

Osteoarthritis and arthroplasty of the hip and knee

Primarily osteoarthritis is a degenerative condition characterized by focal loss of articular hyaline cartilage, inflammation of synovial tissue and accompanying osteophyte formation (Courtney and Doherty, 2014; Clarke et al, 2015). Clinically this manifests as joint pain, stiffness and loss of function. Secondary osteoarthritis is the result of underlying intra-articular disease (Table 1).

Epidemiology

Approximately 10 million people in the UK suffer from symptoms attributable to osteoarthritis; a large proportion of these experience constant pain and disability. It is estimated that osteoarthritis will be the fourth leading cause of disability worldwide by 2020 and currently results in over 36 million lost workdays per year (National Institute for Health and Care Excellence, 2014; Briggs, 2015; Clarke et al, 2015).

Diagnosis

Osteoarthritis may be diagnosed clinically in patients aged 45 years or older, suffering from activity-related joint pain, with or without morning stiffness lasting no longer than 30 minutes (National Institute for Health and Care Excellence, 2014). Hip osteoarthritis can cause hip and/or groin pain, worse on weight-bearing, which may radiate distally to the knee. Knee pain may

Table 1. Risk factors for the development of osteoarthritis

	Primary osteoarthritis	Secondary osteoarthritis
Constitutional	Advanced age Obesity Female sex	Dysplasia Perthes' disease Post trauma Osteonecrosis
Biomechanical	Joint injury Reduced muscle strength	Paget's disease
Genetic	Family history	

From National Institute for Health and Care Excellence (2014)

radiate proximally to the hip, as the nerve root supply is shared (L2–4). Radiographs aid diagnosis, exclude differentials, stage disease and facilitate operative planning. Features include loss of joint space, osteophytes, subchondral sclerosis and subchondral cysts (LOSS mnemonic) (Figure 1).

Table 2. Management of osteoarthritis

Non-pharmacological (conservative)	Patient education
	Weight loss
	Exercise
Pharmacological	Physiotherapy
	Analgesics (non-steroidal anti-inflammatory drugs)
	Topical treatments
Operative	Intra-articular steroid injections
	Joint preserving (arthroscopy, osteotomy)
	Joint obliterating (arthrodesis)
	Joint replacement (arthroplasty)

From National Institute for Health and Care Excellence (2014)

Management

Management of osteoarthritis may be non-operative (non-pharmacological or pharmacological) or operative (Table 2).

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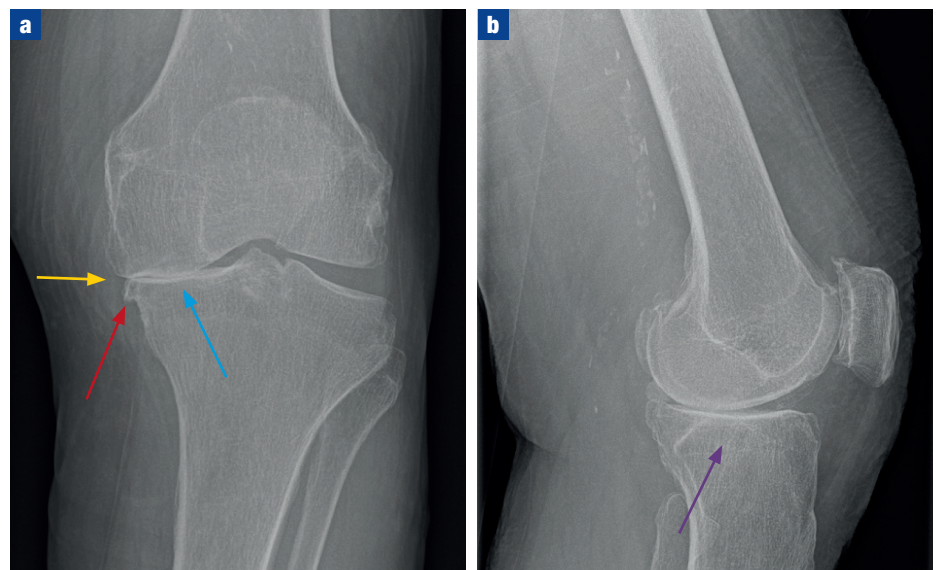


Figure 1. a. Anteroposterior and **(b)** lateral radiograph of left knee showing characteristic radiographic features of osteoarthritis. Yellow arrow: loss of joint space, red arrow: osteophyte, blue arrow: subchondral sclerosis, purple arrow: subchondral cyst.

Table 3. Approaches to the hip joint

Approach	Anterior	Anterolateral	Lateral	Posterior
Eponym	Smith–Petersen	Watson–Jones	Hardinge	Moore or Southern
Position	Supine	Lateral	Lateral or supine	Lateral or prone
Incision	Anterior iliac crest to anterior superior iliac spine, extending distally towards lateral patella	Starting 2.5 cm postero-distally to anterior superior iliac spine, running down femoral shaft, centred on greater tuberosity	Starting 5 cm proximal to tip of greater tuberosity, running distally in line with the femur	Starting 7 cm postero-proximally to the greater tuberosity, running down femoral shaft
Structures at risk	Lateral femoral cutaneous nerve, lateral femoral cutaneous artery	Femoral nerve, artery and vein	Superior gluteal nerve, femoral nerve	Sciatic nerve
Dissection	Superficial: between sartorius and tensor fascia lata	Superficial: between tensor fascia lata and gluteus maximus	Superficial: between tensor fascia lata and gluteus maximus	Superficial: split gluteus maximus
	Deep: between rectus femoris and gluteus maximus	Deep: detach abductor mechanism	Deep: split gluteus maximus and vastus lateralis	Deep: detach piriformis and obturator internus
Advantages	Muscle sparing, low dislocation rate	Low dislocation rate, good acetabulum exposure	Good exposure of the femur	Good exposure of acetabulum and femur
Disadvantages	Limited access to femur and posterior acetabulum	Damage to abductors	Damage to abductors	High dislocation rate

From Petis et al (2015)

Further review of osteoarthritis and non-surgical management can be found elsewhere (Courtney and Doherty, 2014). Patients experiencing symptoms that substantially impact on daily life and are refractory to non-operative treatments should be considered for surgical management (National Institute for Health and Care Excellence, 2014).

Arthroplasty overview

Arthroplasty (Greek, arthron – relating to joints, plastos – formed) involves the surgical remodelling of a joint to restore congruity. The primary aim is to relieve pain, with the secondary aim of improving joint function. Over 200 000 joint replacements are performed annually in the UK, 92% as a result of osteoarthritis (National Joint Registry, 2017). Other indications for arthroplasty include inflammatory arthritis, trauma and developmental abnormalities.

Perioperative management

Clinicians should assess the impact of joint symptoms and exclude other causes of pain, e.g. trauma, bursitis, infection, neuropathy, referred back pain. A thorough history is essential as 72% of patients with osteoarthritis have significant medical comorbidities. Social histories help identify any community support that may be required postoperatively. Physical examination of the

joint may reveal stiffness, loss of motion and crepitus. Neurovascular status of the limb must also be assessed and documented. ‘Joint schools’ are useful in educating patients regarding the surgical pathway.

Anticoagulants and non-steroidal anti-inflammatories should ideally be stopped preoperatively to reduce bleeding risk and avoid acute kidney injury. Active infection (e.g. urine infection, cellulitis) must be treated before surgery.

Nerve blocks, local anaesthetic infusions and spinal anaesthesia are used to reduce pain and enable early mobilization. Mobilization begins as soon as possible postoperatively and the patient is discharged within 24–72 hours. Day case arthroplasty is gaining popularity. Enhanced recovery pathways optimize perioperative wellbeing by reducing the surgical stress response, leading to reduced rates of readmission, complications and length of hospital stay, and improved patient satisfaction (Jones et al, 2014).

Hip arthroplasty

Total hip arthroplasty has evolved significantly since 1891 when Professor Glück used ivory to replace femoral heads damaged by tuberculosis (Knight et al, 2011). Modern total hip arthroplasty began in the 1960s with the Charnley low friction arthroplasty and has been so successful as to be labelled

the operation of the 20th century (Knight et al, 2011). Total hip replacements are now the third most commonly performed operation in the UK. Primary total hip arthroplasty is a highly effective medical intervention with 96% of patients reporting an improvement in symptoms (Jenkins et al, 2013).

Total hip arthroplasty involves replacement of the hip joint with two femoral components (stem and head) that articulate with two acetabular components (shell and liner) (Figure 2).

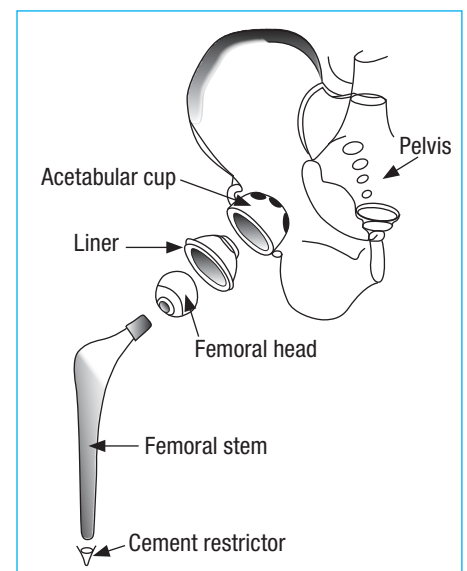


Figure 2. Components of a total hip arthroplasty.

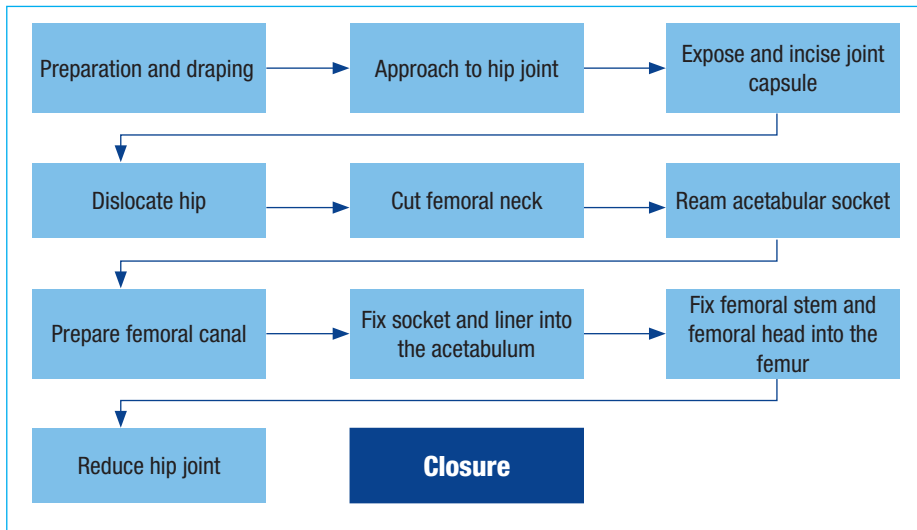


Figure 3. Basic surgical steps for a total hip replacement.

Approach

The best surgical approach to the hip joint remains controversial (Table 3). Internationally the posterior and lateral approaches are most commonly used (Petis et al, 2015). There has been interest in minimally invasive surgery, whereby the incision is less than 10 cm through a direct anterior or direct superior approach, but such approaches have not gained widespread use. The basic surgical steps are shown in Figure 3.

Implant fixation

Prostheses may be cemented, uncemented ('press-fit') or hybrid (cemented stem, uncemented cup). The optimal method for total hip arthroplasty remains controversial. In 2003, 60% of total hip arthroplasties were fully cemented, 16.9% uncemented and 12.3% hybrid compared to 29.6%, 38.5% and 28.1% respectively in 2016 (Briggs, 2015; National Joint Registry, 2017).

Bone cement is polymethylmethacrylate plus additives including radio-opacifiers (barium sulphate), green chlorophyll to distinguish cement from bone and antibiotics (gentamicin or vancomycin). Cement is not adhesive, but rather functions as a grout that interdigitates at the bone-implant interface providing immediate integration. Uncemented prostheses have a porous surface to facilitate osseointegration, which requires biologic fixation by bony ongrowth (Vaishya et al, 2013).

Advantages of cemented total hip arthroplasty include a lower average cost and improved short-term clinical outcomes.

(Abdulkarim et al, 2013; Briggs, 2015). A risk of the cementing process is bone cement implantation syndrome, characterized by hypotension, hypoxia and cardiac arrhythmias. Bone cement implantation syndrome is likely caused by embolization of fat and bone marrow debris. Cement fragments can also cause third body wear and local inflammation, leading to aseptic loosening and pain. Uncemented total hip arthroplasties avoid these limitations, but meta-analyses indicate no significant difference in rates of revision, all-cause mortality or complications. (Abdulkarim et al, 2013; Vaishya et al, 2013; López-López et al, 2017).

Bearing surfaces

Various combinations of bearing surfaces exist (Tables 4 and 5). 'Hard on soft' implants such as ceramic on polyethylene and metal on polyethylene are most commonly used in the UK (32%) (Clarke et al, 2015).

Table 4. Ideal arthroplasty bearing characteristics

Minimal wear
Debris from wear not generating an immune response
Low coefficient of friction
Low rate of dislocation
Mechanically and chemically sound to minimize fractures, scratching
Cost effective

'Hard on hard' implants such as ceramic on ceramic implants are hard wearing with low friction and offer an attractive option for younger patients. However, they are poorly tolerant of implant malposition and fragments may cause third body wear of both new and retained components.

Metal on metal prostheses emerged to try to overcome the issue of polyethylene volumetric wear and dislocation. However, pseudotumour-like tissue reactions (aseptic lymphocytic vasculitis-associated lesions) form as a result of metal ion release following corrosion of the bearing surfaces (Clarke et al, 2015). Aseptic lymphocytic vasculitis-associated lesions result in large areas of tissue destruction and necrosis, associated with poor outcomes even after revision surgery. Systemic toxicity (neuro-ocular, cardiac, thyroid toxicity) as well as increased chromosomal abnormalities was found, primarily as a result of higher serum cobalt levels. Studies indicate higher rates of implant failure, revision and mortality, and their use has fallen to 0.7% (Knight et al, 2011; National Joint Registry, 2017). UK national guidelines for managing patients

Table 5. Comparison of bearing surfaces

Prosthesis	Advantages	Disadvantages
Metal on polyethylene	<ul style="list-style-type: none"> Safe Cost effective Good long-term evidence available 	<ul style="list-style-type: none"> Aseptic loosening
Ceramic on ceramic	<ul style="list-style-type: none"> Low wear Low friction Inert particles 	<ul style="list-style-type: none"> Expensive Require expert insertion Fracture risk Dislocation risk
Metal on metal	<ul style="list-style-type: none"> Low wear Low dislocation rate 	<ul style="list-style-type: none"> Local and systemic toxicity Potentially carcinogenic

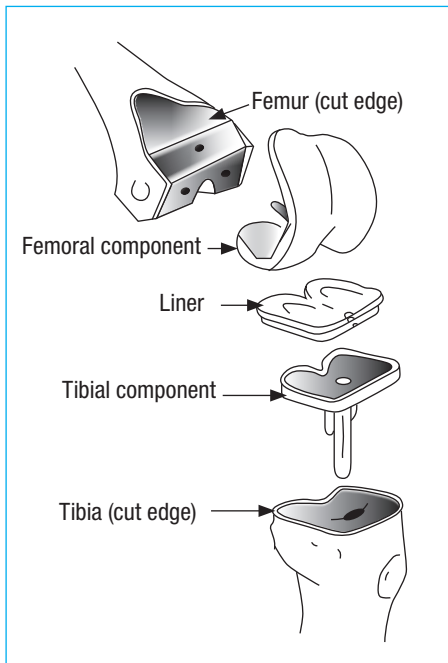


Figure 4. Components of total knee arthroplasty.

with metal on metal implants are available (Medicines and Healthcare products Regulatory Agency, 2017).

Knee arthroplasty

Primary total knee arthroplasty is the second most common joint replacement and the fourth most common surgical procedure performed in the UK (National Joint Registry, 2017). The first knee replacements were developed in the 1970s and implant design continues to evolve. Total knee arthroplasty involves the resection and replacement of the distal femoral and proximal tibial joint surfaces (Figure 4). Unicompartmental knee arthroplasty is available for patients with osteoarthritis limited to one compartment, usually medial. Patellofemoral replacements can be performed in isolation, or through resurfacing the patella with a polyethylene button during total knee arthroplasty. In young patients with unicompartmental osteoarthritis, an osteotomy may be preferable as this alters the mechanical axis of the limb to off-load the painful arthritic part of the joint.

Approach

The medial parapatellar approach is the most common; an anterior midline skin incision, then an incision through the quadriceps tendon that curves around the medial border of the patella. There are additional approaches, termed quadriceps sparing,



Figure 5. Modular knee prosthesis.

which include the subvastus and mid-vastus approaches. Quadriceps sparing approaches aim to preserve the quadriceps strength, enable faster rehabilitation and decrease postoperative pain, but these approaches may increase complications, implant malposition and operative time.

Prosthesis design

There are three key concepts in total knee arthroplasty design: femoral rollback, constraint and modularity. Femoral rollback describes the movement of the point of contact between the tibia and femur, which becomes more posterior as the knee flexes, enabling the knee to flex without impinging,

Constraint refers to the degree of stability the prosthesis provides under flexion–extension and valgus–varus stress. There is a spectrum of constraint: cruciate retaining (least constrained), posterior stabilized, constrained condylar and hinged knee replacement (most constrained). Modularity describes the ability to add augments to the prosthesis to compensate for bone loss. Tibial components are either modular, which have a metal tibial tray with a polyethylene insert (Figure 5), or non-modular consisting of a single polyethylene monobloc. The tibial polyethylene insert can be mobile or fixed within the tibial tray. A mobile bearing allows rotation of the insert on the metal tray, decreasing contact pressure to reduce polyethylene wear.

Implant selection depends on the individual patient, the stability of the knee and degree of bone loss. Similarly to total hip arthroplasty, total knee arthroplasties can be cemented or uncemented (Figure 6). In 2016 62.2% of all primary total knee arthroplasties used cemented fixed bearing cruciate-retaining implants (National Joint Registry, 2017). New designs continue to be developed, offering custom-designed implants, patient-specific instrumentation and computer-navigated knee arthroplasty.

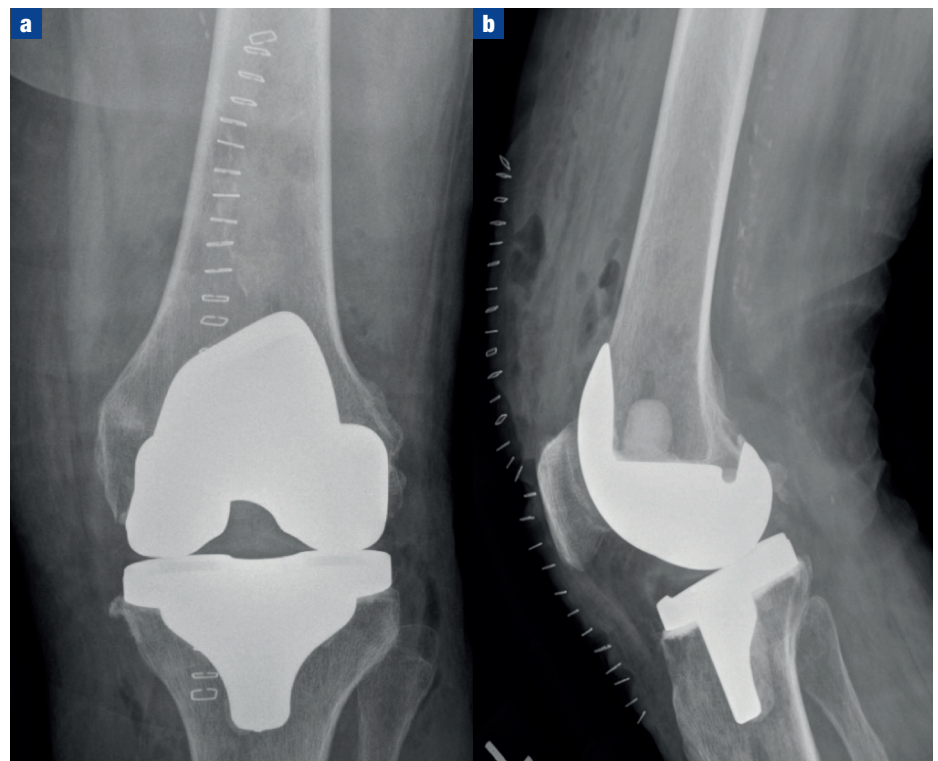


Figure 6. **a.** Postoperative anteroposterior and **(b)** lateral knee radiograph following total knee replacement and skin clips (Stryker Triathlon cemented total knee system).

KEY POINTS

- Osteoarthritis is a degenerative disease of the articulate cartilage which presents clinically with joint pain, stiffness, loss of function and disability.
- Management of osteoarthritis may be non-pharmacological, pharmacological or operative, which usually involves joint replacement.
- Osteoarthritis is the most common indication for arthroplasty with over 200 000 joint replacements performed annually in the UK.
- Total hip arthroplasty is the most commonly undertaken arthroplasty in the UK, and the third most commonly performed operation, with total knee arthroplasty following.
- Implants may be cemented, uncemented or hybrid and can be composed of several different material combinations with metal on polyethylene being used most commonly in the UK.

Complications

General complications

Infection is the most common complication following joint arthroplasty (Table 6) (Berry, 1999). Superficial wound infection is relatively common. Deep infection

Table 6. Complications associated with total hip arthroplasty

Intraoperative	Fracture (1–5%)	
	Nerve injury	
	Leg length discrepancy or malposition	
	Cement reactions	
	Anaesthetic complications	
Postoperative	Early	Bleeding
		Infection
		Venous thromboembolism
		Dislocation
	Late	Aseptic loosening
		Periprosthetic fracture (<1%)
		Implant failure (0.27%)

From Berry (1999)

occurs in less than 1% of cases but can be disastrous (National Joint Registry, 2017). Perioperative antibiotic prophylaxis aims to reduce this. Early onset prosthetic joint infections (≤ 6 weeks) may be managed with debridement, antibiotics and implant retention. Late onset deep infections are associated with biofilm formation which may require staged revision surgery.

Stiffness characterized by limited range of motion, functional impairment and dissatisfaction is a common and disabling problem post-total knee arthroplasty. Risk factors include poor preoperative range of motion, obesity, socioeconomic status, ethnicity and non-compliance. Methods to improve stiffness include intensive physiotherapy and continuous passive motion devices. Persistence of inadequate range of motion may be treated with manipulation under anaesthetic which attempts to address early abnormal scarring. Results are best if undertaken before 12 weeks postoperatively.

Venous thromboembolism is the leading cause of perioperative mortality. Patients commonly receive chemical and/or mechanical thromboprophylaxis for up to 35 days, reducing the incidence of symptomatic venous thromboembolism to <1% and fatal pulmonary embolism to <0.1% (Berry, 1999).

Painful aseptic loosening is the most common cause of revision. Time-dependent

implant wear and release of debris incites local inflammation leading to activation of osteoclasts, release of cytokines and proteolytic enzymes and subsequent osteolysis. Aseptic loosening is diagnosed clinically by increasing pain, worse on weight bearing, in the absence of infection, but radiographs may demonstrate radiolucency at the bone–prosthesis interface.

The incidence of subclinical nerve damage post-total hip arthroplasty may be as high as 75%, but the incidence of significant nerve palsy is 1–3% (Table 7). The risk of major vascular injury is 0.3% and is increased with the use of acetabular screws (Barrack and Butler, 2003).

Specific complications

Total hip arthroplasty dislocation occurs in approximately 3% of patients. They are commonly posterior as a result of flexion, adduction and internal rotation of the hip (a common composite movement required when putting on socks). The majority of patients with early postoperative dislocation are managed with closed reduction alone. Recurrent instability may require revision surgery. Dual mobility acetabular components are useful in total hip arthroplasty for complex cases such as osteoarthritis secondary to neuromuscular disorders and revision cases. The dual mobility construct enables articulation between the acetabular liner and shell, increasing the effective range of movement and allowing the head–liner complex to function as a large femoral head, which decreases the risk of dislocation.

Leg length discrepancy following total hip arthroplasty can cause pain, gait abnormalities and patient dissatisfaction. Preoperative templating and trial of components during surgery before definitive implantation can reduce symptomatic discrepancies.

The majority of total knee arthroplasties are performed under a tourniquet to minimize blood loss and reduce perioperative morbidity. Tourniquets can cause neurological injury and reperfusion injury if applied for an extended period of time.

Conclusions

Osteoarthritis is a common cause of morbidity worldwide, and its prevalence is increasing. Joint replacement is undertaken when symptoms become refractory to non-operative management. It is likely that the demand for surgical intervention

Table 7. Causes of nerve injury and the nerves commonly at risk post total hip arthroplasty

Cause		
	Idiopathic	47%
	Traction	20%
	Contusion	19%
	Haematoma	11%
	Dislocation	2%
	Laceration	<1%
Nerves at risk	Sciatic (particularly the peroneal division)	
	Femoral	
	Obturator	
	Superior gluteal nerve*	

From Barrack and Butler (2003). *Damage to the superior gluteal nerve causes weakness of the hip abductors, leading to the characteristic Trendelenburg gait

will grow as the population ages. Total hip arthroplasty and total knee arthroplasty are among the most commonly performed orthopaedic surgeries and are associated with excellent clinical outcomes. Controversy remains regarding the best method for implant fixation and choice of bearing surface, but these should be tailored to the individual needs of the patient. **BJHM**

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Conflict of interest: none.

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