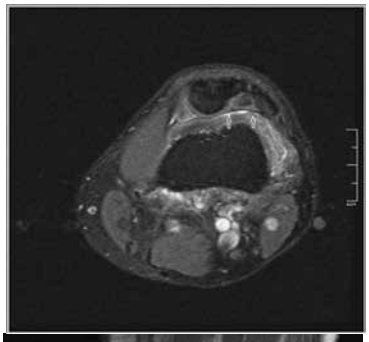
Calculations of the transverse diameter of the fragments, cartilage thicknesses of the fragment and the patella, and the distance between the fragment and patella were made on the axial plane. Patellar retinaculum integrity was investigated in all cases. MR images of the patients were evaluated for the presence of abnormal signal across the synchondrosis. Cartilage signal in synchondrosis was defined as signal intensity on fat-suppressed PD-weighted and T1-weighted sequences similar to the signal intensity in the patellar cartilage. Fibrous signal was defined as a signal intensity hypointense to articular cartilage in both sequences. Fluid signal was defined as signal intensity in both sequences similar to joint fluid. The knee joint was also examined for a cause of the symptoms. The examinations were reviewed by two experienced radiologist in consensus.

Results

Of the 18 patients, six (33.3%) were female and 12 (66.6%) were male. The mean age of the group was 42.1 years with a range of 32-53 years. Ten (55.5%) patients demonstrated right knee involvement, six (33.3%) left knee involvement, and two (11.1%) patients had involvement in both knees. Single fragment was detected in 16 (80%) knees, and more than one fragment were detected in 4 (20%) knees. All the bipartite fragments were on the superolateral quadrant of the patella (100%). The mean fragment transverse diameter was 11.6 mm (8.2-15 mm), and

Figure 1. Antero-posterior radiograph of both knees demonstrating right bipartite patella with the accessory fragments (arrow) in the upper outer quadrant

a



b

Figure 2. a) Axial fat-suppressed proton density-weighted, b) Sagittal T1-weighted images shows the cartilage overlying the patella and accessory fragments and confirms the presence of cartilage signal (arrow) across the synchondrosis

the mean patella-fragment distance was 1.67 mm (1.1-2.1 mm). Continuous patellar cartilage on the fragment was observed in all patients (100%) (Figure 2). The mean fragment cartilage thickness was 1.9 mm (1.5-2.8 mm) and the mean patellar cartilage thickness was 3.8 mm (2.6-5.6 mm). The patellar retinaculum was intact in all cases (100%). Of the 20 knees with bipartite patella, ten (50%) knees had cartilage signal (Figure 2), four (20%) knees had fibrous

a

b

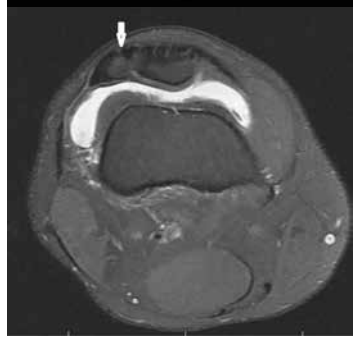
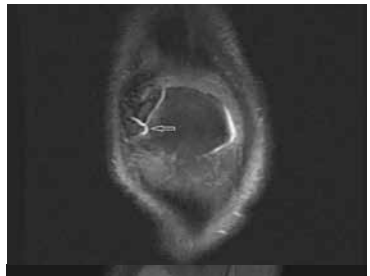


Figure 3. a) Coronal T1 weighted, b) Axial fat suppressed proton density-weighted images confirm the presence of a bipartite fragment at the superolateral pole of the patella. Note the presence of fibrous signal (arrow) present between the patella and its bipartite fragment

a



b

Figure 4. a) Coronal and, b) Sagittal fat-suppressed proton density-weighted image shows a tripartite patella with fluid signal (arrow) between the fragments and the patella

signal (Figure 3), and six (30%) knees had fluid signal (Figure 4) across the synchondrosis. Bone marrow edema was not detected in fat-suppressed PD-weighted sequences of the patella and the fragment.

Discussion

Bipartite patella is considered a developmental variation of ossification and may be an asymptomatic, incidental finding. Although the patella is formed from a single center of ossification in most humans, a number of cases may have more than one center. Centers of ossification usually fuse into a single structure, the patella, however, in a few of these cases, a small fragment may remain separate from the rest of the patella, with fibrocartilage structures between them (1,4,7). It was first described by Wenzer Gruber in 1883 (1,2,4,6,7). The pathogenesis is still controversial. Direct trauma or repetitive microtrauma that cause abnormal mobility at the fibrocartilaginous interface between ossification centers are thought to be responsible for the etiopathogenesis (2,4,7,8). The etiopathogenesis might also be related to stress occurring at the vastus lateralis insertion (9,10). Bipartite patella occurs in approximately 2% to 3% of the general population. The anomaly is bilateral in approximately 50% of individuals. Bipartite patella is more common in males than in females (1,2,4,6). The female/male ratio in our study was 1:2 and this was similar to that in the previous studies. However, our rate of bilateral detection was low. Knee radiograms and MRIs of patients who were detected to have the variation were unilateral in 16 cases. Therefore, it was not possible to evaluate the other knee in these patients.

Oohashi et al. (6) have reported that bipartite patella accounted for 94% (131/134 knees), and tripartite patella for 6% (8/134 knees). We detected more than one fragment in 20% of the knees (4/20). Oohashi et al. (6) recently proposed a new classification for developmental anomaly of the patella. The incidence of superolateral bipartite patella in their study was 83%, lateral bipartite patella-12%, superolateral and lateral tripartite patella-4%, and superolateral tripartite patella was 1%. All cases of patella partita were classified as superolateral in our study. There are very few reports in the English language literature regarding the MRI features of bipartite patella. The current study revealed that the transverse diameter of the patellar fragment was lower than 2 cm (mean 11.6 mm), and the patella-fragment distance was less than 2 mm (mean 1.6 mm), similar to the study of O'Brien et al. (2).

Several reports based on surgical observations and autopsy findings indicate an intact articular cartilage over the accessory fragment with a continuous bridge between the two (11-13). We observed that bipartite fragment cartilage was thinner, yet continuous with the patellar cartilage in all cases.

Histologically, the interposed tissue between the bipartite fragment and the main patella can be fibrous tissue, fibrocartilage or hyaline cartilage (7). O'Brien et al. (2) detected fluid signal in this region in 82% of 25 asymptomatic patients. In the current study, we detected a higher proportion of cartilage signal than fluid signal in the synchondrosis.

Bipartite patella is generally asymptomatic and diagnosed incidentally (2,4,7,8). An accessory fragment can usually be seen on a standard anteroposterior radiograph of the knee (2,8). The initial radiograph may be confused with a non-displaced stress fracture. The radiograph of the contra-lateral knee in this situation can be useful (5). A standard radiograph and computed tomography will also show the bipartite fragment but they do not recognize if that fragment is the cause of patients' symptoms and do not it identify any bone marrow or soft tissue edema (2,3). Oohoshi and Koshino (10) have reported that abnormally high scintigraphic uptake occurs frequently in both symptomatic and asymptomatic bipartite patella. Bone scintigraphy does not differentiate between the two. MRI has been recently described as a method of assessing bipartite patella. Detection of bone marrow edema on MRI in symptomatic patients is important (3,4,8). In particular, fat-suppressed T2-weighted images are diagnostic. Kavanagh et al. (3) have evaluated knee MRI scans of 53 patients with bipartite patella. Bone marrow edema within the bipartite fragment was detected in 35 of 53 patients (66%) and among 18 subjects with no edema, an alternative explanation was found for knee pain in 13 patients (72%). Of the 18 patients with no edema within the bipartite fragment, an alternative explanation for the symptoms was found in 15 patients in the current study. Of these 15 patients, four were diagnosed with meniscal tear, three-with quadriceps tendinosis, two-with an anterior cruciate ligament tear, four-with femoratibial osteoarthritis, and one patient was diagnosed with femoral osteochondral lesion. However, our study has some limitations. The study design was retrospective,

and the study sample was small. We were not able to evaluate the clinical findings of patients who had undergone MRI and had bipartite patella.

Conclusion

In conclusion, knowledge of normal anatomic variations allows easier identification and diagnosis of certain pathologies.

Our study demonstrated that most fragments are separated from the patella by a distance of 2 mm or less, and that these bipartite fragments are generally less than 2 cm in diameter. We also observed that the cartilage covering the patella is thicker than the cartilage covering the bipartite fragment.

Ethics

Ethics Committee Approval: The study were approved by the Ankara Numune Education and Research Hospital of institutional review board, Informed Consent: Consent form was not filled out by all participants. The study was retrospective, Peer-review: External and internal peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: Semra Duran, Concept: Semra Duran, Elif Günaydın, Design: Semra Duran, Hatice Gül Hatipoğlu, Data Collection or Processing: Semra Duran, Elif Günaydın, Analysis or Interpretation: Semra duran, Bülent Sakman, Literature Search: Semra Duran, Hatice Gül Hatipoğlu, Writing: Semra Duran, Elif Günaydın, Conflict of Interest: No conflict of interest was declared by the authors, Financial Disclosure: The authors declared that this study has received no financial support.

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