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REVIEW

Periprosthetic femoral fractures

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Abstract

The incidence of periprosthetic femoral fractures is rising in the UK, because of an ageing population and an increasing number of hip arthroplasty operations being performed. They can occur intra- or postoperatively, and usually follow low energy trauma. They present with pain, swelling over the thigh, and an inability to weight bear. Periprosthetic femoral fractures are usually classified as per the unified classification system. Their management usually is dependent on their classification, with type A (fracture at level of greater or lesser trochanter) managed non-operatively with protected weight bearing, type B (fracture adjacent to implant) managed with either open reduction internal fixation or revision surgery, and type C (fracture distal to implant) managed with open reduction internal fixation. Owing to their complexity, these patients must be adequately optimised before surgery and appropriately rehabilitated.

Key words: Hip fracture; Open reduction and internal fixation; Osteoporosis; Periprosthetic femoral fracture; Revision surgery

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Introduction

Periprosthetic femoral fractures are a post-arthroplasty complication which can occur during surgery or following trauma. Their incidence is rising in the UK because of the increased number of hip replacement surgeries over the last decade, and an ageing population (Frankel et al, 1999). They are an important healthcare problem, and the National Hip Fracture Database (Royal College of Physicians, 2022) has started to collect and publish key performance indicator statistics for UK hospitals based on their care for patients with periprosthetic femoral fractures, with a plan to introduce a best practice tariff for this in future. This will provide a financial incentive for UK hospitals to ensure that patients with periprosthetic femoral fracture are appropriately optimised, with a hope that this improves overall outcomes.

Periprosthetic femoral fractures have challenging reconstructive issues and are associated with considerable patient morbidity (Baryeh and Sochart, 2022). Early identification and understanding of the risk factors are critical for their management. This article describes the epidemiology of periprosthetic femoral fractures, the classification, clinical features, investigations and appropriate management options for these complex patients. It outlines key methods for optimising a patient with a periprosthetic femoral fracture on presentation to hospital, whether via the emergency department or following an inpatient fall.

Epidemiology and risk factors

The incidence of periprosthetic femoral fractures in the USA is around 25.3 per 1000 total hip replacements (Pike et al, 2009). The National Hip Fracture Database recorded 2606 periprosthetic fractures in 2021, 72% of which were associated with the hip (Royal College of Physicians, 2022). Around 80 000 hip replacement surgeries were completed in 2022 in England, having increased from around 64 000 per year in 2009 (Stewart, 2023). As a result, the number of periprosthetic femoral fractures is estimated to increase by at least 4.6% per decade for the next 30 years (Ramavath et al, 2020).

Patients with periprosthetic femoral fractures are 70.6 years of age on average, with 64% being women, in part because women have a higher rate of osteoporosis and undergo more arthroplasties (Baryeh and Sochart, 2022). Any condition that impairs muscle strength, vision and balance will increase the risk of falls (Foran and Sheth, 2023). In the ageing UK population, increasing levels of frailty and numbers of patients experiencing hip fractures may lead to more frail patients with periprosthetic femoral fractures, who will need increasing levels of care.

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Uncemented arthroplasty has a higher incidence of intraoperative periprosthetic femoral fracture (reported 3–18% risk) than cemented arthroplasty (reported 0.1–1% risk) (Tsiridis et al, 2003). This may be why National Institute for Health and Care Excellence (2023) recommends the use of cemented protheses in patients with hip fracture undergoing replacement surgery, especially in patients with osteoporotic bone (Royal College of Physicians, 2022). This is supported by the results of a UK randomised control trial (the WHITE 5 study) which found a significantly lower risk of periprosthetic femoral fracture in patients who had undergone cemented hemiarthroplasty following a hip fracture (Fernandez et al, 2022). However, periprosthetic femoral fractures can still exist around cemented stems, and most cases seen in the UK will likely be related to cemented arthroplasties.

Osteolysis is the progressive destruction of periprosthetic bony tissue, seen on radiographs as radiolucent lines and cavitation at the implant–bone or cement–bone interface (Saleh et al, 2004). It is a major risk factor for periprosthetic femoral fractures as it reduces bone stability and can cause aseptic loosening of the arthroplasty, ultimately leading to a higher fracture risk (Franklin and Malchau, 2007).

Classification

Periprosthetic fractures are traditionally classified as per the unified classification system, a modification of the Vancouver classification (Table 1). The classification considers the fracture site, the quality of the femoral implant and the adequacy of the surrounding femoral bone stock (Masri et al, 2004; Duncan and Haddad, 2014). Figure 1 gives a guide to anatomical landmarks of the femur.

Clinical features

Periprosthetic femoral fractures are usually caused by low energy trauma, such as a fall from standing height (Pike et al, 2009). Patients usually present with pain, swelling or bruising around the hip or thigh, as well as an inability to weight bear (Foran and Sheth, 2023). The patient's leg may also be shortened, rotated or deformed in appearance. Patients may also present with abductor deficiency or compromise to the abductor trochanteric complex, either from detachment of the gluteus tendon or greater trochanter (Thete and Goyal, 2015), which usually manifests itself as a Trendelenburg gait.

Investigations

A thorough clinical evaluation of the patient is required, considering the mechanism of the injury, functional state and medical history, as well as assessing neurovascular status.

Table 1. Unified classification system modification of the Vancouver classification

Classification	Description of fracture	Sub-classification
A	Fractures involving the trochanteric area	A (G): greater trochanter A (L): lesser trochanter
B	Fractures adjacent to femoral implant	B1: well-fixed implant B2: loose implant, good bone stock B3: loose implant, poor bone stock
C	Fracture distal to femoral implant	NA
D	Fracture between two prosthetic implants (hip and knee)	NA
E	Fracture of two bones supporting a prosthesis (tibia and fibular in knee replacement)	NA
F	Fracture of the articular surface of a replacement which was not replaced itself (acetabulum fracture in a hemi-arthroplasty)	NA

From Duncan and Haddad (2014)

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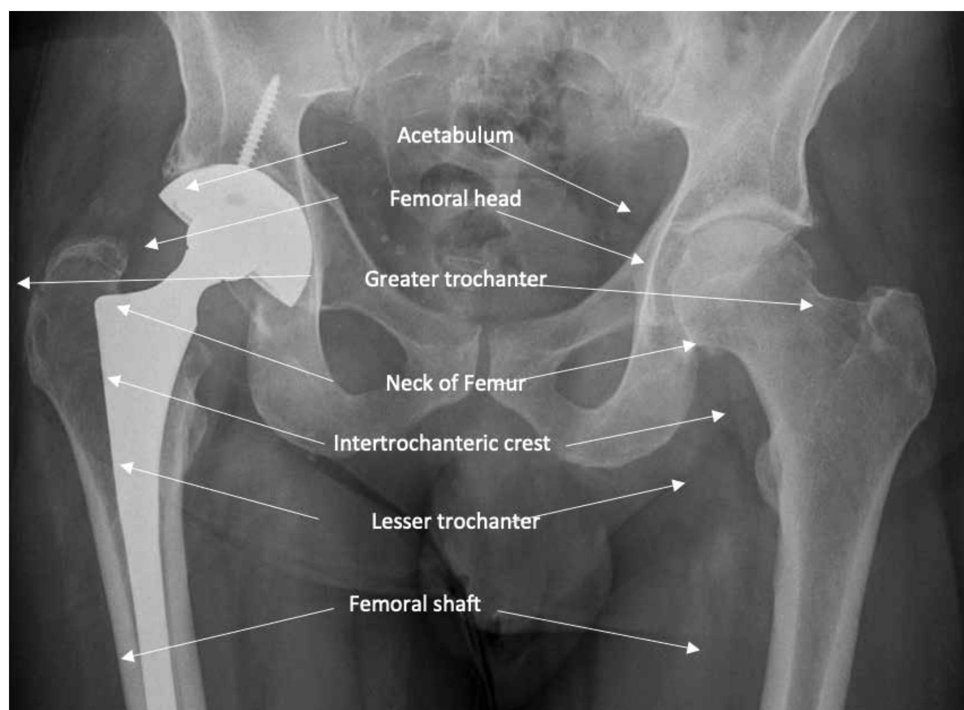

Figure 1. Total hip replacement of right hip, frontal anterior-posterior view (normal).

A secondary survey should be completed for all patients presenting following trauma; this systematic assessment allows evaluation and potential treatment of secondary injuries and can help plan and prioritise management (Zemaitis et al, 2022). It is also important to ask if pain was experienced before any trauma as this may indicate implant loosening, osteolysis or infection. It is useful to ask about the use of bisphosphonates, as this is linked to atypical fractures (Ramavath et al, 2020).

Radiographs are the initial imaging modality required to evaluate suspected periprosthetic femoral fractures (Mushtaq et al, 2019), including anterior-posterior views of the pelvis and orthogonal views of the full-length femur. To confirm the extent of implant fixation, computed tomography can be helpful in detecting osteolysis, debonding and disruption of the cement mantle (Ramavath et al, 2020), and is ideal for evaluating periprosthetic fluid collections or ossified masses, and exact acetabular cup location (Roth et al, 2012). Magnetic resonance imaging is also useful for detecting soft tissue abnormalities such as local tissue reactions in metal-on-metal implants or abductor deficiency (Mushtaq et al, 2019). Vascular imaging may be indicated and should be performed in all cases with intra-pelvic components. Previous images are needed for comparison and to identify any osteolysis or prosthetic loosening. Further blood work is also needed, such as full blood count, urea and electrolytes, group and save and C-reactive protein (Pike et al, 2009), as well as blood iron levels for patients with metal-on-metal bearings. Aspiration may be performed when infection is suspected as it has a very high specificity for diagnosing prosthetic joint infection. However, it should only be performed aseptically, ideally in an operating theatre (Qu et al, 2013).

Management

Initial acute management

The British Hip Society (2021) has published a standard of care for the patient with a periprosthetic femoral fracture. Any patient with a periprosthetic femoral fracture, whether presenting to the emergency department or sustained following an inpatient fall, should have an urgent review by the doctor. A thorough history should be taken surrounding the mechanism of the fall, any previous problems or pain in the affected joint, when the original surgery was performed, comorbidities, allergies, regular medications and social history, such as the patient's living arrangements. The operation note from the original surgery should be obtained to find out which implant was used.

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These patients need adequate pain management. A pain assessment should be done on arrival and paracetamol offered immediately and every 6 hours preoperatively. Their pain should be assessed half an hour after administration of any analgesic, and if there is no improvement, stronger analgesics such as morphine may be used (National Institute for Health and Care Excellence, 2023). Opioid analgesia can have side effects and can have minimal effects on pain severity. Fascia iliac compartment block performed in the emergency department reduced pain in 64% of patients after 4 hours and in 72% of patients after 8 hours without any other pain medication (Groot et al, 2015). Fascia iliac compartment block is safe, efficient, practical, and can be used alongside other analgesics to manage the patient's pain (Groot et al, 2015). These measures can also help when transporting patients to, and around the hospital, as well as allowing better examination of mobility with less pain.

Baseline investigations should be performed including bloods (full blood count, urea and electrolytes, group and save) and a 12-lead electrocardiogram to ensure no anaesthetic delay to surgery. Urgent anterior-posterior and lateral radiographs should be arranged of the pelvis and full-length views of the affected femur.

Patients should be given maintenance fluids over 8 hours in the form of 0.9% saline with added potassium chloride in the presence of hypokalaemia. The patient should be starved for 6 hours before surgery and only drink clear fluid until 2 hours before surgery. Patients should also be given laxatives such as lactulose or senna for bowel preparation. If constipation occurs as a result of opioids, naloxegol may be used. Nutritional supplements may be prescribed to most older patients and to anyone with a MUST (Malnutrition Universal Screening Tool) score over 2 (Blackpool Teaching Hospitals NHS Foundation Trust, 2018).

Patients are at a high risk of venous thrombosis and pulmonary embolism in the perioperative period, so a risk assessment should be carried out on arrival at the emergency department. High-risk patients should be given prophylactic low molecular weight heparin as it can be continued up to 12 hours before surgery and started again 6 hours postoperatively. Compression stockings or mechanical intermittent pneumatic devices such as foot or calf pumps may also be used (Blackpool Teaching Hospitals NHS Foundation Trust, 2018; Shigemoto and Sawaguchi, 2022).

Many older patients take concomitant anticoagulation medication, so this should be reviewed before surgery to assess bleeding and embolism risk (Blackpool Teaching Hospitals NHS Foundation Trust, 2018). Vitamin K can be used as a reversal agent in patients taking warfarin until a normal international normalised ratio is reached. Direct oral anticoagulants have a shorter half-life, so operations with a mild risk of blood loss may be undertaken within 24–36 hours of stopping these drugs. Antiplatelet medications such as aspirin or clopidogrel should be stopped at least a week before surgery to reduce their anticoagulant effect. In an emergency presentation such as a periprosthetic femoral fracture, the risk of delaying surgery outweighs the benefit of waiting to adequately withhold these medications, so careful discussion with the anaesthetic team is required, to allow close monitoring of the patient's bleeding risk (Shigemoto and Sawaguchi, 2022).

Comorbidities that may delay surgery, such as cardiovascular disease, should be identified and optimised. For anaemia, blood transfusion may be indicated if the patient has symptoms or a sudden drop in their haemoglobin level. A group and save cross match of the patient's blood should be done before surgery, with appropriate blood products available during surgery (Blackpool Teaching Hospitals NHS Foundation Trust, 2018). Conditions such as electrolyte imbalance, diabetes, cardiac failure, cardiac arrhythmias and ischaemia should all be optimised before surgery (Shigemoto and Sawaguchi, 2022; National Institute for Health and Care Excellence, 2023).

There should be prompt discussion at rapid access multidisciplinary team meetings to provide a treatment plan within 24 hours of admission. Bone quality, stem stability and fracture configuration should be considered at these meetings (Abdel et al, 2015). For patients who are unfit for surgery and have non-displaced hip fractures, conservative management may be preferred with protected or limited weight bearing and radiographic surveillance (Tsiridis et al, 2003; Cossey et al, 2005). Traction may also be used for such patients with displaced fractures or type A fractures (Mont and Maar, 1994), but this tends to be only used for preoperative pain relief (Tsiridis et al, 2003) and as a last resort because of the risk of prolonged recumbency (Ramavath et al, 2020).

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Table 2. Checklist for management of a patient with a periprosthetic hip fracture
History of condition (may require trauma history)
Examination of hip
Analgesics on admission + every 6 hours (paracetamol→morphine→nerve block)
Bloods: full blood count, urea and electrolytes, group and save
12-lead electrocardiography
Appropriate imaging (anterior-posterior and lateral radiographs of the pelvis and affected femur)
Maintenance fluid over 8 hours
Anticoagulation medication review
Venous thrombosis and pulmonary embolism risk assessment
Starved for 6 hours before surgery (2 hours for clear fluids)
Treat: anaemia, electrolyte imbalances, diabetes, cardiac failure, cardiac arrhythmias and ischaemia
Multidisciplinary team meeting for treatment within 24 hours
Surgery within 72 hours with appropriate surgical kit, performed by experienced surgical team

Where indicated, surgery should be performed within 72 hours (British Hip Society, 2021) in a theatre with teams who are familiar with the required surgical kit, and dual consultant operating if possible. The availability of an intensive therapy unit or high dependency unit bed should be confirmed before surgery if likely to be required postoperatively. All patients with a periprosthetic femoral fracture should have autologous cell salvage available intraoperatively. Whether an open reduction and internal fixation or revision, or combination of both, is performed, the aim should be to allow all patients with periprosthetic femoral fractures to fully weight bear after surgery (British Hip Society, 2021). Table 2 outlines a checklist for the initial management of a patient with a periprosthetic femoral fracture.

Type A fractures

Minimally displaced fractures of the greater trochanter can be treated with protected weight bearing for 6–12 weeks (Figure 2). Displacement of over 2 cm is likely to be associated with increased pain, implant loosening and abductor deficiency (Ramavath et al, 2020). In these instances, fixation methods such as cerclage wire fixation, tension band wiring and greater trochanteric reattachment may be used to reduce and fixate the fracture (Tsiridis et al, 2003; Sun et al, 2017). Comminuted fractures may need a claw plate, although simple fractures can be treated with compression wiring or cabling (Hamadouche et al, 2003).

In most cases the fracture is the result of particle-induced osteolysis, which will need to be managed. This can range from bearing surface exchange with bone grafting along with fixation of the trochanter, to a full acetabular and femoral stem revision. This decision will depend on radiological and intraoperative findings showing the extent of the osteolysis, the component stability and the type of prosthesis (Patsiogiannis et al, 2021).

Type B fractures

For type B1 fractures, where there is a stable stem and an intact cement mantle, open reduction and internal fixation is recommended (Quah et al, 2017), using conventional plates or locking cable-plate and cable-grip systems (Ramavath et al, 2020) (Figure 3). Revision surgery with an uncemented long-stem prosthesis is typically advised in type B2 fractures as the stem is unstable, especially when the cement mantle is insufficient (Quah et al, 2017). As stem stability is best tested in surgery, a fracture suspected to be type B1 may be reclassified to type B2 during surgery, so planning for both possibilities is essential for good outcomes. Type B2 fractures can also be treated with open reduction and internal fixation using locking compression plates, as this reduces operative time and postoperative complications (Joestl et al, 2016; Baum et al, 2019), but larger scale studies are needed to determine if this approach significantly improves patient outcomes.

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Figure 2. a. Anterior-posterior and (b) oblique radiographs demonstrating a fracture of the greater trochanter with no evidence of dislocation or loosening, with adequate bone stock supporting the stem. (This case is likely to be amenable to conservative management.)

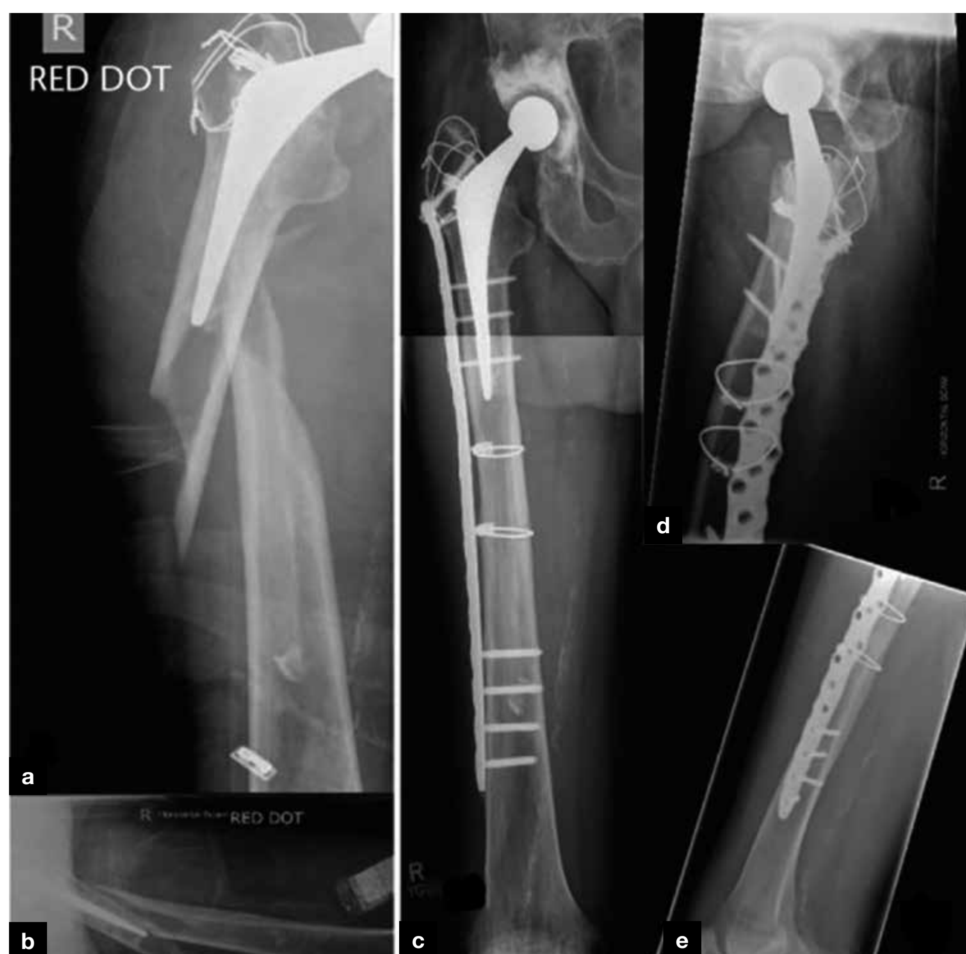

Figure 3. a. Anterior-posterior and (b) lateral views showing a preoperative type B1 femoral fracture, around a stable prosthesis. c–e. Retrospective views of the fracture following the operation, which was done using open reduction and internal fixation using cerclage wires and locking compression plates (Patsiogiannis et al, 2021).

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Cemented stems offer the benefits of local antibiotic delivery, a decreased risk of iatrogenic fracture, and rapid fixing in broad osteoporotic femurs (Ramavath et al, 2020). However, the cement can fuse within the fracture site and hinder osseous healing in cases with large defects suggestive of bone loss. Therefore, an uncemented modular stem that enables bypassing of the fracture site can be used to prevent this (Parvizi and Vegari, 2011). Bone grafting may also be performed in young patients likely to undergo further revision, as good bone stock is important in case reconstruction is needed in future.

Management of type B3 fractures is the most demanding because of the variability in bone loss resulting from osteolysis and fracture comminution, and the potential involvement of the acetabulum which requires separate management. The femur fracture is usually managed by a combination of prosthetic revision, allograft composites or femoral replacement.

Many different stems can be used in revision cases, with cementless tapered stems often used as a result of advances in revision femoral prosthetics (Khan and Kyle, 2019). Coated curved stems or, more commonly, tapered revision stems are typically used. However, selecting the right implant requires extensive preoperative planning, and the surgeon should be familiar with the implant used in order to produce good and reproducible results (Patsiogiannis et al, 2021).

Preoperative templating is essential and helps the surgeon to preserve bone stock within the proximal metaphysis (Patsiogiannis et al, 2021). During surgery, it is necessary to obtain sufficient stem stability distally in the diaphysis; added stability can be obtained by wrapping the soft tissue attachments of the femur around the prosthesis (Khan and Kyle, 2019).

For larger defects, impaction grafting can be used as well as use of allograft prosthetic composites into a proximal femur with severe osteolysis. This yields greater restoration of the bone stock, particular in younger patients (Ramavath et al, 2020; Patsiogiannis et al, 2021).

Proximal femur replacement can be used to treat these fractures, even with its increased risk of infection, dislocation and early loosening. Proximal femoral replacement may be used for older patients with severe bone deficiency and poor mobility, where revision surgery may be less important, as it is typically less demanding for the patient (Parvizi and Vegari, 2011; Ramavath et al, 2020).

Type C fractures

As type C fractures do not involve the stem, management is usually independent of the prosthesis. Internal fixation is recommended to reduce cast duration and allow early mobilisation (Ramavath et al, 2020). Locking plates have a lower reoperation rate (11.8%) than other methods, but conventional plating (26.1%) and retrograde intermedullary nailing (24.2%) are also options (Chatziagorou et al, 2019). If the fixation method extends up the stem of the prosthesis, cerclage cables and unicortical screws should be used (Tsiridis et al, 2003).

In cases where revision surgery is undertaken, maintaining proximal bone and soft tissue attachments where possible leads to better recovery. Antibiotic prophylaxis (flucloxacillin and gentamicin) should be given 6, 12 and 18 hours after surgery to reduce the infection risk (Blackpool Teaching Hospitals NHS Foundation Trust, 2018). All treatment plans should aim to enable complete weight-bearing as soon as possible after surgery, and all cases of periprosthetic femoral fracture should be entered into the National Hip Fracture Database.

Conclusions

Periprosthetic hip fractures can be complex and are increasing in prevalence. Anterior-posterior and lateral radiographs show the fracture most clearly and are used for classification. Computed tomography and magnetic resonance imaging may also be used to determine any further damage. The British Hip Society standard for care for periprosthetic femoral fractures should be followed for all cases. Fractures can be managed conservatively when indicated. The surgical plan for management is determined by the classification of the fracture, with options ranging from open reduction and internal fixation to revision surgery and bone grafting, and partial or total femoral replacement.

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Key points

- Periprosthetic femoral fractures are on the rise in the UK, presenting a significant healthcare challenge.
- Key risk factors for periprosthetic femoral fractures include patient age, female sex, muscle weakness, and conditions like osteoporosis. The choice of cemented or uncemented arthroplasty affects the intraoperative risk.
- The British Hip Society emphasises the importance of rapid evaluation, pain management and optimised preoperative care.
- Timely and thorough investigations, including radiographs, computed tomography and magnetic resonance imaging, aid in accurate diagnosis and planning.
- The unified classification system categorises periprosthetic femoral fractures into types A, B, and C, guiding the approach to their management.

Conflicts of interest
The authors declare that there are no conflicts of interest.

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