The case:

A 56-year-old man was suddenly unable to extend his leg. Radiographs and magnetic resonance imaging were obtained (Figures 1 and 2).

Figure 1: Lateral knee radiograph. Figure 2: Sagittal T1-weighted MRI.

Your diagnosis?

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Diagnosis: Quadriceps Tendon Rupture

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BACKGROUND

Quadriceps rupture is debilitating, resulting in the inability to extend the knee, which is essential for ambulation. Most quadriceps tendon ruptures occur in patients aged >40 years, in contrast to patellar tendon ruptures, which usually occur in patients aged <40 years. The rupture may occur spontaneously or following total knee arthroplasty, but usually is associated with systemic diseases including chronic renal failure, diabetes, rheumatoid arthritis, hyperparathyroidism, systemic lupus erythematosus, gout, amyloidosis, repeated (usually steroid) injections into the quadriceps tendon, or obesity.1 In young individuals, although rare, spontaneous quadriceps tendon rupture occurs in otherwise healthy young athletes, usually as a result of direct trauma. Most quadriceps tendon ruptures are unilateral, occurring 15-20 times more commonly than bilateral tears.2

A diagnostic triad—pain, inability to actively extend the leg, and a palpable suprapatel lar gap—has been described. However, clinical presentation is variable, and misdiagnosis is common.3 Patients usually present because of knee pain after a fall or with a history of acute knee pain preceding a fall.

Most quadriceps tendon ruptures occur within 2 cm of the superior pole of the patella.4,5 Tears originate in the central anterior portion of the tendon and may extend medially or laterally into the retinacula.6 If a complete tear is

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Figure 1: Lateral radiograph shows abnormal density adjacent to the superior pole of the patella with irregular, poorly defined margins of the quadriceps tendon. Patellar position is minimally low. Figure 2: Sagittal T1-weighted MRI reveals complete disruption of the quadriceps tendon at the patellar attachment. Fluid in the knee tracks into the gap and anterior to the patella.
present, active extension of the leg is not possible. Pain, however, may limit motion and examination. Knee joint effusion may be present, which can further limit the physical examination, and swelling and hematoma may mask the tendon defect. Imaging is useful to distinguish partial from complete tears as treatment of these injuries is different.

**IMAGING**

**Radiographs**

The diagnosis of a quadriceps tendon rupture on radiographs is difficult, as most of the radiographic findings are shown on the lateral view. Several well-described signs of quadriceps rupture on radiographs include hemarthrosis, blurring of the quadriceps tendon margins, suprapatellar mass with calcification (an avulsed fragment of the patella or sequela of prior degenerative disease of the tendon), low patellar position (patella baja or infra), and an undulating, or lax, patellar tendon (Figure 3). Chronic, recurrent tendinopathy is occasionally visualized as a jagged superior pole of the patella. This has been described as the “tooth” sign.

**Arthrography**

Given the advances in MRI and ultrasound, arthrography is rarely performed as a diagnostic test. However, it can distinguish partial from complete ruptures of the quadriceps tendon. Contrast extending outside the quadriceps tendon or into the soft tissues anterior to the patella, sometimes filling the pre- or infrapatellar bursae, is diagnostic of complete tendon rupture.

**Ultrasound**

Due to the superficial position of the quadriceps tendon, ultrasonography is highly sensitive for diagnosing partial and complete tendon ruptures. In a study of 12 quadriceps tendon ruptures, ultrasound was able to demonstrate all 12 partial (focal hypoechoic defect) and complete (complete disruption of the tendon fibers) tears. These findings were confirmed in 5 cases that went to surgery, including 4 complete ruptures and 1 partial rupture. In this study, the sensitivity and specificity were 100% for complete ruptures.

The normal quadriceps tendon is 6- to 11-mm thick and has homogenous echotexture with groups of linearly oriented echoes extending the length of the tendon. Myxoid degeneration with loss of the normal linear array and echogenic nonshadowing foci of calcium are common findings in tendinopathy (Figures 4 and 5). Focal discontinuity is seen in tears, which can be partial or full width.

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**MRI**

Magnetic resonance imaging is routinely used for presurgical evaluation of quadriceps tendon ruptures given its high accuracy in the detection and localization of the injury site. The normal quadriceps tendon has a laminated...
appearance with up to four separate layers, but most tendons are composed of only two or three distinct layers. Normally, the quadriceps tendon demonstrates low-signal intensity with all sequences (Figure 6). The average thickness in the normal anteroposterior direction is 6-10 mm with an average width of 28-42 mm. Thin bands of fat can occasionally be visualized separating the tendons above their final junction on T1-weighted sagittal images.

The superior image resolution and multiplanar imaging capabilities of MRI allow for accurate localization of a rupture and discrimination between partial and complete tears, as well as tendinopathy. Magnetic resonance imaging in tendinopathy shows focal increase diameter of the tendon, usually near the patellar insertion. An abnormal intermediate intrasubstance signal is present (Figure 7). Occasionally, a high-T2 signal, cystic inclusion may be noted. Focal signal void related to calcification can be difficult to discern.

Discontinuity of a portion of the tendinous layers indicates a partial tear. Partial tears show abnormal high-signal intensity within the substance of the tendon on all sequences, but intact fibers can be visualized coursing through or around the high signal (Figure 8). With a complete tear, a high signal intensity is noted within and adjacent to the tendon and no intact fibers can be seen on T2-weighted and short time inversion recovery images (Figure 9). The proxi-
mal portion of the tendon may have a wavy appearance and is frequently retracted with the patella tilted anteriorly. Almost all partial and complete tendon ruptures are associated with a joint effusion.\(^{14}\)

**TREATMENT**

Treatment of complete and partial quadriceps tendon ruptures differs. Incomplete tears usually are treated nonsurgically with the leg immobilized in complete extension for 6 weeks. After 6 weeks, strengthening exercises with protected range of motion are initiated. The immobilization is gradually discontinued as quadriceps muscle control and strength return. Joint effusions are treated aggressively as they have been shown to decrease muscle strength.\(^{15}\)

Complete ruptures require surgical repair, although the optimal timing of surgery is debatable. Early intervention is recommended because the tendon begins to retract within 72 hours.\(^{16}\) Generally, outcome is optimized when surgery is performed within 2 days to 2 weeks following injury.\(^{3,5}\) Various operative techniques have been described, including mattress stitching of reapproximated edges, suturing the tendon through holes drilled into the patella, and tendon lengthening procedures such as a Z-plasty or V-Y technique.

**SUMMARY**

Quadriceps tendon ruptures usually occur in people aged \(>40\) years who have underlying medical conditions. The injury is disabling and outcome is optimized with early management. The classic clinical symptoms may not be present, in which case radiographs, ultrasound, and MRI often are essential for early diagnosis.  

**REFERENCES**