Skeletal Radiol (1991) 20:181–185

Skeletal Radiology

The wrinkled patellar tendon: an indication of abnormality in the extensor mechanism of the knee

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Abstract. Rupture of the quadriceps tendon is an uncommon condition which requires early diagnosis and treatment to avert prolonged disability. In four patients who had surgically confirmed quadriceps tendon rupture, lateral radiographs of the knee and/or sagittal magnetic resonance (MR) images demonstrated a corrugated appearance to the patellar tendon. Sagittal MR images of the knee following patellectomy in one patient and radiographs of a transverse fracture of the patella in another also demonstrated this appearance. MRI has superb contrast resolution which provides optimal visualization of the contour of the patellar tendon on sagittal images. A retrospective review of 50 consecutive knee MRI examinations was carried out to evaluate the appearance of the normal patellar tendon. In 49 of 50 patients, the sagittal images demonstrated a straight or nearly straight patellar tendon. A corrugated appearance of the patellar tendon on sagittal images indicates a reduction in the normal tensile force applied to it and indicates the need for careful evaluation of the patella and quadriceps tendon mechanism.

Key words: Quadriceps tendon rupture – Patellar tendon – Extensor mechanism of knee – Magnetic resonance imaging

Rupture of the quadriceps tendon is usually caused by either a direct blow or a forceful flexion of the knee while the muscle is contracted [12]. Spontaneous rupture of the quadriceps tendon is uncommon but has been reported in association with a number of chronic disease states, including systemic lupus erythematosis [10, 16], chronic renal failure [7], rheumatoid arthritis [9], gout [6], and steroid therapy [4]. The condition has also been reported in healthy individuals [13–15]. Rupture of the quadriceps tendon is usually a clinical diagnosis suggested by a palpable gap or sulcus above the patella, hemarthrosis, and inability to extend the knee with unhampered flexion [11–12]. Knee pain and severe hematoma accompanying the acute injury may at times preclude an accurate physical examination. Although the usefulness of magnetic resonance imaging (MRI) in the diagnosis of quadriceps tendon rupture has been reported [2], the presence of a secondary deformity of the patellar tendon suggesting this diagnosis has not previously been emphasized.

Five cases in which injury to the quadriceps tendon mechanism produced wrinkling of the patellar tendon are reported. In four patients findings were demonstrated on MRI. In two patients for whom radiographic examination had been performed, findings were demonstrated on the routine lateral radiograph of the knee. One patient who did not undergo MRI examination showed wrinkling of the patellar tendon on the lateral radiograph of the knee.

To determine the significance of wrinkling of the patellar tendon, 50 consecutive MRI examinations of the knee performed for evaluation of knee pain and instability were reviewed retrospectively. Clinically, none of these patients were thought to have quadriceps tendon rupture. It was determined that a "wrinkled" appearance of the patellar tendon was specific for injury to the quadriceps tendon mechanism; when this sign was present, scrutiny of the extensor mechanism cephalad to the patellar tendon was indicated. This finding has important implications since rupture of the extensor mechanism of the knee often goes undetected. The value of this sign will be demonstrated by examples.

Materials and methods

To determine the normal appearance of the patellar tendon, we retrospectively analyzed sequential MRI examinations of the knee performed between February and April 1990 for patients with knee pain or instability. The examinations were performed on 30 men

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and 20 women 13–61 years of age (mean 31 years). Images were obtained on a Siemens 1.5-T Magneton scanner. The routine imaging protocol consisted of spin echo, sagittal and coronal sequences (field of view 15 cm, slice thickness 4 mm, TE 25/90, TR 2000, 2 repetitions) as well as sagittal, gradient echo images (field of view 15 cm, TE 12, TR 405, 20° flip angle, slice thickness 4 mm, 2 repetitions), and a 3-dimensional acquisition. On the sagittal images, the appearance of the patellar tendon was subjectively graded as straight, mild wave, and wrinkled, as illustrated in Figs. 7, 8, and 1, respectively. An attempt to correlate the MRI appearance with knee pathology was made.

The initial MRI examinations from the two patients who prompted this investigation were performed on a Picker 0.5-T imaging system. In both, surgical exploration and tendon repair confirmed the MRI findings.

Results

Case 1

This 72-year-old man fell and subsequently had recurrent "giving way" of his knee. Physical examination revealed an inability to extend the knee actively. A soft-tissue gap was palpable superior to the patella. Surgical exploration showed a severely attenuated quadriceps tendon just cephalad to its patellar insertion. A complete tear was not identified, and imbrication was performed. Six weeks after surgery the patient reinjured his quadriceps tendon. Routine radiography and MRI examinations were then performed. Figure 1 is a sagittal MR image and a lateral radiograph of the knee in this patient. The MR image shows abnormal signal and contour in the quadriceps tendon. Also noted is a "wrinkled appearance" of the patellar tendon with a caudally displaced patella. Similar, though less graphic, findings are seen on the lateral radiograph.

Case 2

This 51-year-old man twisted his knee while bowling. He developed marked swelling and tenderness about the medial aspect of the knee. His past medical history was significant only for intermittent knee pain of 1.5 years' duration which appeared to worsen and was most noticeable while playing racket sports. Physical examination was difficult to perform but revealed lack of active full extension. An MRI was ordered for further evaluation and demonstrated a wrinkled deformity of the patellar tendon (Fig. 2). Quadriceps tendon rupture was surgically confirmed and repaired.

Case 3

This 61-year-old man slipped on ice, and both knees buckled. Subsequently he was unable to stand. Following physical examination by the emergency room physician, a diagnosis of knee strain was proposed. Treatment included a knee brace and ibuprofin. Two weeks later the patient was still unable to walk. Repeat physical examination revealed a palpable gap superior to the patella, and the patient was unable to extend his knee actively. Surgical exploration demonstrated complete quadriceps tendon rupture on the left side and incomplete quadriceps tendon rupture on the right side. Lateral knee radiographs (Fig. 3) at the time of initial presentation showed wrinkling of the patellar tendons.

Case 4

This 29-year-old, obese woman had a history of knee pain since childhood. At 10 years of age, she underwent soft-tissue realignment of the right patella and then a patellectomy at age 19. An MRI examination was obtained for evaluation of persistent knee pain. Sagittal images showed a corrugated appearance of the patellar tendon. A lateral radiograph confirmed this finding (Fig. 4).

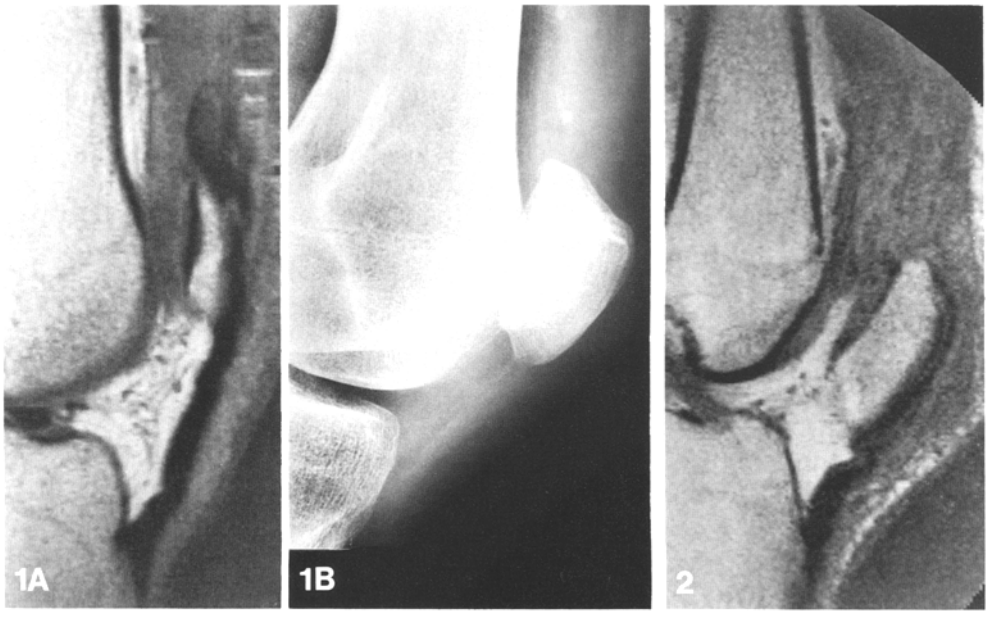


Fig. 1. A T_1-weighted magnetic resonance (MR) image in the sagittal plane demonstrates a "wrinkled appearance" to the patellar tendon indicating quadriceps tendon rupture. **B** Lateral knee radiograph of same patient shows loss of the normal quadriceps tendon outline, suprapatellar calcification, and a "wrinkled" appearance to the patellar tendon

Fig. 2. T_2-weighted sagittal MR image in a patient with quadriceps tendon rupture. There is disruption of the contour of the quadriceps tendon with areas of abnormally high signal. Patellar tendon has a corrugated appearance

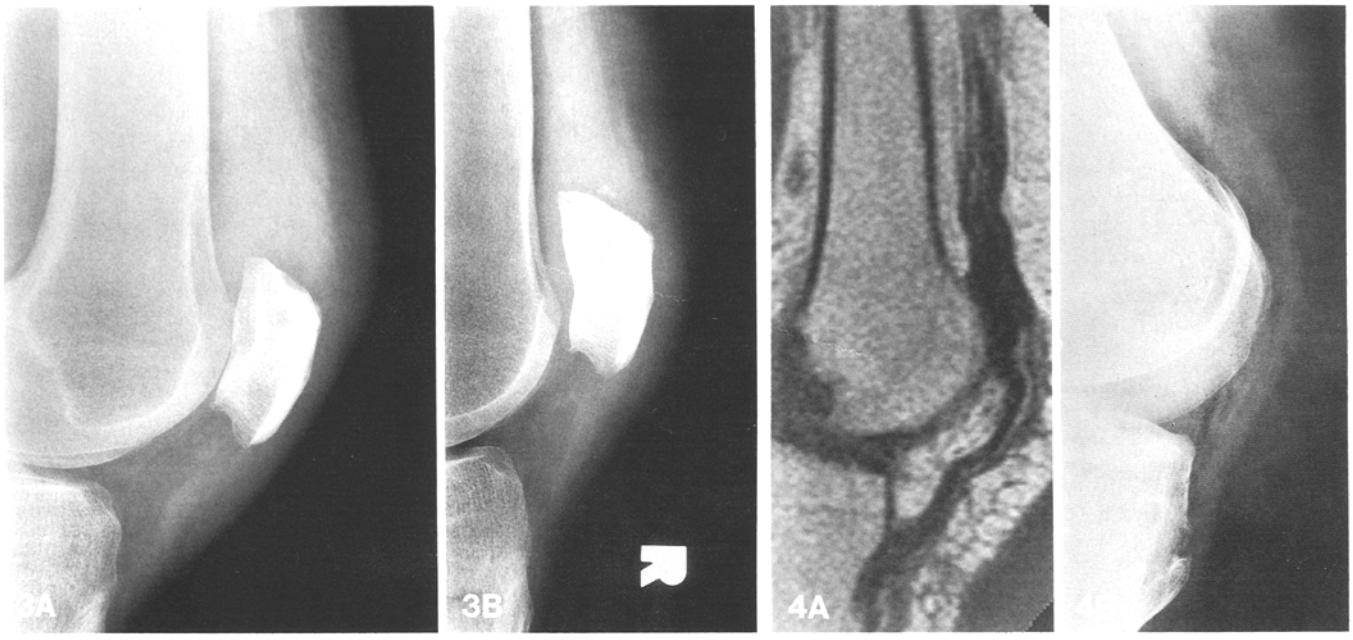


Fig. 3. A Lateral radiograph of the left knee in a patient with complete quadriceps tendon rupture. There is abnormal thickening in the region of the quadriceps tendon with blurring of the surrounding fat planes and a "wrinkled" appearance to the patellar tendon. **B** Lateral radiograph of same patient's right knee which was surgically confirmed as incomplete quadriceps tendon rupture. Similar radiographic findings are present, although less marked than shown, on the left side

Fig. 4. A Sagittal MR image in a patient following patellectomy. Patellar tendon has a "wrinkled" appearance. **B** Lateral knee radiograph of same patient also demonstrates a "wrinkled" appearance of the patellar tendon

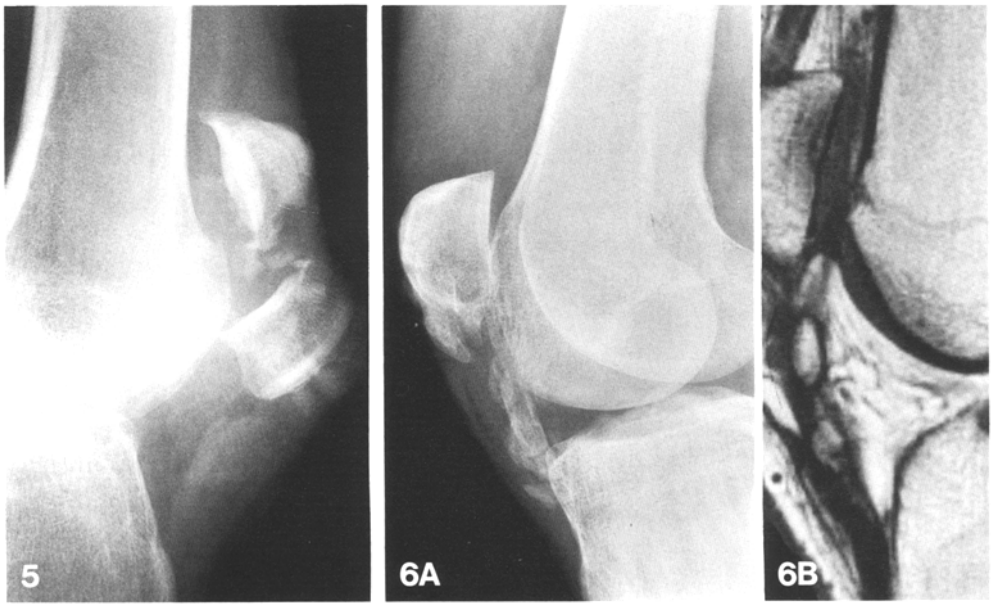


Fig. 5. Lateral radiograph of the knee in a patient with a transverse patellar fracture. Patellar tendon has a "wrinkled" appearance

Fig. 6. A Lateral knee radiograph in a patient with a previous fracture of the inferior pole of the patella who had undergone patellar tendon reconstruction. Calcification and ossification are identified in the patellar tendon which also has a corrugated contour. **B** Sagittal MR image in same patient shows regions of high signal intensity surrounded by rings of signal void within the patellar tendon corresponding to regions of ossification. The tendon also has a corrugated contour

Case 5

This 54-year-old, previously healthy man was involved in a high speed motor vehicle accident. He sustained multiple injuries including transverse patellar fracture (Fig. 5). An MRI examination in the sagittal plane showed a wrinkled deformity of the patellar tendon.

Table 1 summarizes the findings of a retrospective review of 50 MRI examinations of the knee. A frankly "wrinkled" patellar tendon was identified on MRI and radiographic examination in only 1 patient (Fig. 6). The patient was a 29-year-old man who had sustained a comminuted fracture of the lower one-third of his patella approximately 2 years prior to the imaging studies. At

Table 1. Summary of review data of MRI examinations of the knee

	Patellar tendon appearance[b]		
	Straight	Mild wave	Wrinkled
Meniscal tear	14	4	1[c]
Cruciate tear	2	1	
Collateral ligament injury	1		
Joint effusion	9	2	
Normal miscellaneous findings[a]	22		

[a] Includes meniscal degeneration, popliteal cysts, plica, osseous lesions
[b] $n = 50$ patients; each abnormality was tabulated individually for patients with multiple abnormal findings
[c] See Fig. 6

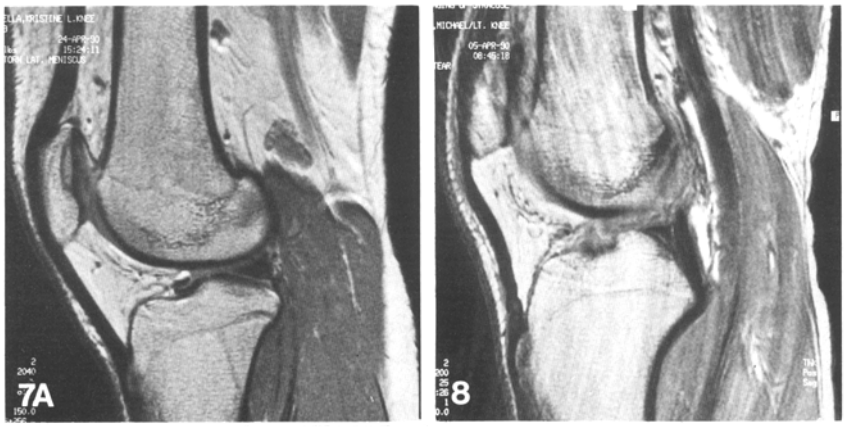
the time of injury, the distal pole of the patella was resected, and the patellar tendon was reconstructed. MRI examination also demonstrated a tear of the posterior horn of the medical meniscus.

Of the remaining 49 patellar tendons, 5 had a very mild wave and 44 were straight. None of the patients with a "mild wave" finding had an otherwise normal examination result. Four of these patients had meniscal abnormalities and one patient, additionally, had a concurrent anterior cruciate ligament tear; the remaining patient had a joint effusion but no other identified pathology. Figure 7 is a sagittal MR image and a lateral radiograph of the knee in a patient with knee pain but no identified pathology. It is noted on both images that the patellar tendon is normally straight. Figure 8 compares the appearance of a tendon rated as "mild wave" with one noted as "straight."

Discussion

Rupture of the quadriceps tendon is an uncommon injury which often goes clinically undetected. Of the 17 patients reported by Ramsey and Muller, 7 (41%) had a delay in diagnosis ranging from 14 days to 1 year after the injury because the condition was not recognized by the examining physician [11]. Various explanations have been proposed as to why this diagnosis is so frequently overlooked clinically. These include pain, limitation of motion, and severe suprapatellar hematoma [2, 11].

MRI, arthrography, conventional radiography, and sonography have all been found useful in the diagnosis



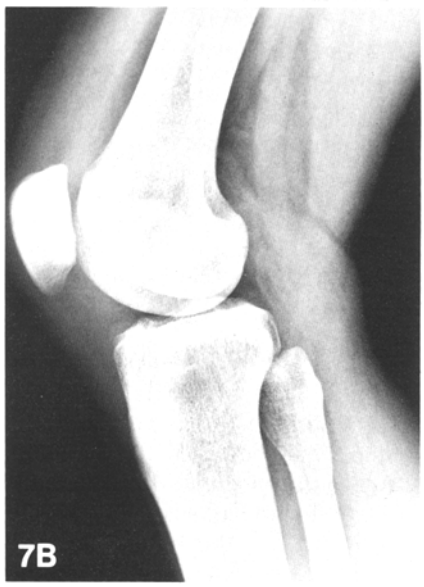


Fig. 7. A Sagittal MR image in a patient with knee pain but no documented pathology. Patellar tendon is normally straight. **B** Lateral knee radiograph in same patient shows a straight patellar tendon

Fig. 8. Sagittal MR image in a patient with anterior cruciate ligament tear. Patellar tendon has a "mild wave" contour

of quadriceps tendon rupture [1, 2, 5, 8]. Because of its superior contrast resolution MRI exquisitely defines this injury. Due to their low mobile proton content, normal tendons appear to have a low signal on all conventional spin echo sequences, thereby yielding excellent contrast to the adjacent high signal of normal fat [3]. In a case report by Barasch et al., the MRI findings on T_1-weighted sagittal images were summarized as a stellate area of high signal intensity in the quadriceps tendon just above the superior portion of the patella, thickening of the quadriceps tendon, a forward patellar tilt, and a retracted patellar tendon [2]. Our cases of quadriceps tendon rupture confirm these findings. Of particular interest is the "wrinkled appearance" of the patellar tendon demonstrated, but not commented on, in their figures. This finding is also present in the case report of Newberg and Wales [8]. Sagittal MR images in a patient following patellectomy and lateral radiographs of a patient with a transverse fracture of the patella also demonstrate a corrugated appearance to the patellar tendon. In 49 of 50 sagittal MRI examinations of the knee performed for pain or instability, the patellar tendon was straight or nearly straight.

Our experience suggests that a wrinkled appearance of the patellar tendon, seen on either MRI or plain film examination of the knee, demands careful evaluation of the extensor mechanisms of the knee cephalad to the patellar tendon.

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