

# Soft tissue extensor mechanism tendon ruptures of the knee

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## Abstract

Ruptures of the extensor mechanism of the knee are serious injuries requiring prompt diagnosis and treatment. They can be divided into soft tissue and bony causes. Soft tissue tendon injuries can be either partial or complete. Rupture of the quadriceps tendon is an uncommon injury and is more frequent in patients over the age of 40 years. Patella tendon ruptures are even rarer and are more frequent in patients under the age of 40 years. Causes can be direct or indirect. Complete ruptures of the quadriceps tendon or patella tendon benefit from early surgical management, while partial ruptures may be managed non-operatively. This article gives an overview of the presentation, assessment and management of soft tissue extensor mechanism tendon ruptures for core surgical, acute care common stem and emergency medicine trainees.

**Key words:** Extensor mechanism; Knee; Patella tendon; Quadriceps tendon; Surgery; Tendon

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## Introduction

Ruptures of the extensor mechanism of the knee are serious injuries requiring prompt diagnosis and treatment. The extensor mechanism of the knee consists of the quadriceps muscles and tendon, patella, patella retinaculum, patella tendon and adjacent soft tissues. It inserts onto the superior aspect of the patella.

Disruption of the extensor mechanism can be divided into bony and soft tissue causes and can be a result of direct or indirect trauma. Bony disruption, consisting of patella fractures, is the most common, up to six times more likely than soft tissue causes (Saragaglia et al, 2013). Soft tissue causes can be either quadriceps or patella tendon injury.

The first written description of an extensor mechanism injury (quadriceps tendon rupture) is credited to the Roman physician Galen, who described it in a young wrestler. The athlete was unable to extend his knee and had difficulty walking on inclined surfaces, even after a prolonged recovery.

Quadriceps tendon rupture is uncommon, with the incidence of complete rupture 1.37/100 000 per year (Clayton and Court-Brown, 2008). Ruptures are more common in patients over the age of 40 years and are significantly more frequent in men, with a ratio of 4–8:1 (Clayton and Court-Brown, 2008).

Most quadriceps tendon ruptures are unilateral and are indirect (occurring spontaneously). They may also be direct as a result of trauma, occurring with eccentric loading of a slightly bent knee on a planted foot.

Patella tendon ruptures are even rarer and tend to be seen in active, predominantly male patients, younger than 40 years old. The incidence of patella tendon rupture is 0.68/100 000 (Serino et al, 2017). They may be caused directly or indirectly – the latter is more frequent when the quadriceps suddenly contracts, with the knee in 60° of flexion.

Bilateral quadriceps tendon ruptures may occur up to 12% of the time (Vidil et al, 2004) and are even rarer in patella tendon ruptures. They are more common in patients with underlying comorbidities, such as renal failure, diabetes, rheumatoid arthritis, hyperparathyroidism or connective tissue disorders. Corticosteroid use and intra-articular injection are also recognised risk factors (Rose and Frassica, 2001; Kim et al, 2006).

Injuries to the soft tissues of the extensor mechanism may be classified according to the extent of rupture, being either complete or partial.

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This article provides an overview of the presentation, assessment and management of ruptures of the soft tissues of the extensor mechanism for core surgical, acute care common stem and emergency medicine trainees.

## Anatomy and biomechanics

The quadriceps is the main extensor of the knee and the tendon connects to four muscles which coalesce; the rectus femoris, vastus intermedius, vastus lateralis and vastus medialis. The tendon is arranged in a trilaminar structure with three layers: the superficial layer consists of rectus femoris tendon, the medial layer the vastus medialis and lateralis tendons and the deep layer the vastus intermedius tendon.

The quadriceps tendon inserts onto the superior aspect of the patella and the medial and lateral portions of the tendon pass down on either side of the patella and contribute to the medial and lateral retinacula and capsule (Andrikoula et al, 2006). This contributes to the medial and lateral stability of the patella.

The patellar tendon (called a tendon because the patella is a sesamoid bone) is a continuation of the quadriceps tendon. It originates at the superior pole of the patella, passing over the inferior pole distally to insert onto the anterior aspect of the tibial tuberosity.

The pre-patellar fascia also forms part of the extensor mechanism and is therefore involved in knee extension. It is formed from the expansion of the vasti and fascia lata as they pass anteriorly over the patella.

## Pathoanatomy

The quadriceps tendon and patella tendon undergo degenerative change with ageing, which may make the tendon more susceptible to injury in older patients. Fatty degenerative changes and tendinosis are more prevalent in older patients with extensor mechanism rupture (Kannus and Józsa, 1991).

Quadriceps tendon rupture most commonly occurs in the central portion of the tendon between 1 and 2 cm superior to the patella, which corresponds to the avascular region. In older patients, ruptures are more frequent at the osseotendinous junction at the superior pole of the patella (Pengas et al, 2016).

The patella tendon most commonly ruptures from its proximal origin at the inferior pole of the patella where there is a corresponding area of avascularity and is commonly associated with patella fractures (Pengas et al, 2016). It may also rupture in the tendon midsubstance and at the tibial tubercle.

In addition, as with other tendons, the quadriceps tendon and patella tendon are susceptible to tendinopathy with overuse, which can cause inflammation and lead to microscopic tears within the tendon.

## Clinical presentation

Patients usually present with a history of a sudden, tearing or popping sensation in the thigh above the knee during activity or following a direct blow to the tendon or knee. Most patients are subsequently unable to get up or walk. There may be a prior history of mild pain to the region or the knee.

A clinical triad of acute pain, together with an acute loss of knee extension and a palpable gap within the tendon 2 cm above the patella on examination, is highly suggestive of quadriceps tendon rupture (Ni Fhoghlu et al, 2015). In patella tendon ruptures, a palpable gap may be felt distal to the patella, along with acute knee pain and loss of knee extension.

On palpation, the site of injury is swollen, bruised and tender. There is usually a palpable discontinuity within the tendon, the patella may be more mobile than usual, and there is a haemarthrosis within the knee joint.

The inability to straight leg raise or extend the knee actively from 90° of flexion is pathognomonic of discontinuity of the extensor mechanism. Less commonly, if the rupture involves only the tendon and most of the retinacular fibres remain intact, some extension will be possible. A false positive finding is possible, where contraction of the sartorius

Table 1. Key clinical history and examination findings of extensor mechanism injuries		
Diagnosis	History	Clinical examination
Tendinosis	Gradual onset of pain on activity, symptoms may be chronic over a period of time, improves with rest	<ul style="list-style-type: none"> <li>■ Localised swelling and tenderness</li> <li>■ Otherwise normal findings</li> </ul>
Partial rupture	Acute onset of pain, relatively minor trauma	<ul style="list-style-type: none"> <li>■ Patient able to extend knee</li> <li>■ Tenderness on palpation of tendon</li> </ul>
Complete rupture	Acute onset of pain, relatively minor trauma, may be unable to walk	<ul style="list-style-type: none"> <li>■ Patient unable to extend knee</li> <li>■ Palpable defect in tendon</li> </ul>
Patella fracture	Direct trauma to knee or associated with extensor mechanism injury, may be unable to walk, severe pain	<ul style="list-style-type: none"> <li>■ Palpable patella defect</li> <li>■ Significant haemarthrosis of knee</li> <li>■ Patient unable to extend knee if associated extensor mechanism injury</li> </ul>

muscle when the hip is internally rotated may permit a straight leg raise to be performed in the presence of a rupture (Matava, 1996) (Table 1).

## Imaging

Anteroposterior (Figure 1) and lateral (Figure 2) radiographs of the knee should be taken whenever there is concern regarding injury to the extensor mechanism. They help with the diagnosis of patellar fractures and permit measurements to be taken to determine tendon ruptures in the knee.

Radiographic features specific to quadriceps tendon rupture may include inferior displacement of the patella (known as patella baja), obliteration of quadriceps tendon, poorly defined suprapatellar mass, suprapatellar calcific densities, anterior superior patellar



**Figure 1.** Preoperative antero-posterior radiograph of quadriceps rupture. Inferior displacement of the patella (patella baja) is present, as well as soft tissue swelling (likely a joint effusion). The patella tendon appears as a wavy line as there is no tension because of the disruption of the quadriceps tendon.



**Figure 2.** Preoperative lateral radiograph of acute quadriceps tendon rupture.

spur at the quadriceps tendon insertion and joint effusion (Kaneko et al, 1994). In patella tendon rupture, there may be superior displacement of the patella (patella alta) as well as obliteration of the tendon, effusion and degenerative changes (Matava, 1996). Patella baja and alta are visible on the lateral radiograph.

Additional radiograph views may be considered, including merchant or skyline views to rule out patella dislocation or osteochondral fractures (Matava, 1996).

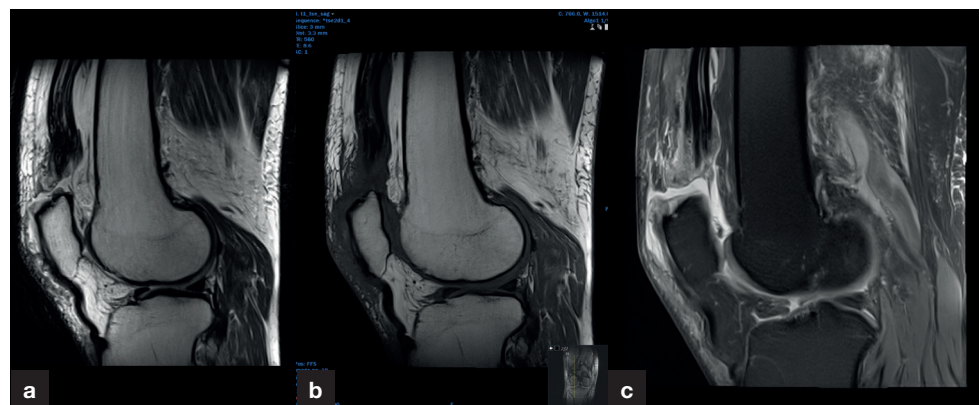
Ultrasonography is more accurate than plain radiography for the diagnosis of rupture of the extensor mechanism. It is inexpensive and dynamic, but it is also operator dependant. Magnetic resonance imaging has improved diagnostic accuracy but is limited by its availability and high cost (Ni Fhoghlu et al, 2015).

Magnetic resonance imaging examination may be helpful in detecting other intra-articular pathology (Figure 3). Perfitt et al (2014) proposed that all suspected patients should either proceed directly to magnetic resonance imaging or be initially assessed by ultrasound, followed by magnetic resonance imaging, to eliminate false positive diagnoses.

### Treatment in the emergency department

The clinical history should include thorough details of the mechanism of the injury, any preceding symptoms, the presence or absence of knee swelling and whether the patient was able to mobilise after the injury (Figure 4).

The patient's comorbidities, the use of therapeutic, recreational and performance activity levels are important for preoperative preparation and postoperative rehabilitation.



**Figure 3.** a. T2-weighted and (b) T1-weighted sagittal magnetic resonance imaging views of the knee showing complete rupture of the distal quadriceps tendon (arrows) and low lying patella with a waxy lax appearance to the patellar tendon. c. Proton density fat-saturated sagittal views show an associated moderately sized suprapatellar joint effusion.

All patients should have their risk of venous thromboembolism assessed preoperatively and be treated accordingly, following local and National Institute for Health and Care Excellence (2018) guidelines.

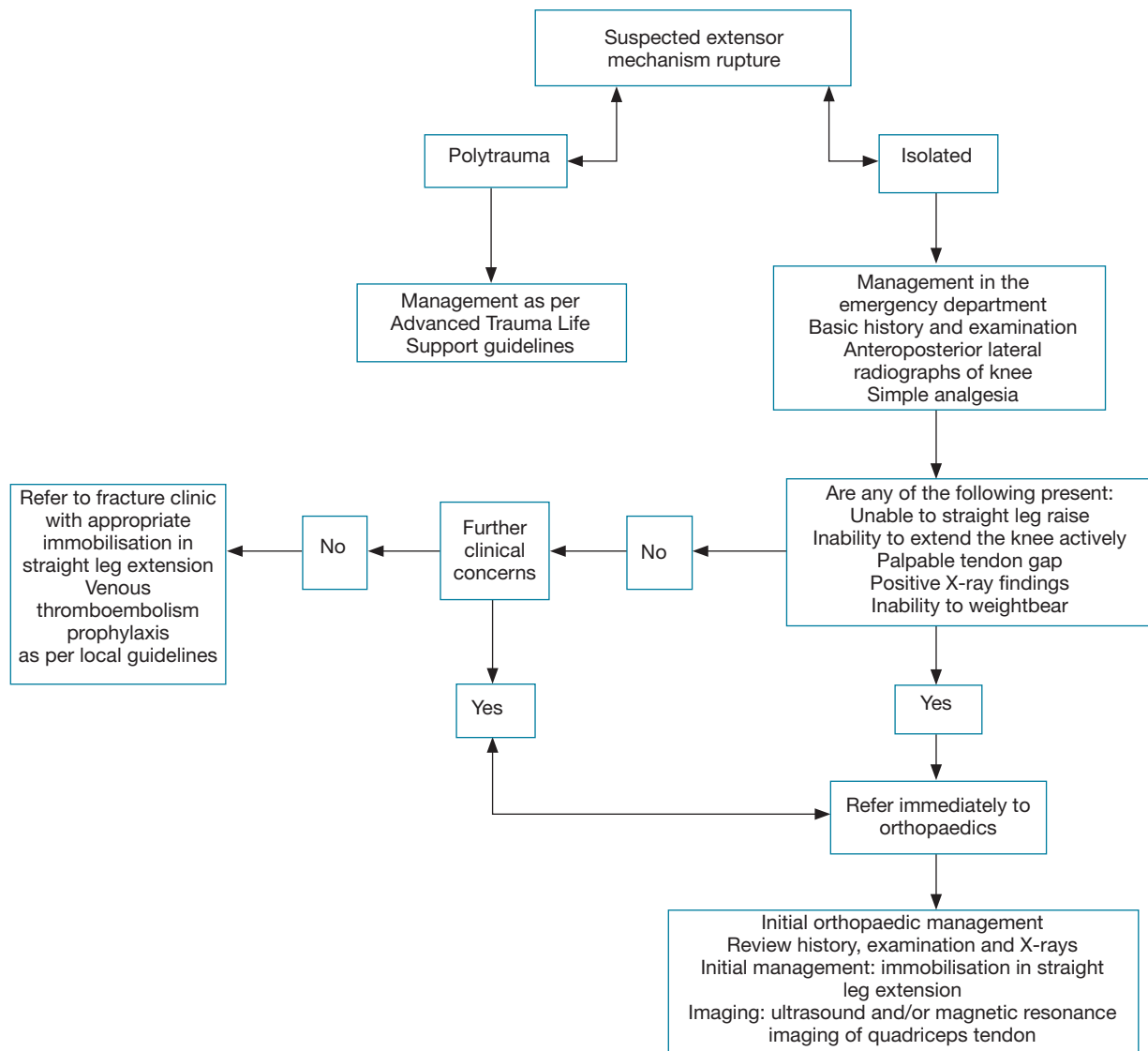
The knee should be examined for the specific signs described above, together with an examination for concurrent ligament injury. A full neurovascular assessment of the affected limb should be carried out and documented. For completeness of examination, the joints below and above the area of injury should also be assessed.

The limb should be immobilised, in either a plaster cast back slab or a knee brace, to hold the knee in extension. A brace permits easy access for outpatient imaging.

Young patients with traumatic tears do not require blood tests. However, an older patient with a low energy tear may require further investigation, including full blood count, urea and electrolyte levels and random blood glucose level. A sickle test should be requested when appropriate.

Once rupture has occurred, injured knees tend not to be too painful, although those managed as outpatients will need analgesics such as paracetamol or mild opiates. Anti-inflammatory medication is not recommended around the time of repair, as this may influence healing. Patients can be mobilised weight bearing using crutches.

Patients need to be counselled regarding the benefits of operative or non-operative management, including risks and operative benefit.



**Figure 4.** Algorithm for the initial assessment and management of rupture of the extensor mechanism in the emergency department.

## Management of complete tear

Once an acute complete tear is diagnosed, it should be managed surgically regardless of age, unless patient factors prohibit operative intervention (Figure 5). Patients over 80 years old have been shown to benefit from surgery (Ramseier et al, 2006). Non-operative management leads to reduced function with weakness (Serino et al, 2017).

Timing of surgery is the most important factor in outcomes of extensor mechanism rupture surgery, rather than reconstructive technique. Earlier surgery is associated with the best functional and patient outcomes (Serino et al, 2017). There remains a lack of consensus on the exact timing of surgery, but most authors agree that surgery after 7 days leads to poorer outcomes (Siwek and Rao, 1981; Ramseier et al, 2006). Further delay may lead to retraction of the ruptured tendon and healing with separation and fibrosis, making apposition difficult and increasing tension along the suture lines.

Many different techniques are reported for the surgical management of ruptures of the extensor mechanism (Figures 6–8). Transosseous patellar drill holes are considered the gold standard for treating ruptures near the patellar poles, whereas mid-tendon tears are more commonly treated with simple end-to-end sutures (Lee et al, 2013). Suture anchors have been trialled as an alternative to patella drill holes. They are less invasive, with smaller skin incisions and a shorter operative time, but there is no clear evidence that they lead to better outcomes (Ibounig and Simons, 2016). Additional tendon augmentation using sutures or cerclage wire is advocated by most authors (Ramseier et al, 2006). Serino et al (2017) suggested that the choice of surgical technique should be based on rupture location and surgeon preference.

Chronic tears can be reconstructed, but they are technically more demanding as a result of tendon scarring and retraction and are associated with poorer outcomes compared to acute tears (Serino et al, 2017). Tendon auto or allograft should be considered for augmentation.

Postoperatively, patients tend to be immobilised in extension initially, either in a cylinder cast or range of motion brace. Traditionally this has been for 6 weeks (Boudissa et al, 2014), although there is a trend to mobilise patients earlier. However, Serino et al (2017) found that early mobilisation (before 6 weeks) led to more complications.

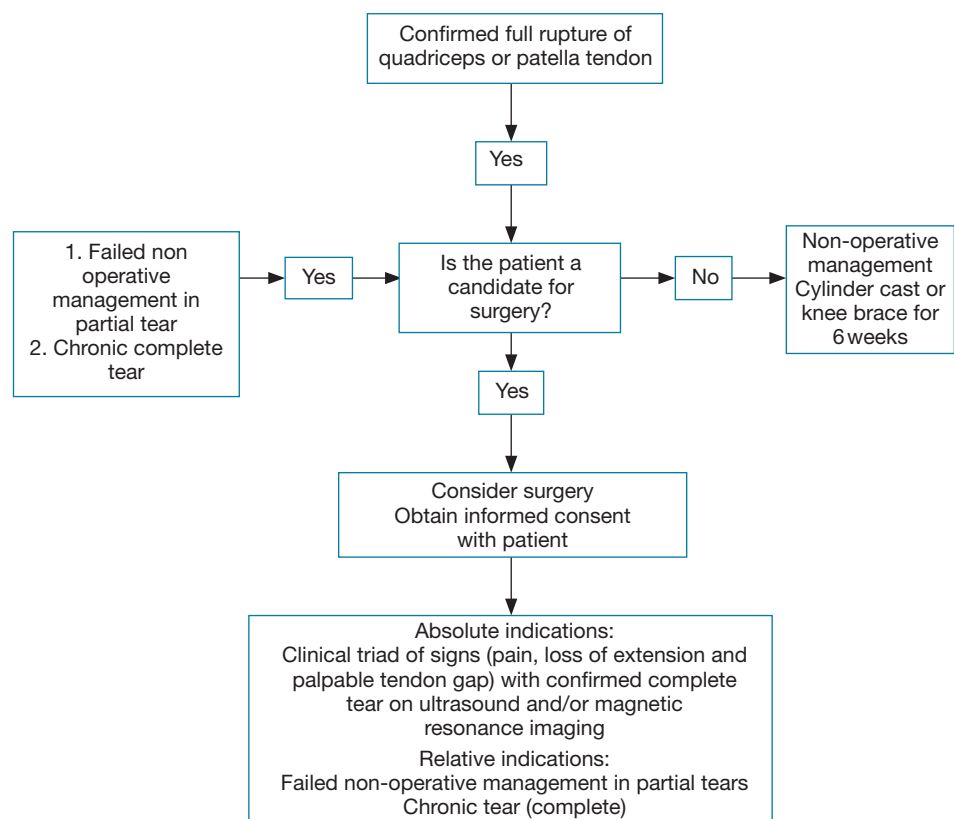
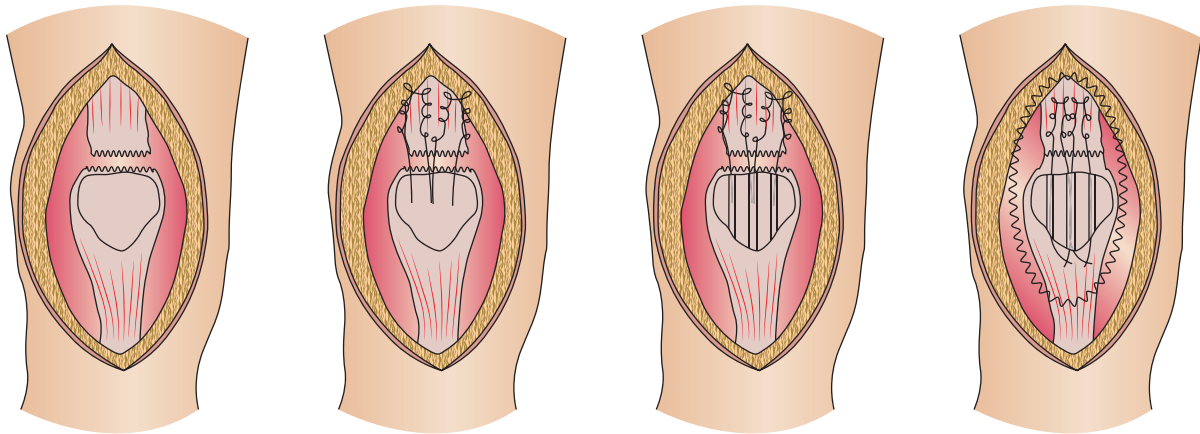
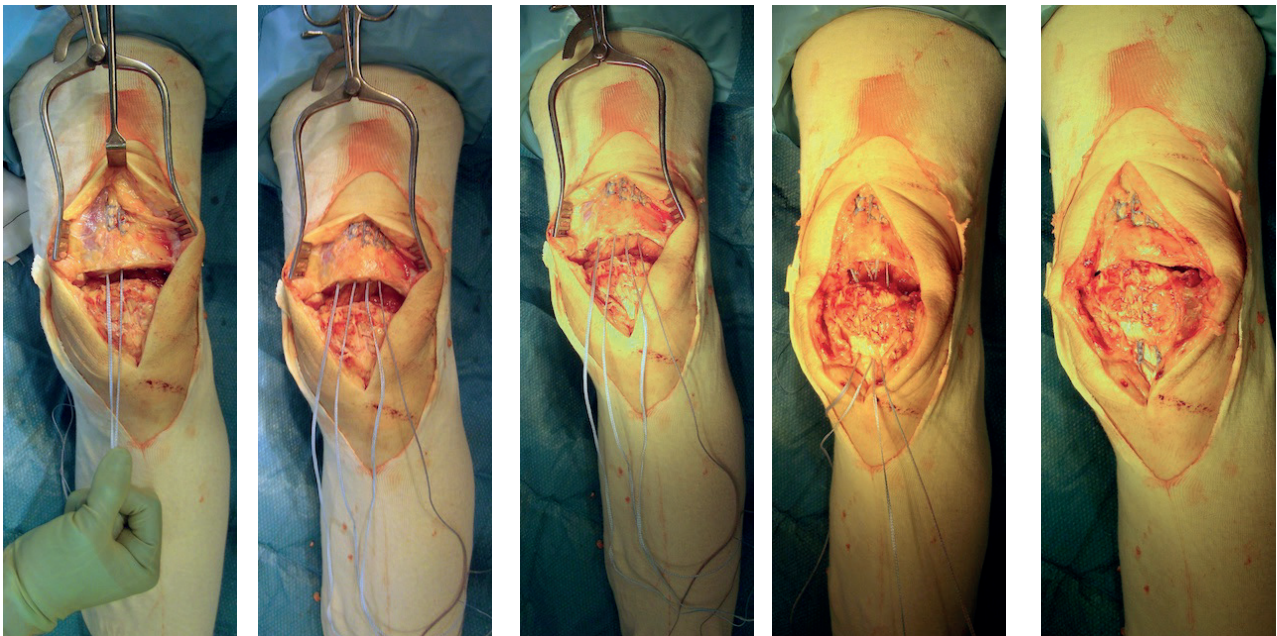


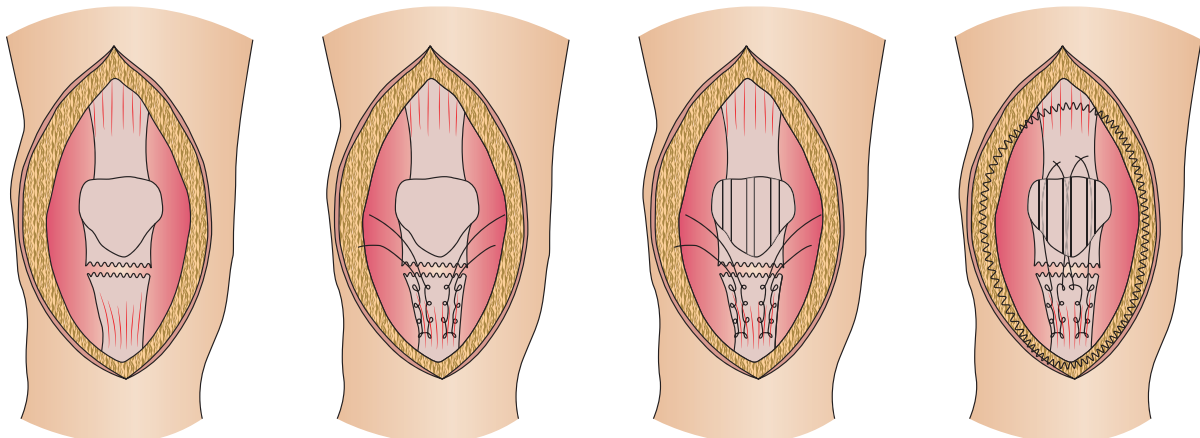
Figure 5. Definitive treatment of rupture of the extensor mechanism.



**Figure 6.** A traditional quadriceps tendon rupture repair using the authors' preferred technique. A Krackow suture technique, tied proximally, and three transosseous patella drill holes and non-absorbable sutures passed through the patella and tied distally. Augmentation with further suturing circumferentially.



**Figure 7.** Operative photos of the authors' preferred operative technique for quadriceps tendon repair as described in [Figure 6](#).



**Figure 8.** A traditional patella tendon rupture repair using the authors' preferred technique. A Krackow suture technique, tied distally, and three transosseous patella drill holes and non-absorbable sutures passed through the patella and tied proximally. Augmentation with further suturing circumferentially.

## Management of partial tear

Partial tears with an intact extensor mechanism are generally managed non-operatively with the leg immobilised in full extension, in a cylinder cast for at least 6 weeks. This is followed by a brace and a period of physiotherapy until active knee extension can be performed without pain or deficit. There is a role for surgery in younger, active patients with ongoing pain and decreased function after a trial of non-operative management (Raatikainen et al, 1994).

## Conclusions

Ruptures of the extensor mechanism are uncommon and require prompt diagnosis through history, clinical examination and appropriate imaging to determine whether the injury is partial or complete, acute or chronic. Complete ruptures of the tendons of the extensor mechanism nearly always require surgical management. There are a multitude of surgical techniques, with no clear evidence of a superior technique. Timing of surgery has a greater effect than technique. Partial ruptures are generally managed non-operatively.

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### Conflicts of interest

The authors declare that they have no conflicts of interest.

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### Key points

- Extensor mechanism tendon rupture is an uncommon but significant and disabling injury.
- Tendon ruptures are either complete or partial.
- Complete ruptures benefit from surgery as early as possible.
- There is no proven advantage of any specific surgical technique in the treatment of ruptures of the extensor mechanism.

## Curriculum checklist

This article covers the following areas from the acute care common stem (ACCS) and core surgical training (CST) curricula:

- Know the anatomy of the axial skeleton and joints (ACCS/CST)
- Common soft tissue injuries to the knee (musculoskeletal trauma) – presentation, management and complications (ACCS/CST)
- Be able to recognise which soft tissue knee injuries (musculoskeletal trauma) need an orthopaedic opinion and those that cannot be treated in the emergency department (ACCS).

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