

Periacetabular osteotomy

Anatomy & Pathophysiology

SURGICAL APPROACH & BIOMECHANICS

- Periacetabular osteotomy (PAO) was described by Ganz and others in the 1980s as a method for stabilizing symptomatic dysplastic hips in skeletally mature patients [16].
- The goal of PAO is to prevent arthritic deterioration in symptomatic dysplastic hips [16].
- The osteotomy is performed through a Smith-Petersen approach [16].
- The Smith-Petersen approach allows for reproducible bony cuts and extensive rotational freedom for acetabular repositioning [16].
- The Smith-Petersen approach carries little risk of osteonecrosis of the acetabular segment [16].
- The labrum and anterior femoral head-neck junction can be accessed through the distal end of the Smith-Petersen approach via arthrotomy [16].
- The rotated acetabular fragment is stabilized with screw fixation [16].
- Patients can be mobilized relatively quickly after PAO because the posterior column is left in continuity [16].
- Leaving the posterior column in continuity keeps the ischium attached to the axial skeleton [16].

INDICATIONS & PATHOLOGICAL CRITERIA

- PAO is indicated for symptomatic younger patients with spherically congruent dysplasia of the hip [16].
- A lateral center edge (LCE) angle of less than 20 degrees is an indication for PAO in symptomatic younger patients [16].
- Minimal or no secondary arthritic changes (Tönnis grade 0 or 1) are required for PAO indication in symptomatic younger patients [16].
- Symptomatic patients with weight-bearing or activity-related pain and center edge angles between 20 and 25 degrees may be reasonable surgical candidates for PAO [16].
- Women with coxa valga and excessive anteversion are specifically noted as potential candidates for PAO with center edge angles between 20 and 25 degrees [16].

- Adolescent patients with hip dysplasia who have fair congruity may be considered for PAO [16].
- Adolescent patients with hip dysplasia tend to fare better than older patients [16].
- PAO in adolescent patients may delay the need for hip replacement for one to two decades [16].
- Preoperative age older than 35 is an independent factor predictive of PAO failure [16].
- Fair or poor joint congruence is an independent factor predictive of PAO failure [16].
- When preoperative age is older than 35 and joint congruence is fair or poor, the chance of resultant severe pain or conversion to total hip replacement reaches 95% [16].
- Patients older than 50 years of age have radiographic and clinical 2-year results similar to those in patients younger than 50 years of age [16].
- PAO can be indicated for patients older than 40 years with a spherical femoral head and minimal arthritic change [16].
- Pincer-type femoroacetabular impingement (FAI) with global acetabular retroversion is an indication for PAO [16].

ASSOCIATED FEMORAL PATHOLOGY & OSTEOTOMIES

- Intertrochanteric osteotomy of the proximal femur is occasionally performed as a simultaneous procedure with PAO [16].
- Varus derotational osteotomy is performed to correct excessive valgus and anteversion of the proximal femur [16].
- Valgus osteotomy can be performed for coxa vara [16].
- Valgus osteotomy can be performed for aspherical Perthes type femoral head deformity to maintain articular congruence [16].
- Valgus osteotomy is used to avoid impingement of the greater trochanter with the rotated acetabular rim [16].
- Relative neck lengthening with osteochondroplasty of the femoral neck through open surgical dislocation combined with PAO has reported good short-term benefits in patients with typical Perthes deformity [16].

COMPLICATIONS & RISK FACTORS

- In a multicenter study of 1760 periacetabular osteotomies, the incidence of sciatic or femoral nerve partial or complete palsy was 2.1% [17].
- Half of the sciatic or femoral nerve palsies following PAO recovered fully [17].
- Recovery from nerve palsy following PAO was more likely when the femoral nerve was involved [17].
- Complications following PAO include superficial and deep infection [17].
- Heterotopic ossification is a reported complication following PAO, though it is rarely symptomatic [17].
- Acetabular fragment migration requiring reoperation is a reported complication following PAO [17].
- Symptomatic hardware requiring removal is a reported complication following PAO [17].

- The rate of symptomatic thromboembolic events following PAO is approximately 1% using a variety of thromboprophylactic measures [17].
- Obesity raises the risk of complications following PAO by a factor of 10 [17].
- Larger blood loss is associated with a higher rate of perioperative complications following PAO [17].
- Longer surgery duration is associated with a higher rate of perioperative complications following PAO [17].
- Associated femoral osteotomy is associated with a higher rate of perioperative complications following PAO [17].

COMBINED ARTHROSCOPIC PROCEDURES

- Arthroscopy of the central compartment to treat labrochondral pathology at the same time as PAO has been reported [17].
- Short follow-up of combined arthroscopy and PAO does not demonstrate complication rates higher than PAO alone [17].
- The use of arthroscopy for labral and chondral disorders due to dysplasia is controversial [17].
- Some reports indicate that arthroscopic procedures for dysplasia create increased instability [17].
- Patients with borderline dysplasia with impingement (LCE angle 20 to 24 degrees) fall between clear indications for PAO and arthroscopic FAI surgery [17].
- At 26 months, Larson et al. found good to excellent results in 61% of patients with borderline dysplasia after labral repair or debridement [17].
- In the study by Larson et al., associated femoral osteochondroplasty was performed in 72% of patients with borderline dysplasia [17].
- In the study by Larson et al., capsular plication was performed in 82% of patients with borderline dysplasia [17].
- Domb et al. reported good to excellent results in 77% of patients with borderline dysplasia (LCA ≥ 18 degrees and ≤ 25 degrees) at 2 years after arthroscopic labral repair with capsular plication with inferior shift [17].
- Patients with borderline dysplasia are more likely to have higher grades of chondral damage on both the femoral head and acetabulum at the time of FAI arthroscopic surgery compared to patients without borderline dysplasia [17].
- Greater degrees of acetabular chondral damage are predictors of poorer outcomes in patients with borderline dysplasia treated with arthroscopy [17].
- Greater labral damage is a predictor of poorer outcomes in patients with borderline dysplasia treated with arthroscopy [17].
- Lesser degrees of femoral head cartilage damage are predictors of poorer outcomes in patients with borderline dysplasia treated with arthroscopy [17].

Investigations

RADIOGRAPHY

- Plain radiographs are the first imaging studies obtained for patients presenting with hip pain [6].
- Standard AP radiographs of the hip and pelvis are used to examine bony architecture, check for evidence of joint space narrowing or changes to bone quality, and quantify femoral head coverage [6].
- The Dunn view and frog leg view are appropriate to measure the alpha angle to determine the presence of impingement [6].
- A complete hip series usually consists of an anterior-posterior (AP) pelvis, a centered AP hip, a lateral view (frog-leg, cross-table, Dunn 45° or 90°), and a false-profile (Lequesne) view [7].
- Acetabular morphology is assessed on AP pelvis radiographs to evaluate acetabular overcoverage and undercoverage [7].
- The femoral head-neck junction morphology is often assessed using the alpha angle [7].
- Some studies have shown that radiographs, in particular the Dunn 45° view, may be more accurate for determining the alpha angle measurement than CT or MRI [7].
- The Tönnis angle is defined by the angle of the acetabular sourcil and a line parallel to the transverse pelvis axis, with values between 0° and 10° considered normal [7].
- The lateral center-edge angle of Wiberg is the angle between a line from the center of the femoral head perpendicular to the transverse pelvis axis and a second line from the center of the femoral head to the superolateral most point of the acetabulum, with angles of 20°–40° considered normal [7].
- The femoral head extrusion index is defined by the length of the femoral head that lies beyond the acetabulum as a percentage of the total horizontal width of the femoral head, with values greater than 25% considered abnormal [7].
- Coxa profunda is diagnosed when the fossa line touches or is medial to the ilioischial line on an AP pelvis radiograph [7].
- The “crossover” sign on an AP pelvis radiograph indicates acetabular retroversion related to lateralization of the anterior acetabular wall relative to the posterior acetabular wall [7].
- An optimal AP pelvis image requires the sacrococcygeal joint to be between 3 and 5 cm above the superior border of the symphysis pubis for neutral pelvic tilt [7].
- Osteoarthritis of the hip can be categorized using the Kellgren-Lawrence or Tönnis classifications [7].
- Radiographs remain integral to the assessment of fractures and can be supplemented with CT to further investigate suspected occult fractures, define fracture morphology, and assist in preoperative planning [7].

MAGNETIC RESONANCE IMAGING

- MRI is the modality of choice for patients suspected of soft tissue or intra-articular pathology, given its superior sensitivity and specificity [6].

- Conventional MRI is effective at identifying osteochondral injuries, musculotendinous pathologies, and inflammation [6].
- Magnetic resonance arthrography (MRA) is more appropriate than conventional MRI to determine injuries to the labrochondral structures and the ligamentum teres and to identify the presence of loose bodies and synovial chondromatosis [6].
- The utility of MRA in the accurate detection and staging of articular cartilage lesions is reduced, with sensitivity reported to be less than 50% compared with arthroscopic findings [6].
- Recent advances in MRI imaging techniques, such as delayed gadolinium-enhanced MR imaging and T2* mapping, allow for a more in-depth analysis of the structure of articular cartilage [6].
- Delayed gadolinium-enhanced MR imaging and T2* mapping were effective at detecting early changes to the articular cartilage surfaces of patients with hip dysplasia and femoroacetabular impingement [6].
- Noncontrast MRI at 3T is generally adequate for diagnosing intra-articular pathology [10].
- If 3T imaging is unavailable, MRA can be considered at 1.5T for increased diagnostic accuracy [10].
- MRI is helpful in identifying femoral neck stress fracture in athletes and predicting patients that may require surgical intervention [10].
- MRI is useful for the assessment of DDH and FAI, as well as for extra-articular pathologies, stress injuries of bone, and hip arthroplasties [10].
- MRI is helpful in assessing complications of conventional and resurfacing hip arthroplasties, particularly those with metal-on-metal bearing systems [10].
- Major MRI findings that help predict histologic ALVAL scores include synovial thickening, synovitis, synovial volume, abductor disruption, and soft-tissue edema [10].
- A prospective study found similar accuracies between noncontrast 3T MRI and 1.5T MRA in femoroacetabular impingement [8].
- In a retrospective study evaluating noncontrast 3T MRI versus hip arthroscopy, accuracy for labral tears was 98% and for acetabular cartilage lesions was 90% [8].

COMPUTED TOMOGRAPHY

- CT scans are effective for examining cortical and cancellous bone and can be used to create three-dimensional reconstructions of the hip for use in surgical planning [6].
- Measurements of femoral head coverage and acetabular and femoral impingement can be performed reliably using CT images [6].
- CT overcomes the limitations of radiography by providing three-dimensional assessment of bony morphology and, to some degree, assessment of soft-tissue abnormalities [2].
- Combined with arthrography, CT can evaluate chondrolabral abnormalities, specifically in patients with contraindications to MRI [2].
- CT is helpful in fracture evaluation, particularly in the setting of negative radiographs or for further defining fracture morphology in patients requiring surgical reduction [2].

- Low-dose CT with three-dimensional reformats is particularly useful in surgical planning of complex or borderline deformities [12].
- 3D volume renderings from CT are useful to aid in preoperative planning in FAI and subspine impingement [10].

ULTRASONOGRAPHY

- Ultrasonography provides real-time dynamic assessment of the hip and is useful in diagnosing soft-tissue abnormalities about the hip joint [2].
- Ultrasonography is particularly useful in providing real-time guidance during diagnostic and therapeutic procedures [2].
- Although ultrasonography is a valuable tool to examine pediatric hip conditions, its utility in evaluating the adult hip is limited [6].
- Ultrasonography can be an effective modality to identify musculotendinous disruptions, effusions associated with intra-articular pathology, or inflammatory conditions, such as bursitis [6].
- Ultrasonography is increasingly used for targeted injections into muscles, tendons, or intra-articularly around the hip for use with corticosteroids or biologic treatments [6].
- Ultrasonography allows bedside evaluation of the hip and can be used to guide interventions in the office setting [10].
- Ultrasonography cannot image inside bone because bone cortex reflects almost all sound waves [11].
- Internal joint structures are not well visualized by ultrasonography unless they are in a superficial location [11].
- Image quality and interpretation of ultrasonography depend on the experience of the ultrasonography technician and the radiologist [11].

GENERAL PRINCIPLES

- A thorough understanding of normal anatomy and biomechanics is necessary to identify pathology and determine the appropriate course of treatment [1].
- Findings from imaging studies should complement clinical examination findings to provide the most accurate diagnosis [1].
- Clinical examination tests and imaging findings should be used to confirm a suspected clinical diagnosis [1].

References

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