CME Article

Magnetic resonance imaging of variants of the knee

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ABSTRACT

Magnetic resonance imaging has become the imaging modality of choice for evaluation of internal derangements of the knee. Anatomical variants are often an incidental finding on these examinations. Knowledge and recognition of variants is important, not only to avoid misdiagnosis but also to avoid additional imaging and over-treatment. This pictorial essay provides an overview of variants encountered during a review of 1,873 magnetic resonance imaging examinations of the knee. Emphasis is laid on these variants that are clinically important.

Keywords: knee anatomy, knee imaging, knee variants, magnetic resonance imaging

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INTRODUCTION

Magnetic resonance (MR) imaging has become the imaging modality of choice for evaluation of internal derangements of the knee. Normal variants are often encountered as incidental finding on MR images. Knowledge and recognition of variants is important for accurate analysis of MR images. Incorrect interpretation may lead to unnecessary additional imaging and over-treatment. Initially, we performed a review of the literature on normal variants of the knee. Subsequently, 1,873 MR imaging examinations of the knee, performed during May 2005 and December 2006, were retrospectively reviewed. Postoperative knees were excluded. The overall frequency of variants encountered in these examinations was 28.4%. Variants may affect different anatomical structures, such as osseous structures, muscles, menisci, plicae, recesses and ligaments. The commonest variants in our study are synovial plicae, which are found in 13.4% of patients. This pictorial essay illustrates the various variants of the knee, with emphasis on these variants that are of clinical importance; variants that may become symptomatic, are prone to pathology or may simulate disease.

BONE MARROW

Conversion of red to yellow marrow is a physiological dynamic process that is age-related. Foci of residual red bone marrow are often found in the distal femur, and less frequently in the tibia and fibula.[1] The amount of residual red bone marrow is variable and can be focal, multifocal, confluent, patchy or completely homogeneous.[1,2] Incidences in the literature vary from 0.7% to 35%.[1,2] In our study, we found an incidence of 5.8%. MR imaging may show various amounts of red bone marrow with low signal intensity on T1-weighted images and high signal intensity on T2-weighted images (Fig. 1). Differential diagnosis should include pathological bone marrow infiltration. Criteria for differentiation are absence of epiphyseal involvement, no cortical destruction or soft tissue mass, no changes in the tibia and fibula, and absence of extensive femoral involvement.[3]

Fig. 1 Sagittal SE T1-W MR image of the right knee in a 20-year-old woman shows residual islands of red bone marrow in the distal femur. There are no signal changes in the epiphysis or patella, which contain fatty yellow marrow.

PATELLA

Patellar shape and size

The patella is the largest sesamoid bone in the human

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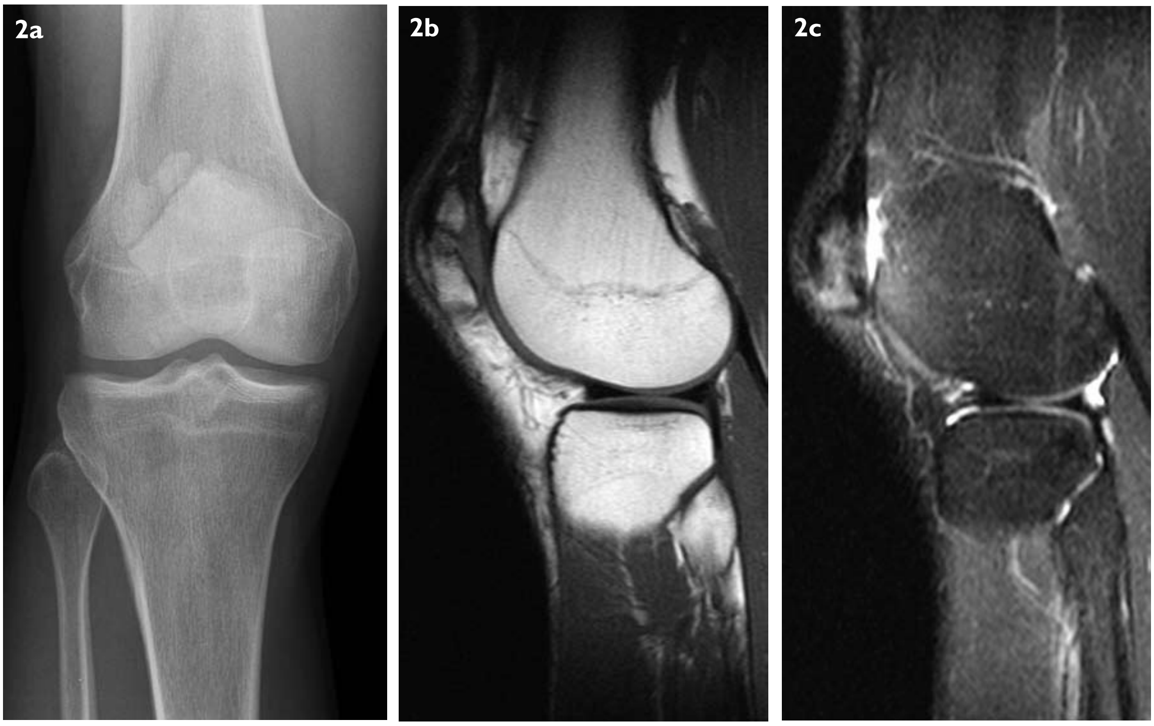

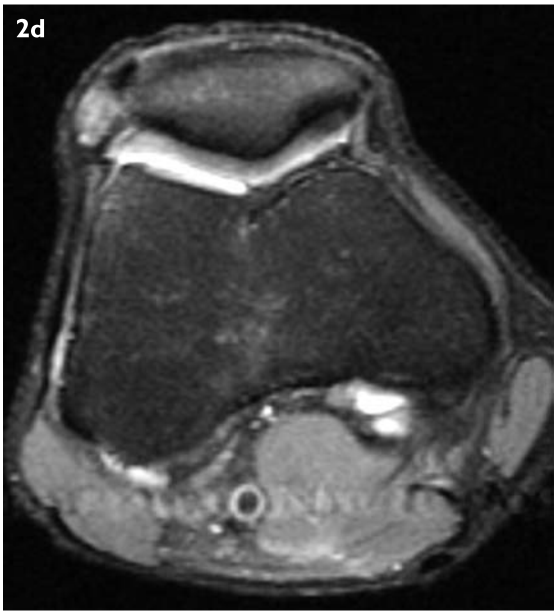

Fig. 2 Tripartite patella in a 28-year-old woman with anterior knee pain. (a) Anteroposterior (AP) radiograph of the right knee shows two cortical delineated accessory ossification centres at the superolateral aspect of the patella. (b) Sagittal SE T1-W MR image depicts well an accessory fragment. Also note the cartilage signal across the synchondrosis. (c) Sagittal and (d) axial TSE T2-W MR images of the same patient show bone marrow oedema in the accessory fragments and patella.

body. Multiple anatomical variants have been described. Abnormalities in size include patella parva and magna. Abnormalities in morphology described in the literature include "hunter's cap" patella, "pebble-like" patella, and half-moon shape of the patella. Until now, no correlation has been proven between these anatomic variants and either chondromalacia or patellar instability.[4] We only encountered one patient with "hunter's cap" patella in our study.

Bipartite and multipartite patella

Bipartite and multipartite patellae are defined as one or more accessory ossification centres near the patella. They are noted in 2% of patients on radiographs and are bilateral in 40%.[5] In a recent prospective MR imaging study, Kavanagh et al found a prevalence of 0.7%.[6] Bipartite patella is nine times more common in boys than girls and much more frequent than multipartite patella.[5] In 1921, Saupe proposed a classification of bipartite patella, based on the position of the separated fragment: type I, at the inferior patella pole; type II, at the lateral margin; and type III (which is the most common one) at the superior lateral pole.[7] The aetiology is still a matter of debate.[8] Although most often an incidental finding, in some cases bipartite patella may become symptomatic and cause anterior knee pain.[7,9,10] Standard radiographs (Fig. 2a) are not useful to distinguish asymptomatic from symptomatic variants. MR imaging is the imaging modality of choice. In patients with symptomatic bipartite patella, MR imaging shows bone marrow oedema both within the fragments along the margins of the synchondrosis[10] (Figs. 2b–d). Differential diagnosis includes patellar fractures. In our study, we found an incidence of 0.53%. All except one patient presented with anterior knee pain and showed bone marrow oedema. All our cases were Saupe type III.

Dorsal patellar defect

Dorsal patellar defect is a characteristic well-defined lytic

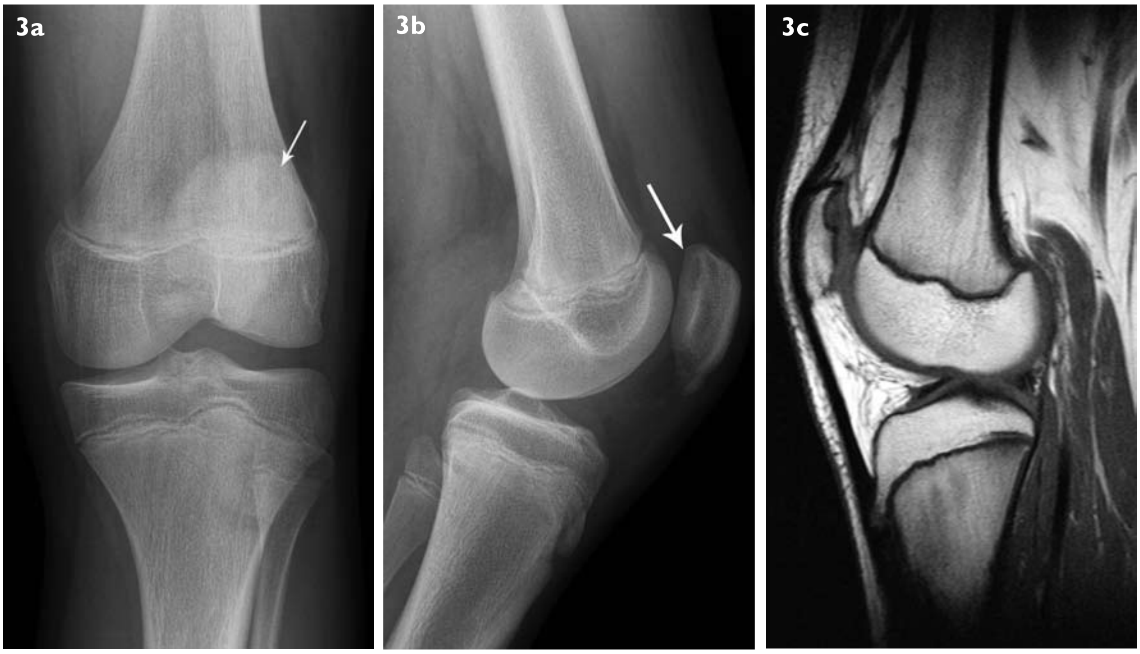

Fig. 3 Dorsal patellar defect in a 14-year-old boy. (a) AP and (b) lateral radiographs of the left knee show a well-defined lucency in the posterolateral aspect of the patella (white arrow). (c) Sagittal SE T1-W and (d) axial TSE T2-W MR images show the well-circumscribed defect in the superolateral aspect of the patella, with chondral thickening covering the cortical defect.

lesion, usually located in the superolateral aspect of the patella. On radiographs, it has a round contour, frequently shows a sclerotic border and ranges in size from 4 mm to 26 mm[11,12] (Figs. 3a–b). Prevalence on radiographs ranges from 0.3% to 1%, and may be bilaterally in one-third of patients.[12,13] In our study, we found an incidence of 0.16%. As for bipartite patella, the aetiology of dorsal patellar defect is still uncertain. van Holsbeeck et al postulated that abnormal stresses applied by the vastus lateralis muscle (which inserts at the superolateral aspect of the patella), play a central role in the pathophysiology of both dorsal patellar defect and bipartite patella.[8] MR imaging shows a cortical defect at the superolateral aspect of the patella, which is compensated by overgrowing articular cartilage[14,15] (Figs. 3c–d). Patients are mostly asymptomatic. Association of dorsal patellar defect is rare and only found in symptomatic patients.[9] This variant should not be mistaken for osteochondritis dissecans of the patella.[9,15] Other less frequent differential diagnosis include Brodie's abscess and bone tumours.

Patella alta and baja

Patella alta and baja refer to the relationship between the length of the patella and the patellar tendon. Patella alta is associated with chondromalacia patella, increased risk of patellar subluxation or dislocation, patellar and quadriceps tendinosis, and Osgood-Schlatter disease.[16] The most popular measuring technique for the patellar position is the Insall and Salvati index measured on radiographs. This index is defined as the ratio of the length of the patellar tendon (LT) to the length of the patella (LP). On radiographs, LT/LP < 0.8 is defined as patella baja.[9] LT/LP > 1.2 as patella alta. Shabshin et al redefined the index for sagittal MR images.[16] A LT/LP ratio of > 1.5 and < 0.74 defines patella alta (Fig. 4) and baja (Fig. 5), respectively.[16,17] In our study, we found an incidence of patella alta of 0.58% and patella baja of 0.27%.

MUSCLE

Accessory medial or lateral slip of the gastrocnemius muscle

Anomalies of the lateral (Figs. 6 a–c) or medial head of the gastrocnemius are relatively uncommon. Although

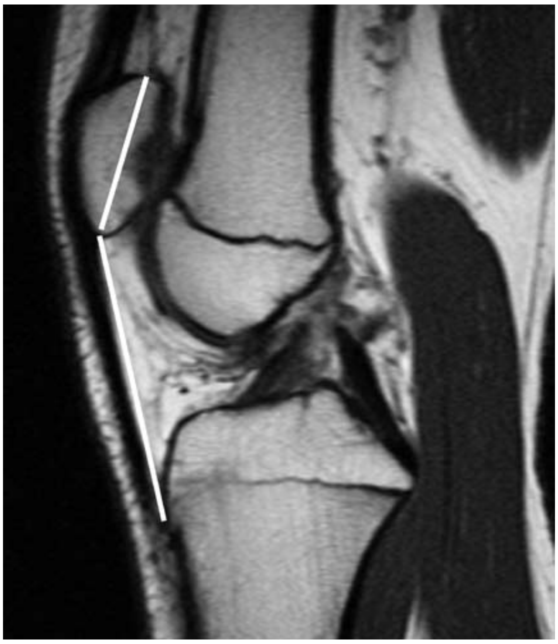

Fig. 4 Patella alta in a 27-year-old woman. Sagittal SE T1-W MR image of the right knee shows an Insall and Salvati index of 1.7.

Fig. 5 Patella baja of the right knee in a 37-year-old woman. Sagittal SE T1-W MR image of the right knee shows an Insall and Salvati index of 0.74.

most often an incidental finding, it may cause popliteal artery entrapment syndrome (PAES).[18-20] Clinical diagnosis of PAES is difficult and must be considered in young patients having intermittent claudication.[18] Classification by Whelan divides PAES into six types (Fig. 6d). In type 3, an aberrant accessory slip from the medial head of the gastrocnemius muscle wraps around the normally-positioned popliteal artery and entraps it.[19] Rare types of PAES caused by anomalous lateral head of the gastrocnemius have not yet been classified.[19,20] In our study, we found three patients with an accessory slip of the lateral head of the gastrocnemius muscle.

Accessory popliteal muscle

Accessory popliteal muscle is a variant of the popliteal muscle, described by various terms: popliteus biceps, popliteus geminus, double-headed popliteus.[21] Accessory popliteal muscle is an additional muscle bundle originating either from the posterior aspect of the lateral femoral condyle or from a sesamoid bone of the lateral gastrocnemius muscle. This supernumerary muscle merges with the popliteal muscle at the posteromedial aspect of the tibia.[21]

Tensor fasciae suralis muscle

The tensor fasciae suralis muscle is a very rare anomalous muscle located in the popliteal region.[22] It arises from the semitendinous muscle, runs superficially to the gastrocnemius medial head and continues as a long thin tendon to join the Achilles tendon.[22] It usually presents as an asymptomatic popliteal mass.[23] Both accessory popliteal and tensor fasciae suralis muscle are rare variants with only a few case reports in the literature.

MENISCI

Discoid meniscus

Discoid meniscus is an anatomical variant in which the meniscus is thickened and disc-shaped, covering a greater area of the tibial plateau than the normal semilunar meniscus.[24] Although far more common on the lateral side, it is described for both lateral and medial menisci. Discoid menisci are arthroscopically classified by Watanabe as complete, incomplete and Wrisberg-type.[24,25] Incidence in arthroscopic studies range from 1.2% to 16.6%. In a recent MR imaging study, Rohren et al found an incidence of 4.5%.[24] In our study, we only found an incidence of 0.45%. Various MR imaging criteria have been proposed for the diagnosis.[24,26] The most widely-used criterion is when three or more 4 mm-thick consecutive sagittal images demonstrate continuity of the meniscus between the anterior and posterior horns (Fig. 7).[24,27] An abnormal, thickened, bow-tie appearance of the meniscus may also be suggestive.[27] Discoid meniscus is often asymptomatic, but has been associated with clinical abnormalities.[24] Discoid lateral meniscus is associated with an increased risk of lateral meniscal tears.

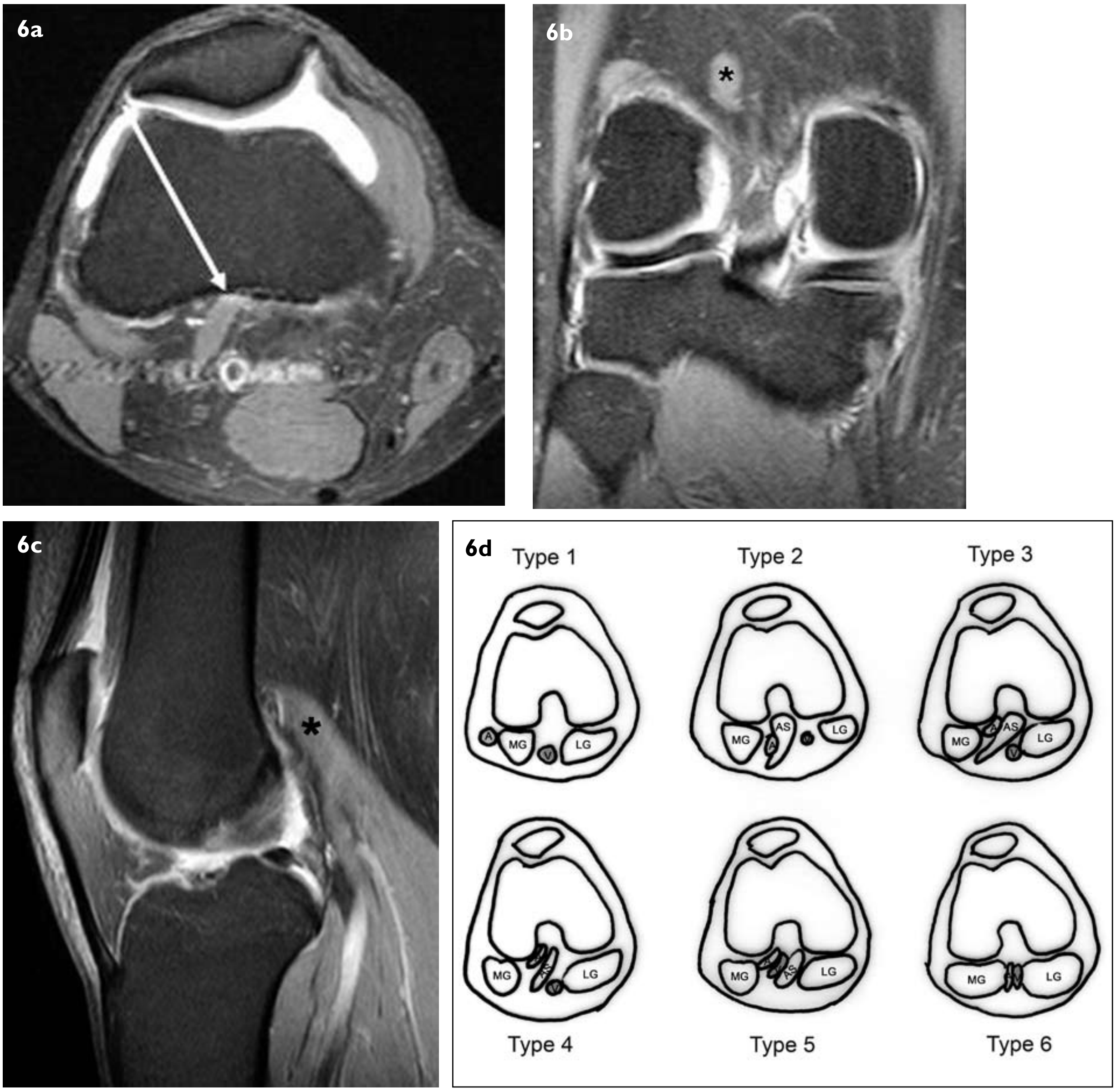

Fig. 6 Abberant slip of the lateral head of the gastrocnemius muscle at the right knee in a 55-year-old man. (a) Axial TSE T2-W MR image shows an aberrant slip of the lateral head of the gastrocnemius muscle curving around the popliteal vessels. The aberrant slip (asterisk) is also noted on the (b) coronal fat-suppressed T2-W and (c) sagittal fat-suppressed T2-W MR images. (d) Axial diagrams show the six subtypes of gastrocnemius medial head variations causing PAES.

There is no association with medial meniscal tears.[24] In children it may cause the "snapping knee" syndrome.[27]

Other variants

The lateral meniscus is morphologically more variable than the medial meniscus. Diagnosis of these variants is mainly based on arthroscopy. Variants of the menisci described in literature include double-layered meniscus, partial deficiency of the meniscus, abnormal band formation, hypoplasia, ring-shaped meniscus and congenital absence of the menisci.[28]

LIGAMENTS

The ligaments of the knee may be highly variable in size and thickness, or may even be absent. Several normal ligamentous structures of the knee have been described that may mimic a meniscal tear at MR imaging. Good anatomical knowledge of the course of these ligaments is essential for correct interpretation of MR imaging studies.

Anterior transverse intermeniscal ligament

The anterior transverse intermeniscal ligament connects the anterior convex margin of the lateral meniscus to the anterior horn of the medial meniscus. It varies in thickness and may even be absent. Other names for this ligament are geniculate ligament, meniscomeniscal ligament, anterior transverse ligament, intermeniscal ligament.[29] Especially when thickened, it may simulate a tear of the anterior horn of the lateral meniscus. The ligament is

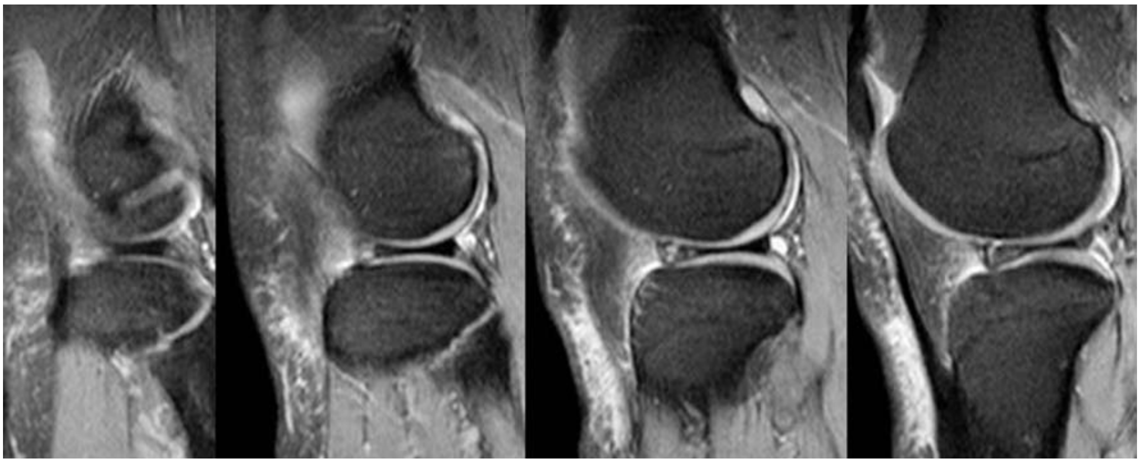

Fig. 7 Sequential sagittal fat-suppressed T2-W MR images taken through the lateral compartment of the left knee of a 42-year-old woman show four body segments of the lateral meniscus, indicating the presence of a discoid meniscus. High signal intensity in the anterior horn is suggestive of internal mucoid degeneration. Also note the post-traumatic infrapatellar subcutaneous oedema.

Fig. 8 (a) Sagittal fat-suppressed T2-W and (b) axial TSE T2-W MR images show a cord-like anterior (thin arrow) and posterior (thick arrow) intermeniscal ligament in the left knee of a 70-year-old woman.

defined as "cord-like" when it has a thickness of 3 mm or more at the attachment sites to the anterior horn of the medial and lateral meniscus. A cord-like meniscus is found in 8.2% of cases.[29,30] In our study, a cord-like anterior intermeniscal ligament was found in 2.6% of patients. A cord-like posterior transverse intermeniscal ligament was less frequent, with only an incidence of 0.32% in our study population (Fig. 8).

Oblique meniscomeniscal ligament

The oblique meniscomeniscal ligament is an intermeniscal ligament that runs obliquely from the anterior horn of one meniscus to the posterior horn of the opposite meniscus.[31] (Fig. 9). It is a relatively uncommon meniscomeniscal ligament with a reported incidence of 1%–4%. In our study, we found an incidence of 1.1%. The ligament, which has no known function, may resemble a displaced meniscal fragment at its attachment site.[31]

Meniscofemoral ligaments

The meniscofemoral ligaments are accessory ligaments that extend from the posterior horn of the lateral meniscus to the lateral aspect of the medial femoral condyle.[32] The meniscofemoral ligament is composed of two branches: anterior branch or ligament of Humphry and posterior branch or Wrisberg ligament.[32,33] The ligaments may simulate a tear of the cruciate ligaments or posterior horn of the lateral meniscus.[33,34] Most pitfalls occur when a structure of low signal intensity closely parallels the outer margin of the meniscus. To avoid these pitfalls, it

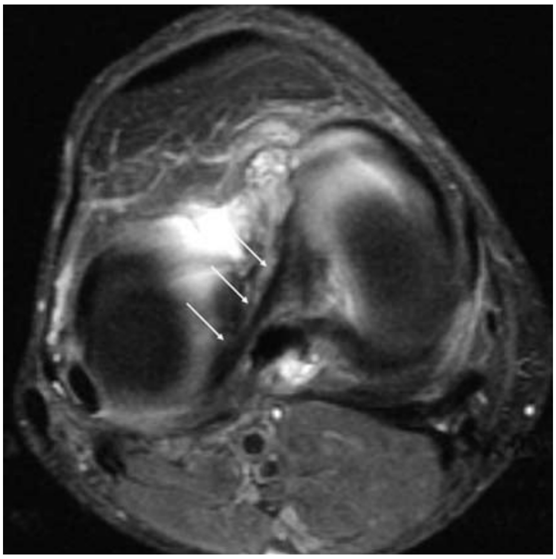

Fig. 9 Axial TSE T2-weighted MR image of the right knee in a 38-year-old man shows the oblique meniscomeniscal ligament that runs from the anterior horn of the lateral meniscus to the posterior horn of the medial meniscus.

Fig. 10 Sagittal fat-suppressed T2-W MR image of the left knee of a 16-year-old woman shows a pseudotear of the lateral meniscus caused by the meniscofemoral ligament (Humphry's ligament). To avoid diagnostic pitfalls, it is necessary to trace the ligament on consecutive sagittal images.

Fig. 11 Sagittal fat-suppressed T2-W MR image of the right knee in a 42-year-old woman shows mild joint effusion and suprapatellar plica.

Fig. 12 16-year-old boy with left knee pain after soccer trauma. Sagittal fat-suppressed T2-W MR image shows an area of fluid signal along the course of the infrapatellar plica which may be related to infrapatellar plica avulsion or simply represent joint fluid.

is necessary to trace the ligament on consecutive sagittal images (Fig. 10). In our study. we only found a thickened meniscofemoral ligament simulating a tear in 0.8% of patients.

PLICAE AND RECESSES

Synovial plicae

A plica is a fold of synovial tissue found in the lining of a joint. These folds are quite filmy, thin and vascularised. They have no known function and are mostly asymptomatic. On MR imaging, they manifest as linear low signal intensity structures, sometimes delineated by joint fluid.

Suprapatellar plica

The suprapatellar plica is located at the border between the suprapatellar bursa and the knee joint cavity. It runs obliquely downward from the synovium at the anterior aspect of the femoral metaphysis to the posterior aspect of the quadriceps tendon, inserting above the patella. It is best visualised on sagittal images (Fig. 11). They are quite common.[35] In our series, we found an incidence of 7%.

Infrapatellar plica

The infrapatellar plica or ligamentum mucosum is the most common plica of the knee. It extends from the inferior pole of the patella through Hoffa's fat pad, to the

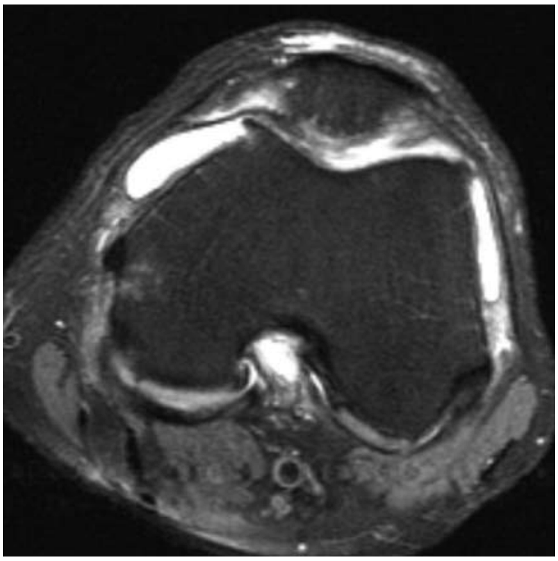

Fig. 13 46-year-old man with persisting medial left knee pain. Axial TSE T2-W MR image shows a long mediopatellar plica extending to the posterior medial patellar facet and anterior aspect of the medial femoral condyle. There is associated bone marrow oedema in the lateral aspect of the patella, due to recurrent impingement.

Fig. 14 Sagittal fat-suppressed T2-W MR image of the right knee in a 38-year-old man shows (a) an ovoid fluid-filled cleft at the posterior inferior aspect of Hoffa's fat pad, and (b) a low signal intensity loose body within the cleft. Because the cleft is in continuity with the main joint cavity, loose bodies from the joint can become lodged in the recess and can be missed at surgery.

intercondylar notch of the femur anterior to the anterior cruciate ligament. It is best visualised on sagittal images. Isolated trauma to the infrapatellar plica is rare, so the radiologist should search for other causes of internal derangement. The infrapatellar plica may distend and be filled with fluid due to underlying joint effusion[36] (Fig. 12). Differential diagnosis includes postoperative changes, loose body within the infrapatellar fat pad, and focal nodular synovitis.[35] In our series, we only found an incidence of 3.1%.

Mediopatellar plica

The mediopatellar plica is also referred to as the medial plica, plica synovialis patellaris, Iino band, plica alaris, synovial shelf or patellar meniscus. It runs obliquely downward and inserts into the synovium covering the infrapatellar fat pad. This plica is best visualised on axial images. Although controversial, plica syndrome may occur when the mediopatellar plica becomes thickened, inflamed or fibrotic.[37] A thickened plica may snap over the femoral condyle in extension and over the patella in flexion. This results in a secondary mechanical synovitis and erosion about the margins of the condyle and patellar cartilage[35] (Fig. 13). In our series, we found an incidence of 6.4% and only in one patient was a symptomatic plica found.

Hoffa's recess

The infrapatellar or Hoffa's fat pad lies in the anterior aspect of the knee joint. Clefts or indentations in Hoffa's fat pad are frequently seen with an incidence in the literature of 13.5%.[38] In our study, we only found an incidence of 4%. These clefts, which are called "Hoffa's recess", are mostly found in the posterior-inferior aspect of the fat pad, just below the insertion of the infrapatellar plica.[39,40] The cleft can be linear, pipe-like, globular, but mostly ovoid in shape.[40] Diagnostic criteria on MR imaging include

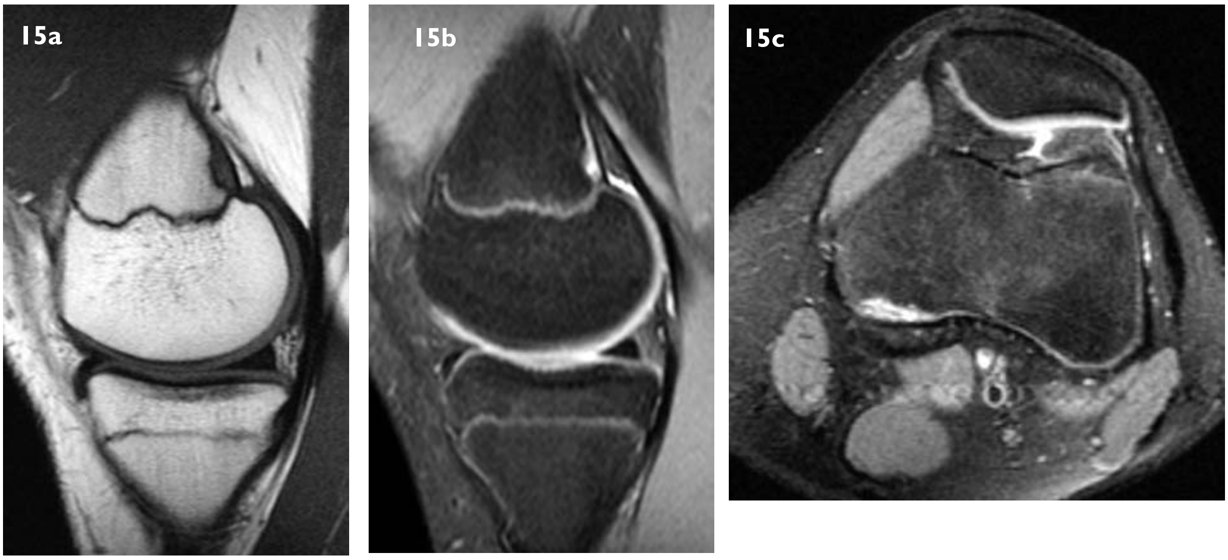

Fig. 15 Cortical irregularity of the left distal femur in a 16-year-old boy. (a) Sagittal SE T1-W MR image shows the irregularity as a well-defined hypointense lesion. The lesion has a high signal intensity on the (b) sagittal fat-suppressed T2-W and (c) axial TSE T2-WI MR images. There is no periosteal reaction or associated soft tissue mass.

a fluid-like signal intensity and size between 5 and 15 mm. The cleft which lies in between the alar folds, is best appreciated on midsagittal MR images. Identification of this recess is important, since it has a connection with the knee joint. Loose bodies can become trapped in the recess and missed at surgery[39] (Fig. 14). Differential diagnosis includes ganglion cysts, Hoffa's disease, synovitis, traumatic laceration and haematomas.[41]

MISCELLANEOUS

Fabella and cyamella

A fabella is a sesamoid bone occurring in the lateral part of the gastrocnemius muscle. It occurs in 11%–13% of patients and is often bilateral.[42] It is common in patients with osteoarthritis, but rarely symptomatic. Pathology of the fabella described in the literature includes fracture, dislocation, erosions and chondromalacia.[43,44] A fabella should not be mistaken for a loose body.[44] A cyamella is a popliteus muscle sesamoid bone, located in the vicinity of the proximal musculotendinous junction.[45] In our study, 6.6% of patients had a normal fabella. We encountered no patients with a cyamella.

Contour irregularity of the distal femur

Numerous cortical irregularities have been documented. One was designated by Resnick and Greenway as a "distal femoral proliferative cortical irregularity", also referred to as "cortical desmoid", "avulsive cortical irregularity", "distal femoral metaphyseal irregularity".[46] It is a benign lesion that occurs along the posterior aspect of the medial femoral condyle in children and adolescents. On radiographs, it appears as a saucer-like radiolucent defect in the cortex with adjacent sclerosis and periostitis and may mimic a malignant process.[47] MR imaging shows low signal intensity on T1-weighted images (Fig. 15a) and high signal intensity intensity on T2-weighted images (Fig. 15b–c) with a low signal intensity interface with the underlying femur. After gadolinium contrast administration, there may be an enhancement.[47] Differential diagnosis includes periosteal osteoblastoma, osteoid osteoma, surface-type osteosarcoma.[48] In our series, this variant was found in 0.21% of cases. Other contour irregularities described in children and adolescents are multiple ossification centres and spiculated margins of ossification of the femoral condyles. These variants should be differentiated from osteochondritis dissecans stage I. Intact overlying articular cartilage and lack of bone marrow oedema are the main important features for differential diagnosis.[49]

CONCLUSION

Anatomical variants in the knee are frequent findings on MR imaging. In our retrospective review, we found variants in almost one-third of patients. Thorough knowledge of the anatomy is crucial, but also familiarity with variants and its possible pathological nature are mandatory for an accurate interpretation of imaging studies.

REFERENCES

1. Vande Berg BC, Malghem J, Lecouvet FE, Maldague B. Magnetic resonance imaging of the normal bone marrow. Skeletal Radiol 1998; 27:471-83.
2. Lang P, Fritz R, Majumdar S, et al. Hematopoietic bone marrow in the

adult knee: spin-echo and opposed-phase gradient-echo MR imaging. Skeletal Radiol 1993; 22:95-103.
3. Deutsch AL, Mink JH, Rosenfelt FP, Waxman AD. Incidental detection of hematopoietic hyperplasia on routine knee MR imaging. Am J Roentgenol 1989;152:333-6.
4. Tecklenburg K, Dejour D, Hoser C, Fink C. Bony and cartilaginous anatomy of the patellofemoral joint. Knee Surg Sports Traumatol Arthrosc 2006; 14:235-40.
5. Lawson JP. Not-so-normal variants. Orthop Clin North Am 1990; 21:483-95.
6. Kavanagh EC, Zoga A, Omar I, et al. MRI findings in bipartite patella. Skeletal Radiol 2007; 36:209-14.
7. Oohashi Y, Noriki S, Koshino T, Fukuda M. Histopathological abnormalities in painful bipartite patellae in adolescents. Knee 2006; 13:189-93.
8. van Holsbeeck M, Vandamme B, Marchal G, et al. Dorsal defect of the patella: concept of its origin and relationship with bipartite and multipartite patella. Skeletal Radiol 1987; 16:304-11.
9. Elias DA, White LM. Imaging of patellofemoral disorders. Clin Radiol 2004; 59:543-57.
10. Vanhoenacker FM, Bernaerts A, Van de Perre S, De Schepper AM. MRI of painful bipartite patella. JBR-BTR 2002; 85:219.
11. Ehara S, Khurana JS, Kattapuram SV, et al. Osteolytic lesions of the patella. Am J Roentgenol 1989; 153:103-6.
12. Johnson JF, Brogdon BG. Dorsal defect of the patella: incidence and distribution. Am J Roentgenol 1982;139:339-40.
13. Narvaez J, Narvaez JA, Clavaguera MT, et al. Dorsal defect of the patella: an uncommon cause of knee pain. Arthritis Rheum 1996; 39:1244-5.
14. Ho VB, Kransdorf MJ, Selinek JS, Kim CK. Dorsal defect of the patella: MR features. J Comput Assist Tomogr 1991;15:474-6.
15. Mellado JM, Salvado E, Ramos A, Camins A, Sauri A. Dorsal defect on a multi-partite patella: imaging findings. Eur Radiol 2001; 11:1136-9.
16. Shabshin N, Schweitzer ME, Morrison WB, Parker L. MRI criteria for patella alta and baja. Skeletal Radiol 2004; 33:445-50.
17. Miller TT, Staron RB, Feldman F. Patellar height on sagittal MR imaging of the knee. Am J Roentgenol 1996; 167:339-41.
18. Atilla S, Ilgut ET, Akpek S, et al. MR imaging and MR angiography in popliteal artery entrapment syndrome. Eur Radiol 1998; 8:1025-9.
19. Kim HK, Shin MJ, Kim SM, Lee SH, Hong HJ. Popliteal artery entrapment syndrome: morphological classification utilizing MR imaging. Skeletal Radiol 2006; 35:648-58.
20. Liu PT, Moyer AC, Huettl EA, Fowl RJ, Stone WM. Popliteal vascular entrapment syndrome caused by a rare anomalous slip of the lateral head of the gastrocnemius muscle. Skeletal Radiol 2005; 34:359-63.
21. Duc SE, Wentz KU, Käch KP, Zollikofer CL. First report of an accessory popliteal muscle: detection with MRI. Skeletal Radiol 2004; 33:429-31.
22. Montet X, Sandoz A, Mauget D, Martinoli C, Bianchi S. Sonographic and MRI appearance of tensor fasciae suralis muscle, an uncommon cause of popliteal swelling. Skeletal Radiol 2002; 31:536-8.
23. Chason DP, Schultz SM, Fleckenstein JL. Tensor fasciae suralis: depiction on MR images. Am J Roentgenol 1995; 165:1220-1.
24. Rohren EM, Kosarek FJ, Helms CA. Discoid lateral meniscus and the frequency of meniscal tears. Skeletal Radiol 2001; 30:316-20.
25. Samoto N, Kozuma M, Tokuhisa T, Kobayashi K. Diagnosis of the "large medial meniscus" of the knee on MR imaging. Magn Reson Imaging 2006; 24:1157-65.
26. Youm T, Chen AL. Discoid lateral meniscus: evaluation and treatment. Am J Orthop 2004; 33:234-8.
27. Kelly BT, Green DW. Discoid lateral meniscus in children. Curr Opin Pediatr 2002; 14:54-61.
28. Saygi B, Yildririm Y, Senturk S, Ramadan SS, Gundes H. Accessory lateral discoid meniscus. Knee Surg Sports Traumatol Arthrosc 2006; 14:1278-80.
29. Aydin AT, Özenci AP, Özcanli H, Özdemir H, Ürgüden M. The reference point to measure the anterior intermeniscal ligament's thickness: an MRI study. Knee Surg Sports Traumatol Arthrosc 2002; 10:343-6.
30. Aydingöz U, Kaya A, Atay O, Öztürk MH, Doral MN. MR imaging of the anterior intermeniscal ligament: classification according to insertion sites. Eur Radiol 2002;12:824-9.
31. Sanders TG, Linares RC, Lawhorn KW, Tirman PF, Houser C. Oblique meniscomeniscal ligament: another potential pitfall for a meniscal tear – anatomic description and appearance at MR imaging in three cases. Radiology 1999; 213:213-6.
32. Vahey TN, Bennett HT, Arrington LE, Shelbourne KD, Ng J. MR imaging of the knee: pseudotear of the lateral meniscus caused by the meniscofemoral ligament. Am J Roentgenol 1990; 154:1237-9.
33. Pfirrmann CW, Zanetti M, Hodler J. Joint magnetic resonance imaging. Normal variants and pitfalls related to sports injury. Radiol Clin North Am 2002; 40:167-80.
34. Carpenter WA. Meniscofemoral ligament simulating tear of the lateral meniscus: MR features. J Comput Assist Tomogr 1990; 14:1033-4.
35. Garcia-Valtuille R, Abascal F, Cerezal L, et al. Anatomy and MR imaging appearances of synovial plicae of the knee. Radiographics 2002; 22:775-84.
36. Cothran RL, McGuire PM, Helms CA, Major NM, Attarian DE. MR imaging of infrapatellar plica injury. Am J Roentgenol 2003; 180:1443-7.
37. Dupont JY. Synovial plicae of the knee. Controversies and review. Clin Sports Med 1997; 16:87-122.
38. Vahlensieck M, Linneborn G, Schild H, Schmidt HM. Hoffa's recess: incidence, morphology and differential diagnosis of the globularshaped clef in the infrapatellar fat pad of the knee on MRI and cadaver dissections. Eur Radiol 2002; 12:90-3.
39. Patel SJ, Kaplan PA, Dussault RG, Kahler DM. Anatomy and clinical significance of the horizontal cleft in the infrapatellar fat pad of the knee: MR imaging. Am J Roentgenol 1998; 170:1551-5.
40. Aydingöz U, Oguz B, Aydingöz O, et al. Recesses along the posterior margin of the infrapatellar (Hoffa's) fat pad: prevalence and morphology on routine MR imaging of the knee. Eur Radiol 2005; 15:988-94.
41. Saddik D, McNally EG, Richardson M. MRI of Hoffa's fat pad. Skeletal Radiol 2004; 33:433-44.
42. Robertson A, Jones SC, Paes R, Chakrabarty G. The fabella: a forgotten source of knee pain? Knee 2004; 11:243-5.
43. Marks PH, Cameron M, Regan W. Fracture of the fabella: a case of posterolateral knee pain. Orthopedics 1998; 21:713-4.
44. Duncan W, Dahm DL. Clinical anatomy of the fabella. Clin Anat 2003; 16:448-9.
45. Akansel G, Inan N, Sarisoy HT, Anik Y, Akansel S. Popliteus muscle sesamoid bone (cyamella): appearance on radiographs, CT and MRI. Surg Radiol Anat 2006; 28:642-5.
46. Stacy GS. Contour irregularities of the distal femur caused by developmental, traumatic, and benign cortically-based neoplastic conditions: radiographic and MRI correlation. Clin Radiol 2004; 59:793-802.
47. Posch TJ, Puckett ML. Marrow MR signal abnormality associated with bilateral avulsive cortical irregularities in a gymnast. Skeletal Radiol 1998; 27:511-4.
48. Nakatani T, Yamamoto T, Akisue T, et al. Periosteal osteoblastoma of the distal femur. Skeletal Radiol 2004; 33:107-11.
49. Gebarski K, Hernandez RJ. Stage-I osteochondritis dissecans versus normal variants of ossification in the knee in children. Pediatr Radiol 2005; 35:880-6.

SINGAPORE MEDICAL COUNCIL CATEGORY 3B CME PROGRAMME
Multiple Choice Questions (Code SMJ 200809B)

	True	False
Question 1. Regarding variants of the patella:		
(a) Bone marrow oedema in a bipartite patella can be seen in symptomatic bipartite or multipartite patella.	☐	☐
(b) Abnormalities in patellar size or morphology are always associated with chondromalacia.	☐	☐
(c) On MR imaging, patella alta is defined when the Insall and Salvati index is more than 1.5.	☐	☐
(d) Dorsal patellar defect is most often found at the inferomedial aspect of the patella.	☐	☐
Question 2. Regarding variants of muscle:		
(a) Accessory muscles are a common finding.	☐	☐
(b) Accessory slip of the gastrocnemius muscle always causes popliteal artery entrapment syndrome.	☐	☐
(c) Accessory tensor fascia suralis muscle often presents as popliteal mass.	☐	☐
(d) Diagnosis of popliteal artery entrapment syndrome must be considered in young patients with claudication.	☐	☐
Question 3. Regarding variants of the menisci:		
(a) The medial meniscus is morphologically more variable than the lateral meniscus.	☐	☐
(b) Discoid menisci are far more common on the lateral than on the medial side.	☐	☐
(c) A bow-tie appearance of the meniscus suggests a discoid meniscus.	☐	☐
(d) Discoid meniscus in children may cause a "snapping knee syndrome".	☐	☐
Question 4. Regarding variants of ligaments:		
(a) The oblique meniscofemoral ligament runs obliquely from the anterior horn of the meniscus to the posterior horn of the opposite meniscus.	☐	☐
(b) The anterior branch of the meniscofemoral ligament is called ligament of Humphry.	☐	☐
(c) To avoid pitfalls when reading MR imaging studies of the knee, it is important to trace the meniscofemoral ligaments on consecutive sagittal images.	☐	☐
(d) A cord-like anterior intermeniscal ligament may simulate a tear of the posterior horn of the medial meniscus.	☐	☐
Question 5. Regarding plicae and recesses:		
(a) Suprapatellar and infrapatellar plicae are best visualised on sagittal images.	☐	☐
(b) Synovial plicae are important supporting structures of the knee.	☐	☐
(c) Identification of Hoffa's recess is important since loose bodies can become trapped in the recess and missed at surgery.	☐	☐
(d) Plicae are mostly asymptomatic variants.	☐	☐

Doctor's particulars:

Name in full: ____________________

MCR number: ____________________ Specialty: ____________________

Email address: ____________________

SUBMISSION INSTRUCTIONS:
(1) Log on at the SMJ website: http://www.sma.org.sg/cme/smj and select the appropriate set of questions. (2) Select your answers and provide your name, email address and MCR number. Click on "Submit answers" to submit.

RESULTS:
(1) Answers will be published in the SMJ November 2008 issue. (2) The MCR numbers of successful candidates will be posted online at www.sma.org.sg/cme/smj by 15 November 2008. (3) All online submissions will receive an automatic email acknowledgment. (4) Passing mark is 60%. No mark will be deducted for incorrect answers. (5) The SMJ editorial office will submit the list of successful candidates to the Singapore Medical Council.

Deadline for submission: (September 2008 SMJ 3B CME programme): 12 noon, 25 October 2008.