

EVIDENCE SUMMARY

Total hip replacement

Overview

SURGICAL APPROACHES

- More than 25% of US surgeons utilize the direct anterior approach (DAA) for primary hip arthroplasty [2].
- Recent studies support less pain, a shorter length of stay, and an earlier return of function with anterior approach surgery [2].
- Large registry and multi-institution studies indicate that the direct anterior approach can be performed safely without an increase in complications in experienced hands [2].
- Abductor sparing approaches through the Watson Jones muscle interval have gained popularity as an alternative to the direct anterior approach [2].
- Abductor sparing approaches through the Watson Jones muscle interval are associated with similar lower pain levels and faster recovery compared to the direct anterior approach [2].

IMPLANT SELECTION AND BEARING SURFACES

- No implant design or system is appropriate for every patient [4].
- Implant selection is based on the patient's needs, anticipated longevity and level of activity, bone quality and dimensions, ready availability of implants and proper instrumentation, and the surgeon's experience [4].
- Utilization of metal-on-metal bearings in primary total hip arthroplasty decreased from 39.2% in 2007 to 5.5% in 2015 [2].
- Utilization of ceramic-on-polyethylene bearings in primary total hip arthroplasty increased from 6.4% in 2007 to 52.0% in 2015 [2].
- Over 90% of acetabular liners used in primary total hip arthroplasty in 2015 were made of cross-linked polyethylene (XLPE) [2].
- Long-term data support a marked decrease in wear, osteolysis, and revision surgery beyond 15 years with cross-linked polyethylene compared with conventional polyethylene [2].

PERIOPERATIVE PROTOCOLS

- Tranexamic acid (TXA) is standard-of-care at most institutions performing hip arthroplasty for reducing surgical blood loss and subsequent transfusions [8].
- There is a dose-dependent relationship between blood transfusions and the subsequent development of periprosthetic joint infection (PJI) [8].
- A 2017 randomized controlled trial demonstrated that oral tranexamic acid was equally effective as intravenous administration at a greatly reduced cost [8].
- A 2016 randomized controlled trial found that combined intravenous and topical application of tranexamic acid reduced total blood loss by an additional 200 mL compared with a single intravenous dose [8].
- No orthopaedic study has demonstrated an increase in venous thromboembolic (VTE) events in the setting of tranexamic acid administration [8].
- Aspirin is endorsed by the American College of Chest Physicians as an effective agent for VTE prophylaxis following total hip arthroplasty [8].
- Aspirin has lower risks of major and minor bleeding complications and lower rates of incisional complications compared with alternative means of chemoprophylaxis [8].
- The majority of total hip arthroplasty patients are now discharged directly home from the hospital rather than to an inpatient rehabilitation facility [8].
- Rapid recovery protocols are commonly utilized for total hip arthroplasty without an increase in perioperative complications [8].
- Selected patients are considered candidates for outpatient total hip arthroplasty, which has increased in popularity without an increase in complications in randomized controlled trials or large national database studies [8].
- A 2017 randomized controlled trial of 120 patients undergoing unilateral total hip arthroplasty reported no significant difference in functional outcomes between patients receiving formal physical therapy and those participating in unsupervised home exercise [8].

PERIPROSTHETIC FRACTURES: ACETABULUM

- The incidence of periprosthetic fracture of the acetabulum during primary total hip arthroplasty with cemented acetabular components is 0.2% [1].
- The incidence of periprosthetic fracture of the acetabulum during primary total hip arthroplasty with noncemented acetabular components is 0.4% [1].
- Intraoperative acetabular fractures typically occur during cup impaction, especially in older patients or those with poor bone quality [1].
- Intraoperative risk factors for acetabular periprosthetic fracture include noncemented acetabular components, underreaming by more than 2 mm, elliptical monoblock components, osteopenia or osteoporosis, Paget disease, and removal of acetabular components at revision [1].
- Postoperative risk factors for acetabular periprosthetic fracture include trauma, osteolysis, and osteopenia or osteoporosis [1].

- Plain radiographs may underestimate bone loss in acetabular periprosthetic fractures [1].
- Judet views (obturator and iliac oblique radiographs) may help identify an anterior or posterior column fracture in acetabular periprosthetic fractures [1].
- Bone scans may help identify late acetabular periprosthetic fractures not seen on plain radiographs [1].
- Bone scans may show areas of increased uptake for 1 to 2 years postoperatively in the absence of fracture [1].
- For Type IA acetabular periprosthetic fractures (intraoperative, nondisplaced, stable component), the cup is left in place and augmented with multiple screws through the cup [1].
- For Type IB acetabular periprosthetic fractures (intraoperative, displaced), the cup is removed, the fragment is fixed with bone screws or a buttress plate, and the component is re-impacted [1].
- For Type IIIA acetabular periprosthetic fractures (traumatic, stable component), the cup is left in place [1].
- For Type IIIB acetabular periprosthetic fractures (traumatic, unstable component), revision to a porous revision acetabular implant with multiple screws is performed [1].
- For Type IVB acetabular periprosthetic fractures (spontaneous, >50% bone stock loss), bulk allograft or metallic augmentation is used to manage the bone defect [1].
- For Type VB pelvic discontinuity fractures (>50% bone stock loss), a cemented acetabular implant, cage construct, or custom triflange component spanning from the ilium to the ischium should be used [1].

PERIPROSTHETIC FRACTURES: FEMUR

- The incidence of intraoperative periprosthetic femoral fracture in primary total hip arthroplasty is 0.1% to 5.4% [1].
- The incidence of intraoperative periprosthetic femoral fracture in revision total hip arthroplasty is 3.0% to 20.9% [1].
- Trauma is the most commonly cited cause of periprosthetic fractures of the femur [1].
- Risk factors for periprosthetic femoral fracture include revision surgery, noncemented press-fit technique, compromised bone stock, and impaction grafting technique [1].
- Prophylactic cerclage wires and cortical onlay strut allografts are recommended to help reduce the risk of periprosthetic femoral fracture during impaction grafting [1].
- A minimum of two views (AP and lateral) are obtained on plain radiographs to help identify the type and extent of periprosthetic femoral fractures [1].

Anatomy & Pathophysiology

BONY ANATOMY AND VASCULAR STRUCTURES

- The medial femoral circumflex artery is located underneath the quadratus femoris muscle or gluteus maximus tendon [22].
- Cutting deep to the area of the medial femoral circumflex artery risks laceration to the vessel [22].

CQ HAND + UPPER LIMB

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- The ascending branch of the lateral femoral circumflex artery passes upward beneath the tensor fasciae latae and is encountered in the space between the tensor fasciae latae and sartorius [22].
- The transverse acetabular ligament extends between the two cotyloid pads at the inferior aspect of the acetabulum [22].
- Errant retractor placement inferior to the transverse acetabular ligament can damage the obturator artery and vein [22].

NERVE ANATOMY AND INJURY MECHANISMS

- The sciatic nerve travels closest to the acetabulum at the level of the ischium [22].
- The peroneal nerve division is most often involved in sciatic nerve injury because this part of the nerve is closest to the acetabulum [22].
- Compression is the most common pathologic mechanism of nerve injury after total hip arthroplasty [22].
- The most common reason for sciatic nerve injury during surgery is errant retractor placement causing excess compression to the nerve [22].
- The lateral femoral cutaneous nerve is at risk during the direct anterior approach to total hip arthroplasty [3].
- Injury to the lateral femoral cutaneous nerve may lead to a painful neuroma or decreased sensation [22].

FEMORAL COMPONENT BIOMECHANICS AND GEOMETRY

- The primary function of the femoral component is the replacement of the femoral head and neck after resection of the arthritic or necrotic segment [23].
- The location of the normal center of rotation is determined by vertical height, medial offset, and version of the taper [23].
- Vertical height is determined primarily by the base length of the prosthetic neck plus the length gained by the modular head used [23].
- Offset is the distance from the center of the femoral head to a line through the axis of the distal part of the stem and is primarily a function of stem design [23].
- Inadequate restoration of offset shortens the moment arm of the abductor musculature and results in increased joint reaction force, limp, and bone impingement [23].
- The normal femur has 10 to 15 degrees of anteversion of the femoral neck in relation to the coronal plane when the foot faces straight forward [23].
- A Morse taper is approximately 3 degrees on each side [23].
- The most common taper used presently is 12 mm/14 mm [23].
- Femoral heads from one manufacturer are not compatible with femoral trunnions of another even if the nominal size is the same [23].
- Toggling of the head on the trunnion, dissociation, material loss, and corrosion may result from mismatching femoral heads and trunnions from different manufacturers [23].

ACETABULAR COMPONENT POSITIONING AND STABILITY

- The traditional target “safe zone” for cup anteversion is 20 to 30 degrees [25].
- The traditional target “safe zone” for cup theta angle (coronal tilt) is 35 to 40 degrees [25].
- The traditional target “safe zone” for stem anteversion is 10 to 15 degrees [25].
- The traditional target for combined anteversion of the cup and stem is 25 to 50 degrees [25].
- Cup retroversion carries a risk of posterior dislocation [25].
- Excess cup anteversion carries a risk of anterior dislocation [25].
- A high cup theta angle (vertical cup) carries a risk of posterior-superior dislocation [25].
- Stem retroversion carries a risk of posterior dislocation [25].
- Excess stem anteversion carries a risk of anterior dislocation [25].
- The primary arc range is controlled by the head-neck ratio [25].
- Best stability is achieved by maximizing the head-neck ratio [25].
- The lever range is controlled by the head radius [25].
- The excursion distance (jump distance) is equal to the radius of the femoral head [25].
- A large femoral head has a higher excursion distance and is more stable [25].
- Acetabular hoods or lipped liners decrease the primary arc range [25].
- Constrained acetabular cups markedly decrease the primary arc range [25].

SPINOPELVIC RELATIONSHIPS

- Patients with spinal deformity, those who have undergone spinal fusion, or those with a fixed spinopelvic alignment have a marked increase in the risk of instability [2].
- The previously well-accepted notion of a consistent or fixed “safe zone” for acetabular cup positioning has been questioned due to the influence of the spine on the functional position of the acetabular implant [2].
- A true safe zone for acetabular cup positioning is patient-specific, taking into account pelvic tilt, spinopelvic relationships, and lumbar spine rigidity versus flexibility [2].

PATHOPHYSIOLOGY OF ASEPTIC LOOSENING AND OSTEOLYSIS

- Periprosthetic osteolysis is a macrophage-initiated biologic response to submicron polyethylene wear debris [6].
- Linear pattern osteolysis is associated with cemented and mechanically unstable components where debris accesses the implant bone interface through the effective joint space [6].
- Focal pattern (balloon) osteolysis develops by accessing through areas where implant fixation is incomplete [6].
- Late implant loosening of cemented components is related to the quality of the cement mantle, cement mantle thickness, component position, and particle access to the effective joint space [6].

- A minimum 2-mm cement mantle thickness is associated with reduced loosening in cemented components [6].
- Increased loosening of cemented components is associated with varus femoral stem positioning [6].
- Initial implant stability is essential for osseointegration of noncemented components [6].
- Component subsidence in noncemented implants is most commonly associated with failure to obtain adequate implant stability [6].
- A minimum of 35% ingrowth is required for acetabular fixation of noncemented components [6].
- Pore size between 150 and 450 μm and interface motion of 50 μm or less are factors for noncemented component fixation [6].

ADVERSE REACTION TO METAL DEBRIS (ARMD) AND TRUNNIONOSIS

- Adverse reaction to metal debris (ARMD) is a T cell mediated biologic reaction to metal wear products [6].
- Factors associated with increased metal particle generation include acetabular implant malposition, reduced or excessive clearance between the head and acetabulum, corrosion at modular junctions, smaller femoral head size ($<46\text{ mm}$) in hip resurfacing, and female sex [6].
- Biologic reactions to metal wear products include synovitis, acute lymphocyte vasculitis-associated lesions, and pseudotumor formation [6].
- Fretting and crevice corrosion may occur in 2% or more femoral stem modular interfaces [6].
- Diagnosis of trunnionosis is made based on a serum cobalt level $> 1\text{ ppb}$ and cobalt ions $\gg\gg$ chromium ions [6].
- Trunnionosis should be considered as a potential cause of pain in symptomatic hips with increasing femoral head diameter ($\geq 32\text{ mm}$), cobalt-chromium heads coupled with titanium stems, flexible titanium stems, or cobalt-chromium modular necks [6].
- Selection of a ceramic femoral head in primary total hip arthroplasty may reduce the risk for trunnionosis [6].

PERIPROSTHETIC FRACTURE PATHOPHYSIOLOGY

- The incidence of periprosthetic fracture of the acetabulum occurring during primary total hip arthroplasty with cemented acetabular components is 0.2% [1].
- The incidence of periprosthetic fracture of the acetabulum occurring during primary total hip arthroplasty with noncemented acetabular components is 0.4% [1].
- Underreaming by more than 2 mm is an intraoperative risk factor for acetabular fracture [1].
- Osteopenia or osteoporosis is a risk factor for both intraoperative and postoperative acetabular fractures [1].
- Paget disease is an intraoperative risk factor for acetabular fracture [1].
- Impaction grafting technique is a risk factor for periprosthetic femoral fracture [1].

HOST-SPECIFIC PATHOPHYSIOLOGY AND COMPLICATIONS

- Sickle cell disease is associated with early prosthetic loosening due to extended bone infarct disease [22].
- Sickle cell disease is associated with a higher risk of periprosthetic joint infection [22].
- Psoriatic arthritis is associated with a higher periprosthetic infection rate [22].
- Ankylosing spondylitis is associated with a higher risk for heterotopic ossification [22].
- Hip hyperextension due to fixed pelvic deformity in ankylosing spondylitis can lead to a higher anterior dislocation rate [22].
- Parkinson disease is associated with a higher dislocation rate, higher perioperative mortality, higher perioperative medical complications, and a higher reoperation rate [22].
- Paget disease is associated with increased blood loss during total hip arthroplasty [22].
- Dialysis is associated with a higher risk of infection and loosening [22].
- Fat emboli syndrome occurs with femoral stem insertion when fat and bone marrow emboli are pressurized into the bloodstream [22].
- Hallmark findings of fat emboli syndrome include intraoperative hypotension, hypoxia, mental status changes, and petechial rash [22].

SURGICAL APPROACH ANATOMY

- The anterior (Smith-Petersen) approach utilizes the internervous interval between the superficial sartorius (femoral nerve) and tensor fasciae latae (superior gluteal nerve) and the deep rectus femoris (femoral nerve) and gluteus medius (superior gluteal nerve) [3].
- The anterolateral (Watson-Jones) approach utilizes the internervous interval between the tensor fasciae latae (femoral nerve) and gluteus medius (femoral nerve) [3].
- The posterolateral approach has no internervous interval and places the sciatic nerve at risk [3].
- The direct anterior approach uses the distal half of the traditional Smith-Petersen approach to the hip [14].
- The direct anterior approach interval is both intermuscular and internervous, requiring little muscular dissection [14].
- The posterolateral approach involves splitting the gluteus maximus and tenotomies of the external rotators [10].
- The posterolateral approach can be extended proximally by osteotomy of the greater trochanter with anterior dislocation of the hip [10].

Classification

- The Paprosky classification is used for periprosthetic fractures of the acetabulum associated with total hip arthroplasty [1].
- Type I acetabular fractures are defined as intraoperative fractures secondary to acetabular implant insertion [1].

- Type IA acetabular fractures are characterized by an acetabular wall fracture recognized intraoperatively that is nondisplaced with a stable component [1].
- Type IB acetabular fractures are characterized by a fracture recognized intraoperatively that is displaced [1].
- Type IC acetabular fractures are characterized by a fracture not recognized intraoperatively [1].
- Type II acetabular fractures are defined as intraoperative fractures secondary to acetabular implant removal [1].
- Type III acetabular fractures are defined as traumatic fractures [1].
- Type IIIA acetabular fractures are characterized by a stable component [1].
- Type IIIB acetabular fractures are characterized by an unstable component [1].
- Type IV acetabular fractures are defined as spontaneous fractures [1].
- Type IVA acetabular fractures are associated with a loss of less than 50% of acetabular bone stock [1].
- Type IVB acetabular fractures are associated with a loss of greater than 50% of acetabular bone stock [1].
- Type V acetabular fractures are defined as pelvic discontinuity [1].
- Type VA acetabular fractures are associated with a loss of less than 50% of acetabular bone stock [1].
- Type VB acetabular fractures are associated with a loss of greater than 50% of acetabular bone stock [1].
- Type VC acetabular fractures are associated with prior pelvic radiation [1].

Clinical Presentation

PAIN LOCALIZATION AND CHARACTERISTICS

- Groin or buttock pain suggests an acetabular or a joint-centered problem [9].
- Anterior thigh pain suggests a femoral-side problem [9].
- Lateral hip pain suggests hip abductor weakness, trochanteric impingement, or inflammation (bursitis/tendinopathy) [9].
- Knee pain may indicate a hip condition [9].
- Patient-reported hip pain may be referred from the lumbar spine, abdomen, or retroperitoneum [9].
- Pain associated with loose total hip components typically occurs with the first few steps a patient takes, known as start-up pain [7].
- A loose acetabular component usually produces pain in the groin [7].
- A loose femoral component may cause pain in the thigh or knee [7].
- Postoperative periprosthetic acetabular fracture should be suspected if groin pain is present after trauma [1].

ONSET AND INCITING FACTORS

- Early-onset and/or unresolved pain may indicate infection, occult fracture, or a mechanically unstable prosthesis [9].
- Delayed-onset pain is more likely to be the result of a low-grade surgical infection, late hematogenous infection, bearing surface wear (synovitis, osteolysis, mechanical loosening), or stress shielding and loss of periprosthetic bone [9].
- Start-up pain or pain with prolonged ambulation is associated with weight-bearing activities [9].
- Impingement between implants and bone can occur during flexion with decreased combined anteversion plus or minus a horizontal component [9].
- Impingement between implants and bone can occur during extension with increased combined anteversion plus or minus a vertical component [9].
- Pain while lying on the side suggests bursitis, abductor weakness, tendinopathy, or tear [9].

PHYSICAL EXAMINATION FINDINGS

- Pain with active hip flexion may suggest psoas tendon irritation or anterior impingement [9].
- Weakness in hip abduction may contribute to lateral hip pain and may originate from a neurologic condition (L5 radiculopathy, sciatic neurapraxia), violation of hip abductors from surgery (multiple procedures), or inadequate rehabilitation [9].
- Neurologic assessment of motor and sensory function may indicate peripheral nerve injury or concurrent lumbar radiculopathy [9].
- Vascular assessment includes checking distal pulses, warmth, and perfusion [9].
- Range of motion assessment includes flexion, abduction, and rotation arcs, as well as comparison of femoral version with the contralateral hip [9].

IMAGING FINDINGS

- Radiographic signs of loosening include component migration or subsidence (linear or angular) [9].
- Radiographic signs of loosening include progressive or complete radiolucency [9].
- Radiographic signs of loosening include absence of spot welding [9].
- Radiographic signs of loosening include pedestal formation in the femur [9].
- Radiographic signs of loosening include bone stock maintained in the femoral neck with calcar sclerosis [9].
- Acetabular osteolysis is characterized by size and location using the Charnley and DeLee classification system, which includes Zone 1 (superolateral), Zone 2 (central), and Zone 3 (inferomedial) [9].
- Plain radiographs underestimate the severity of acetabular osteolysis [9].
- Femoral osteolysis is characterized by size and location using the Gruen classification system, which includes Zones 1 through 7 progressing from proximal/lateral distally to the tip of the implant and back up the medial side to the lesser trochanter [9].

- CT provides assessment of component position and anteversion, the size and location of bone loss, and the quality and location of remaining bone [9].
- MRI with artifact reduction may be useful in identifying soft-tissue lesions around the hip joint [9].
- Ultrasonography may be useful in identifying soft-tissue masses around failed implants [9].
- Nuclear medicine may indicate the presence of components that are not osseointegrated [9].
- Plain radiographs may underestimate bone loss in periprosthetic acetabular fractures [1].
- Judet views (obturator and iliac oblique radiographs) may help identify an anterior or posterior column fracture in periprosthetic acetabular fractures [1].
- The fracture line in periprosthetic acetabular fractures may be obscured by metallic components [1].
- Bone scans may help identify late periprosthetic acetabular fractures not seen on plain radiographs [1].
- CT is seldom needed for periprosthetic acetabular fractures but may help visualize fractures not identified using other imaging methods [1].
- A minimum of two views (AP and lateral) are obtained to help identify the type and extent of periprosthetic femoral fractures [1].
- Radiographs for periprosthetic femoral fractures should be assessed for cortical perforations and longitudinal splits [1].

LABORATORY ASSESSMENT

- An erythrocyte sedimentation rate (ESR) greater than 20 mm/hr suggests an inflammatory state [9].
- A C-reactive protein (CRP) level greater than 7.0 mg/L suggests an acute inflammatory process [9].
- CRP usually normalizes within 3 weeks of surgical intervention [9].
- Complete blood cell count with differential may be elevated with systemic infection or illness [9].
- For chronic postoperative joint aspiration, a white blood cell (WBC) count greater than 2,500 cells/mL and polymorphonuclear leukocytes (PMNs) greater than 90% are indicative of infection [9].
- For acute postoperative joint aspiration, a white blood cell (WBC) count greater than 27,000 cells/mL and PMN values greater than 90% are indicative of infection [9].
- Lower PMN values may be considered if the clinical picture supports infection (elevated ESR or CRP level) [9].

HISTORY AND RISK FACTORS

- Prolonged drainage after surgery, fever, and chills are suggestive of infection [9].
- Treatment with antibiotics after surgery suggests infection [9].
- A history of hip dislocation suggests instability [9].
- A history of multiple procedures is associated with increased risks of infection and instability [9].
- Poor implant track record, including failure of osseointegration, bearing surface wear, or symptomatic alternative bearing, is a relevant historical factor [9].

- Adverse reaction to metal debris (ARMD) may occur with hip reconstructions performed with large metal-on-metal articulations, dual-modular femoral necks, and/or large diameter femoral heads [9].

Investigations

IMAGING: PLAIN RADIOGRAPHS

- The fracture line in periprosthetic acetabular fractures may be obscured by metallic components on plain radiographs [1].
- Radiographs for the painful total hip arthroplasty should be taken in perpendicular planes, with the AP view allowing visualization of the contralateral hip [9].
- Acetabular osteolysis is characterized by size and location using the Charnley and DeLee classification system (Zone 1 superolateral, Zone 2 central, Zone 3 inferomedial) [9].
- Femoral osteolysis is characterized by size and location using the Gruen classification system (Zones 1 through 7) [9].

IMAGING: ADVANCED MODALITIES

- CT provides assessment of component position and anteversion, size and location of bone loss, and quality and location of remaining bone in the painful total hip arthroplasty [9].
- CT may be useful for creating models for reconstruction or customized implants in the painful total hip arthroplasty [9].
- MRI with artifact reduction may be useful in identifying soft-tissue lesions around the hip joint in the painful total hip arthroplasty [9].
- A metal artifact reduction sequence (MARS) MRI can be used to confirm trochanteric bursitis if the diagnosis is not apparent [26].

LABORATORY ASSESSMENT

- An erythrocyte sedimentation rate (ESR) greater than 20 mm/hr suggests an inflammatory state in the evaluation of the painful total hip arthroplasty [9].
- A C-reactive protein (CRP) level greater than 7.0 mg/L suggests an acute inflammatory process in the evaluation of the painful total hip arthroplasty [9].
- A complete blood cell count with differential may be elevated with systemic infection or illness [9].
- Lower PMN values in joint aspiration may be considered if the clinical picture supports infection (elevated ESR or CRP level) [9].

CLINICAL EXAMINATION

- Groin or buttock pain suggests an acetabular or a joint-centered problem in the painful total hip arthroplasty [9].

- Anterior thigh pain suggests a femoral-side problem in the painful total hip arthroplasty [9].
- Lateral hip pain suggests hip abductor weakness, trochanteric impingement, or inflammation (bursitis/tendinopathy) in the painful total hip arthroplasty [9].
- Knee pain may indicate a hip condition, while patient-reported hip pain may be referred from the lumbar spine, abdomen, or retroperitoneum [9].
- Delayed-onset pain is more likely to be the result of low-grade surgical infection, late hematogenous infection, bearing surface wear (synovitis, osteolysis, mechanical loosening), or stress shielding and loss of periprosthetic bone [9].
- Hip abduction weakness may contribute to lateral hip pain and may originate from a neurologic condition (L5 radiculopathy, sciatic neurapraxia), violation of hip abductors from surgery, or inadequate rehabilitation [9].
- Neurologic assessment (motor and sensory) may indicate peripheral nerve injury or concurrent lumbar radiculopathy [9].
- Postoperative fracture of the acetabulum should be suspected if groin pain is present after trauma [1].

SPECIFIC PATHOLOGY ASSESSMENT

- Assessment for adverse reaction to metal debris (ARMD) may be required with hip reconstructions performed with large metal-on-metal articulations, dual-modular femoral necks, and/or large diameter femoral heads [9].
- Trunnionosis should be considered as a potential cause of pain in symptomatic hips with increasing femoral head diameter (≥ 32 mm), cobalt-chromium heads coupled with titanium stems, flexible titanium stems (wedge taper design), or cobalt-chromium modular necks [6].
- Iliopsoas tendinitis can occur with impingement of the iliopsoas tendon over a THA femoral head or prominent edge (oversized or retroverted cup) of the acetabular cup [26].
- Ischiofemoral impingement can occur when the offset is reduced and the lesser trochanter moves closer to the ischium [26].

Treatment

INDICATIONS AND CONTRAINDICATIONS

- Total hip arthroplasty is indicated for patients with chronic discomfort and significant functional impairment due to hip disease who have failed conservative measures [5].
- Conservative measures prior to surgery include weight loss, nonopioid analgesics, activity modification, low-impact exercise, and ambulatory aids [5].
- Surgery is justified when pain at rest and with motion or weight bearing prevents the patient from working or carrying out activities of daily living [5].
- Patients with limitation of motion, limp, or leg-length inequality but little or no hip pain are not candidates for total hip arthroplasty [5].

- Active infection of the hip joint or any other region is an absolute contraindication for total hip arthroplasty [5].
- Unstable medical illnesses that significantly increase the risk of morbidity or mortality are absolute contraindications for total hip arthroplasty [5].
- Asymptomatic bacteriuria is not associated with postoperative surgical site infections and is not considered a contraindication for total hip arthroplasty [5].
- A documented patent ductus arteriosus or septal defect is an absolute contraindication for bilateral total hip procedures under a single anesthetic [5].
- Femoral or periacetabular osteotomy should be considered for young patients with osteoarthritis if the joint is not grossly incongruous and satisfactory motion is present [5].
- Hip preservation options, including core decompression and osteotomy, may delay or obviate the need for arthroplasty in younger individuals [5].

SURGICAL APPROACHES

- The direct anterior approach is utilized by more than 25% of US surgeons for primary hip arthroplasties [2].
- Recent studies support less pain, shorter length of stay, and earlier return of function with the direct anterior approach compared to other techniques [2].
- Concerns regarding the direct anterior approach include increased early complications such as periprosthetic fracture, subsidence, and failure of osteointegration [2].
- Large registry and multi-institution studies indicate the direct anterior approach can be performed safely without an increase in complications in experienced hands [2].
- The posterolateral approach is associated with minimal anatomic disruption, excellent exposure of the socket and femur, and a quick recovery [3].
- The posterolateral approach has a slightly higher dislocation rate compared to other approaches [3].
- The lateral (Hardinge) approach allows access to the anterior and posterior hip joint without osteotomy of the trochanter and has a low rate of postoperative dislocation [3].
- The lateral (Hardinge) approach is associated with a postoperative limp incidence of 18% in primary total hip arthroplasty [3].
- Heterotopic ossification incidence can be as high as 47% in primary total hip arthroplasty performed via the lateral (Hardinge) approach [3].
- Trochanteric nonunion rates for the lateral (Hardinge) approach are reported between 5% and 32% [3].
- The anterior (Smith-Petersen) approach allows hip dislocation without risk to the femoral head blood supply [3].
- Extensive release of abductors in the anterior (Smith-Petersen) approach can result in weakness and a high incidence of heterotopic ossification [3].
- The anterolateral (Watson-Jones) approach has a low incidence of postoperative dislocation and good exposure of the hip joint and proximal femur without trochanteric osteotomy [3].

- Damage to the femoral shaft and malpositioning of the femoral implant during femoral canal preparation are risks of the anterolateral (Watson-Jones) approach [3].
- No clear difference in patient outcomes has been demonstrated between different surgical approaches for total hip arthroplasty [24].
- The direct anterior approach has been associated with a higher rate of femoral problems, including fracture and loosening [24].
- The posterior approach has been associated with a higher rate of dislocation [24].

IMPLANT SELECTION AND FIXATION

- Total hip component selection is based on patient needs, anticipated longevity, activity level, bone quality, implant availability, and surgeon experience [4].
- No single implant design or system is appropriate for every patient [4].
- Porous-coated cementless cups are the preferred choice for acetabular fixation [11].
- Porous-coated hemispheric cementless cups have reliable long-term results that are superior to cemented cups [11].
- Both cementless and cemented fixation methods are acceptable techniques for the femoral component in primary total hip arthroplasty [11].
- Cementless stem fixation is indicated for high-activity-level patients and young male patients to avoid cyclic fatigue of cement [11].
- Cemented stems have a lower risk of periprosthetic fracture in patients with poor bone quality, Dorr C anatomy, and hip fractures [32].
- Cemented stems are generally considered the gold standard for hip fractures [32].
- Cemented cups fail at a higher rate than cemented stems due to shear and tension forces at the cement-bone interface [32].
- Cement fatigue starts at stress points within the cement mantle, such as mantle defects where the prosthesis touches bone [32].
- Vacuum mixing is the most common method to reduce cement porosity, which reduces stress points in the cement [32].
- Pressurization of cement before component insertion enhances cement interdigitation with bone [32].
- Pulsatile lavage of bone before cementing allows better cement interdigitation by ensuring clean, dry bone [32].
- Stem centralization with a distal stem centralizer maintains a uniform cement mantle and prevents mantle defects [32].
- Smooth, highly polished cemented stems are designed to slightly subside into the cement mantle to distribute load and compress cement into bone [32].
- Bone ingrowth requires live host bone, an appropriate ingrowth surface on the implant, and initial rigid fixation [24].

- Motion of the prosthesis within the bone greater than 150 µm leads to fibrous fixation or encapsulation [24].
- Hydroxyapatite is an osteoconductive surface coating that may shorten the time to biologic fixation [24].
- Femoral stress shielding leads to loss of proximal bone density and results from modulus mismatch between the stem and femoral bone [24].
- Femoral stem breakage occurs from cantilever bending [24].
- Grit blasting creates microdivots on the prosthetic surface, allowing bone to grow onto the rough surface for stabilization [18].
- Fixation strength with grit blast fixation is significantly lower than that with porous coating, requiring a greater area of surface coating [18].
- Hydroxyapatite coating thickness less than 50 to 70 µm is preferred to prevent cracking and shearing off [18].
- Noncemented biologic fixation remains the benchmark for revision total hip arthroplasty [29].
- Modular fluted tapered stems offer reliable fixation in revision total hip arthroplasty even with significantly compromised bone stock [29].
- A 2017 single-institution study reported 96% 10-year survivorship for aseptic femoral revisions utilizing modular fluted tapered stems [29].
- Noncemented hemispherical highly porous acetabular cups with supplemental screw fixation are sufficient for most acetabular revisions [29].
- Porous tantalum acetabular cup and augment constructs offer the potential for excellent long-term fixation in major acetabular bone loss [29].
- A 2017 study reported 97% survivorship at 5 years for hips revised with significant acetabular bone loss using porous tantalum constructs [29].
- Cup-cage constructs have shown excellent short-term results for complex acetabular defects, including those with concurrent pelvic discontinuity [29].
- Custom triflange constructs and pelvic distraction are options for complex acetabular defects [29].

BEARING SURFACES

- Over 90% of acetabular liners used in primary total hip arthroplasty in 2015 were made of cross-linked polyethylene [2].
- Cross-linked polyethylene is associated with a marked decrease in wear, osteolysis, and revision surgery beyond 15 years compared with conventional polyethylene [2].
- Increased femoral head size greater than 36 mm is associated with a clinical reduction in dislocation rates [6].
- Increased femoral head size greater than 36 mm is associated with an increased incidence of groin pain [6].
- Increased femoral head size greater than 36 mm is associated with higher polyethylene wear rates among younger and more active patients [6].

- Increased femoral head size greater than 36 mm is associated with corrosion and loosening of the head-neck junction [6].
- Mechanical noise incidence in total hip arthroplasty ranges between 0.2% and 17.0% [6].
- Audible mechanical noise has not been associated with implant failure or revision [6].
- Adverse reaction to metal debris is associated with acetabular implant malposition, reduced or excessive clearance, corrosion at modular junctions, and smaller femoral head size less than 46 mm in hip resurfacing [6].
- Biologic reaction to metal wear products includes synovitis, acute lymphocyte vasculitis-associated lesions, and pseudotumor formation [6].
- Trunnionosis may occur in 2% or more femoral stem modular interfaces [6].
- Diagnosis of trunnionosis is based on a serum cobalt level greater than 1 ppb and cobalt ions significantly greater than chromium ions [6].

PERIOPERATIVE PROTOCOLS

- Tranexamic acid is standard-of-care at most institutions performing hip arthroplasty for reducing surgical blood loss and transfusions [8].
- There is a dose-dependent relationship between blood transfusions and the subsequent development of periprosthetic joint infection [8].
- Oral tranexamic acid was demonstrated to be equally effective as intravenous administration in a 2017 randomized controlled trial [8].
- Combined intravenous and topical application of tranexamic acid reduced total blood loss by an additional 200 mL compared with a single intravenous dose in a 2016 randomized controlled trial [8].
- No orthopaedic study has demonstrated an increase in venous thromboembolic events with tranexamic acid administration [8].
- Aspirin is endorsed by the American College of Chest Physicians as an effective agent for venous thromboembolism prophylaxis following total hip arthroplasty [8].
- Aspirin has a lower risk of major and minor bleeding complications and lower rates of incisional complications compared with alternative chemoprophylaxis [8].
- Novel oral anticoagulants or low-molecular-weight heparin should be considered for patients at higher risk for venous thromboembolism, such as those with a prior unprovoked event [8].
- Rapid recovery protocols are commonly utilized without an increase in perioperative complications [8].
- Selected patients are candidates for outpatient total hip arthroplasty, which has increased in popularity without an increase in complications [8].
- A 2017 randomized controlled trial found no significant difference in functional outcomes between patients receiving formal physical therapy and those participating in unsupervised home exercise after unilateral total hip arthroplasty [8].

POSTOPERATIVE REHABILITATION

- There is no universally accepted postoperative rehabilitation program after total hip arthroplasty [31].
- Rehabilitation should ideally begin before the operation to teach transfers, device use, and dislocation precautions [31].
- In the immediate postoperative period, the hip is positioned in approximately 15 degrees of abduction while the patient recovers from anesthesia [31].
- For patients treated with a posterior approach, a triangular pillow is used to maintain abduction and prevent extremes of flexion [31].
- Bed exercises and limited mobilization may be initiated on the day of surgery if patient discomfort and anesthesia recovery allow [31].
- Straight leg raising is not helpful after total hip arthroplasty and places unnecessary rotational stress on the femoral component [31].
- Gait training usually can begin on the day of surgery [31].
- Early weight bearing to tolerance is permitted if the components were cemented [31].
- For cementless, porous ingrowth implants, many authors recommend limited weight bearing for 6 to 8 weeks, while others encourage early weight bearing as comfort allows [31].
- A literature review found no adverse effects on subsidence and osseointegration with unrestricted weight bearing for cementless implants [31].
- Protected weight bearing during stair climbing is recommended for the first weeks after surgery due to high torsional loads [31].
- A meta-analysis including 1122 patients concluded that unrestricted patients were more satisfied and resumed activity quicker without an increase in dislocation rate compared to those with hip precautions [31].
- Patients can be discharged when able to get in and out of bed independently, walk over level surfaces, and climb a few steps [31].
- Showers are allowed when wound healing is satisfactory, but baths are not [31].
- Sexual activity can be resumed in the supine position [31].
- Outpatient clinic follow-up occurs approximately 2 weeks after surgery, at which time radiographs are made and two-handed support can be discontinued for uncomplicated primary arthroplasty [31].

MANAGEMENT OF COMPLICATIONS

- The incidence of periprosthetic fracture of the acetabulum during primary total hip arthroplasty with cemented components is 0.2% [1].
- The incidence of periprosthetic fracture of the acetabulum during primary total hip arthroplasty with noncemented components is 0.4% [1].
- Risk factors for intraoperative acetabular fracture include noncemented components, underreaming by more than 2 mm, elliptical monoblock components, osteopenia, osteoporosis, Paget disease, and removal of components at revision [1].

- Postoperative risk factors for acetabular fracture include trauma, osteolysis, and osteopenia or osteoporosis [1].
- For Type IA intraoperative acetabular fractures (nondisplaced, stable component), the cup is left in place and augmented with multiple screws, with protected weight bearing for 8 to 12 weeks [1].
- For Type IB intraoperative acetabular fractures (displaced), the cup is removed, the fragment is fixed with bone screws or a buttress plate, and the component is re-impacted or a multipole revision implant is used [1].
- For Type IIIA traumatic acetabular fractures with a stable component, the cup is left in place and protected weight bearing for 8 to 12 weeks is considered [1].
- For Type IIIB traumatic acetabular fractures with an unstable component, revision to a porous revision acetabular implant with multiple screws is performed [1].
- For Type IVA spontaneous acetabular fractures with less than 50% bone stock loss, a large revision acetabular implant with multiple screws and bone graft as needed is used [1].
- For Type IVB spontaneous acetabular fractures with greater than 50% bone stock loss, bulk allograft or metallic augmentation is used to manage the bone defect [1].
- For Type VA pelvic discontinuity with less than 50% bone stock loss, the posterior column is fixed with a pelvic plate and screws before inserting a porous revision acetabular implant [1].
- For Type VB pelvic discontinuity with greater than 50% bone stock loss, the discontinuity is fixed with a pelvic plate and screws, and bulk allograft or metallic augmentation is used [1].
- For Type VC pelvic discontinuity associated with prior pelvic radiation, a cemented acetabular implant, cage construct, or custom triflange component spanning from ilium to ischium should be used [1].
- Prophylactic cerclage wires and cortical onlay strut allografts are recommended to reduce the risk of fracture during impaction grafting [1].
- Acetabular implant orientation targets for stability are 30° to 50° abduction and 5° to 25° anteversion [6].
- Combined acetabular and femoral implant anteversion targets are 35° to 40° for females and 30° to 35° for males [6].
- High abduction combined with high anteversion results in anterior instability with hip extension [6].
- Low abduction combined with low anteversion results in posterior instability with hip flexion [6].
- Decreased femoral offset and inadequate leg length restoration can result in femoral neck impingement and decreased abductor mechanism efficiency [6].
- Female sex, diagnosis of osteonecrosis or femoral neck fracture, spinal fusion or limited lumbar spine mobility, and revision total hip arthroplasty are patient factors associated with increased dislocation risk [6].
- Closed reduction is commonly utilized to manage acute periprosthetic

Complications

PERIPROSTHETIC FRACTURES: ACETABULUM

- Intraoperative risk factors for acetabular periprosthetic fracture include the use of noncemented press-fit components [1].
- Underreaming by more than 2 mm is an intraoperative risk factor for acetabular periprosthetic fracture [1].
- The use of elliptical monoblock components is an intraoperative risk factor for acetabular periprosthetic fracture [1].
- Osteopenia or osteoporosis is a risk factor for both intraoperative and postoperative acetabular periprosthetic fracture [1].
- Paget disease is an intraoperative risk factor for acetabular periprosthetic fracture [1].
- Removal of acetabular components at revision is an intraoperative risk factor for acetabular periprosthetic fracture [1].
- Trauma and osteolysis are postoperative risk factors for acetabular periprosthetic fracture [1].
- Postoperative acetabular fracture should be suspected if groin pain is present after trauma [1].
- Judet views (obturator and iliac oblique radiographs) may help identify anterior or posterior column fractures in acetabular periprosthetic fractures [1].
- The fracture line in acetabular periprosthetic fractures may be obscured by metallic components on plain radiographs [1].
- CT is seldom needed for acetabular periprosthetic fractures but may help visualize fractures not identified using other imaging methods [1].
- Protected weight bearing for 8 to 12 weeks should be considered for Type IA acetabular periprosthetic fractures [1].
- For Type IB acetabular periprosthetic fractures (intraoperative, displaced), the cup should be removed and the displaced fragment fixed with bone screws [1].
- A buttress plate is used for Type IB acetabular periprosthetic fractures if the posterior column is involved [1].
- Re-reaming for Type IB acetabular periprosthetic fractures is performed close to the component size to minimize underreaming [1].
- A multipole revision acetabular implant and protected weight bearing for 8 to 12 weeks should be considered for Type IB acetabular periprosthetic fractures [1].
- Management of Type IC acetabular periprosthetic fractures (not recognized intraoperatively) is the same as that performed for type III, IV, and V fractures [1].
- For Type II acetabular periprosthetic fractures (intraoperative, secondary to implant removal), a large revision acetabular implant with multiple screws may be used if 50% of the remaining host bone retains structural integrity and areas of primary support for the cup remain intact [1].

- For Type IIIA acetabular periprosthetic fractures (traumatic, stable component), the cup is left in place and protected weight bearing for 8 to 12 weeks should be considered [1].
- For Type IIIB acetabular periprosthetic fractures (traumatic, unstable component), revision to a porous revision acetabular implant with multiple screws should be performed [1].
- If a posterior column fracture is present in Type IIIB acetabular periprosthetic fractures, fixation with a pelvic plate and screws should be performed before acetabular implant insertion [1].
- For Type IVA acetabular periprosthetic fractures (spontaneous, <50% bone stock loss), a large revision acetabular implant with multiple screws may be used and bone graft is used as needed [1].
- For Type IVB acetabular periprosthetic fractures (spontaneous, >50% bone stock loss), bulk allograft or metallic augmentation are used to manage the bone defect [1].
- Pelvic plate and screws may be needed to restore column stability in Type IVB acetabular periprosthetic fractures [1].
- A cage or cup-cage construct is used in Type IVB acetabular periprosthetic fractures if the host bone is insufficient to allow bone ingrowth [1].
- The pelvic fracture in Type IVB acetabular periprosthetic fractures should not be fixed using only an acetabular implant with screws that secure the major bone fragments [1].
- For Type VA acetabular periprosthetic fractures (pelvic discontinuity, <50% bone stock loss), the posterior column fracture is fixed with a pelvic plate and screws before acetabular implant insertion [1].
- Revision to a porous revision acetabular implant with multiple screws should be performed for Type VA acetabular periprosthetic fractures [1].
- Bone graft is used to repair the fracture site in Type VA acetabular periprosthetic fractures [1].
- Protected weight bearing for 8 to 12 weeks should be considered for Type VA acetabular periprosthetic fractures [1].
- For Type VB acetabular periprosthetic fractures (pelvic discontinuity, >50% bone stock loss), the discontinuity is fixed using a pelvic plate and screws [1].
- Bulk allograft or metallic augmentation should be used to manage the bone defect in Type VB acetabular periprosthetic fractures [1].
- A cemented acetabular implant, cage construct, or custom triflange component that spans from the ilium to the ischium should be used for Type VB acetabular periprosthetic fractures [1].
- For Type VC acetabular periprosthetic fractures (pelvic discontinuity with prior pelvic radiation), management is the same as that for type VB fractures [1].
- The capability of a porous cup to heal the fracture and achieve biologic fixation is very poor in Type VC acetabular periprosthetic fractures [1].
- A cemented acetabular implant, cage construct, or custom triflange component that spans from the ilium to the ischium should be used for Type VC acetabular periprosthetic fractures [1].

PERIPROSTHETIC FRACTURES: FEMUR

- Revision surgery is a risk factor for periprosthetic femoral fracture, with higher risk than primary total hip arthroplasty [1].
- Noncemented press-fit technique is a risk factor for periprosthetic femoral fracture compared to cemented technique [1].
- Compromised bone stock, such as osteolytic defect or osteoporosis, is a risk factor for periprosthetic femoral fracture [1].
- A minimum of two views (AP and lateral) are obtained on plain radiographs to help identify the type and extent of periprosthetic femoral fracture [1].
- Radiographs for periprosthetic femoral fracture should be assessed for cortical perforations and longitudinal split [1].

INSTABILITY AND DISLOCATION

- Acetabular implant abduction target is 30° to 50° and anteversion target is 5° to 25° [6].
- Combined acetabular and femoral implant anteversion target for females is 35° to 40° [6].
- Combined acetabular and femoral implant anteversion target for males is 30° to 35° [6].
- Decreased femoral offset and inadequate leg length restoration can result in femoral neck impingement against the pelvis or acetabular implant [6].
- Decreased femoral offset and inadequate leg length restoration can result in decreased abductor mechanism efficiency due to reduced moment arm [6].
- Female sex is associated with an increased dislocation rate [6].
- Osteonecrosis and femoral neck fractures are associated with an increased dislocation rate [6].
- Spinal fusion or limited lumbar spine mobility is associated with an increased dislocation risk [6].
- Revision total hip arthroplasty carries an increased dislocation risk compared to primary total hip arthroplasty [6].
- Closed reduction is commonly utilized to manage acute periprosthetic dislocation [6].
- Well-aligned components in periprosthetic instability may be treated with an increased head size, dual-mobility construct, trochanteric advancement, or constrained acetabular liner [6].
- Component revision should be considered for periprosthetic instability if components are malaligned or when femoral offset and/or length cannot be restored with retained components [6].
- The direct anterior approach has been associated with concerns about an increase in early complications, particularly femoral complications such as periprosthetic fracture, subsidence, and failure of osteointegration [2].
- Several large registry and multi-institution studies have shown that the direct anterior approach can be performed safely without an increase in complications in experienced hands [2].
- The posterolateral approach has a slightly higher dislocation rate [3].
- The anterolateral (Watson-Jones) approach has a low incidence of postoperative dislocation [3].

- The lateral (Hardinge) approach has a low rate of postoperative dislocation [3].

INFECTION

- Higher periprosthetic joint infection risk is associated with multiple surgical procedures [6].
- Higher periprosthetic joint infection risk is associated with uncontrolled diabetes, morbid obesity, inflammatory arthritis, malnutrition, smoking, and chronic immunosuppression [6].
- Longer index procedure surgical time is associated with a higher risk for operative field contamination and periprosthetic joint infection [6].
- Antibiotic timing and duration for periprosthetic joint infection prophylaxis should be given within 1 hour before skin incision [6].
- Allogeneic transfusion may independently increase periprosthetic infection [6].
- There is a dose-dependent relationship between blood transfusions and subsequent development of periprosthetic joint infection [8].
- The risk of periprosthetic joint infection can vary from as low as 0.5% to greater than 20% depending on patient-specific comorbidities and surgical factors [16].
- Asymptomatic bacteriuria has not been associated with postoperative surgical site infections and should not be considered a contraindication for total hip arthroplasty [5].
- The results of surgery for adverse local tissue reaction are generally poor, with relatively high rates of infection, instability, and reoperation [7].

ASEPTIC LOOSENING AND OSTEOLYSIS

- Aseptic loosening occurs from osteolysis or osseointegration failure [6].
- Linear pattern osteolysis is associated with cemented and mechanically unstable components, where debris accesses the implant bone interface through the effective joint space followed by acetabular migration or femoral subsidence [6].
- Focal pattern (balloon) osteolysis involves expansile osteolytic lesions that develop by accessing through areas where implant fixation is incomplete [6].
- Late implant loosening of cemented components is related to the quality of the cement mantle and its penetration into cancellous bone [6].
- A minimum 2-mm cement mantle thickness is associated with reduced loosening of cemented components [6].
- Initial implant stability is essential for osseointegration of noncemented components, and component subsidence is most commonly associated with failure to obtain adequate implant stability [6].
- Higher loosening rates of noncemented components may occur with large femoral heads [6].
- Revision is indicated for progressive stem deformation or incomplete fracture [7].
- Left untreated, a deformed or incompletely fractured stem ultimately fractures completely, making revision more difficult because the distal segment must be retrieved from the medullary canal [7].

BEARING SURFACE AND MATERIAL COMPLICATIONS

- The incidence of mechanical noise in total hip arthroplasty is between 0.2% and 17.0% [6].
- Increased rates of mechanical noise are associated with acetabular implant malposition [6].
- Microseparation and lift off are associated with “stripe wear” in total hip arthroplasty [6].
- Audible noise in total hip arthroplasty has not been associated with implant failure or revision [6].
- Factors associated with increased metal particle generation include acetabular implant malposition (edge loading) [6].
- Reduced or excessive clearance between the head and acetabulum is associated with increased metal particle generation [6].
- Corrosion at modular junctions and head-neck taper is associated with increased metal particle generation [6].
- Smaller femoral head size (<46 mm) in hip resurfacing is associated with increased metal particle generation [6].
- Female sex is associated with increased metal particle generation [6].
- Increased femoral head size (>36 mm) has been associated with a clinical, substantial reduction in dislocation rates [6].
- Increased femoral head size (>36 mm) has been associated with an increased incidence of groin pain [6].
- Increased femoral head size (>36 mm) has been associated with higher polyethylene wear rates among younger and more active patients [6].
- Increased femoral head size (>36 mm) has been associated with corrosion and loosening of the head-neck junction [6].
- Diagnosis of trunnionosis is made based on serum cobalt level > 1 ppb and cobalt ions >>> chromium ions [6].
- In 2015, over 90% of acetabular liners used in primary total hip arthroplasty were made of cross-linked polyethylene [2].
- Long-term data support a marked decrease in wear, osteolysis, and revision surgery beyond 15 years with cross-linked polyethylene when compared with conventional polyethylene [2].

SURGICAL APPROACH SPECIFIC COMPLICATIONS

- The anterior (Smith-Petersen) approach limits posterior acetabular visualization [3].
- Extensive release of the abductors in the anterior (Smith-Petersen) approach can result in weakness and a high incidence of heterotopic ossification [3].
- The lateral (Hardinge) approach is associated with heterotopic ossification incidence as high as 47% in primary total hip arthroplasty [3].
- The lateral (Hardinge) approach involves increased intraoperative time and blood loss because of the time needed to repair the trochanteric osteotomy site [3].

- The lateral (Hardinge) approach results in slower rehabilitation due to weight-bearing protection postoperatively, usually a period of 6 weeks to allow for trochanteric healing [3].
- Trochanteric nonunion rates for the lateral (Hardinge) approach

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