Novel Cartilage Imaging Techniques for Hip Disorders

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KEYWORDS

• Hip deformity • Acetabular dysplasia • Osteoarthritis • Imaging

KEY POINTS

- Acetabular dysplasia, cam, and pincer deformities are a major cause of premature hip osteoarthritis.
- An early feature of osteoarthritis is loss of the negatively charged proteoglycans in the extracellular matrix.
- Delayed gadolinium-enhanced MR imaging of cartilage (dGEMRIC) and sodium-imaging techniques are highly specific for assessing cartilage charge density.
- T2 and T1rho are noncontrast biochemical imaging techniques that show early cartilage matrix damage in vitro and some clinical studies.
- dGEMRIC is clinically useful in staging early osteoarthritis in patients with acetabular dysplasia.

INTRODUCTION

Increasingly, hip osteoarthritis is thought to be caused by structural deformities, such as acetabular dysplasia and femoroacetabular impingement (FAI). Acetabular dysplasia results in a shallow acetabulum that leads to hip instability, increased mechanical stress on the acetabular cartilage, and eventual joint degeneration. FAI syndrome is a dynamic mechanical phenomenon of the hip in which the femoral head or neck causes damage to the acetabular labrum and/or cartilage from direct collision between the 2 bony structures. Often the hip is predisposed to FAI syndrome because of a femoral and/or acetabular hip deformity. Currently, surgical techniques such as periacetabular osteotomy, femoral head-neck osteoplasty, and acetabular rim osteoplasty are available to correct the deformities that lead to instability or impingement. The surgical results are limited by the extent of articular damage before surgical intervention. Increasingly, high-resolution MR imaging and biochemical cartilage imaging techniques are becoming clinically important in detecting preradiographic cartilage damage. This article outlines the imaging methods to assess hip structural deformities and methods to assess chondral damage using MR imaging. Imaging is becoming critically important in treating patients with these hip disorders; however, as always, careful clinical-radiographic correlation must be performed to determine if the structural deformity seen on imaging studies is responsible for the patient's problem and hence justifies surgical intervention.

PLAIN RADIOGRAPHIC ANALYSIS OF HIP OSTEOARTHRITIS

Plain radiographic analysis is the main method through which hip structural abnormalities are assessed, and is the gold standard for assessing radiographic osteoarthritis. However, by the time clear evidence of radiographic osteoarthritis is seen, often extensive damage is present in the joint, such that most surgeons would see this as a contraindication for joint-preserving surgery.

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Pelvic Radiograph

The anteroposterior pelvic radiograph is used to assess the presence of radiographic osteoarthritis, determine acetabular coverage and orientation, and increasingly determine femoral head-neck offset.

A properly obtained pelvic radiograph should have the coccyx directly over the pubic symphysis, and the iliac wings, obturator foramina, and acetabular tear drops should be symmetric in appearance (**Fig. 1**). Additionally, if the pelvic inclination is appropriate, the distance between the superior border of the pubic symphysis and the first sacrococcygeal joint should average approximately 32 mm in men and 47 mm in women.[1]

Radiographic osteoarthritis is often graded using the Tönnis classification in hip joint preservation surgery.[2] A more quantitative method of assessing radiographic osteoarthritis is to measure the minimum joint space width (mJSW) of the weight-bearing zone. An mJSW less than 2.5 mm is considered to be definitely pathologic and is associated with poor outcome after FAI surgery.[3] When treating acetabular dysplasia with periacetabular osteotomy, some radiographic osteoarthritis is tolerated as long as the joint space improves and becomes more congruent on abduction internal rotation functional radiographs.[4] However, as a general rule in joint preservation surgery, the presence of Tönnis grade 2 or higher or mJSW less than or equal to 2 mm has been shown to be associated with poor prognosis after surgery.[5]

False Profile Radiograph

For a complete assessment of the acetabular deformity, obtaining a false profile view[6] is recommended (**Fig. 2**). It is a good view to detect early cartilage loss in the superior weight-bearing zone typically seen in cam impingement and acetabular dysplasia. In cases of pincer impingement, the loss of posterior acetabular cartilage can be seen on the false profile view.

In a normal hip, the superior joint space is larger than the posterior joint space on a false profile view (see **Fig. 2**). When this relationship is reversed, it is a sign of significant cartilage loss in the weight-bearing acetabulum. Additionally, in pincer impingement, the counter-coup damage in the posterior acetabulum will be seen as joint space narrowing in this area, subchondral sclerosis, and cyst formation.

MR IMAGING

High-resolution MR imaging is widely used to detect the presence of chondral damage associated with FAI and acetabular dysplasia. MR imaging as a cross-sectional imaging modality also allows assessment of proximal femur and acetabulum morphology. Additionally, MR imaging is useful to rule out other causes of hip pain such as femoral neck stress fracture, benign and malignant tumors, and tendinopathy. True acetabular dysplasia is uncommon; however, cam deformity

Fig. 1. A properly taken anteroposterior pelvic radiograph should have the coccyx directly over the symphysis and symmetric obturator foramina. Additionally, if the pelvic inclination is appropriate, the distance between the superior border of the pubic symphysis and the first sacrococcygeal joint should average approximately 32 mm in men and 47 mm in women.

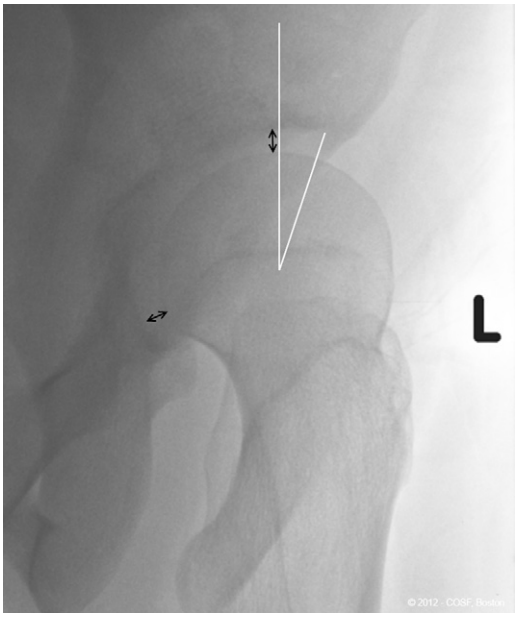

Fig. 2. Typical false profile view. The center-edge angle is measured by drawing a vertical line through the center of the femoral head and a second line through the center of the femoral head to the anterior edge of the sourcil. Typically on a false profile view, the superior joint space is wider than the posterior joint space.