Roles of radiograph, magnetic resonance imaging, three-dimensional computed tomography in early diagnosis of femoro-acetabular impingement in 17 cases

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Objective: To evaluate the roles of radiograph, magnetic resonance imaging (MRI), three-dimensional computed tomography (3-D CT) in early diagnosis of femoro-acetabular impingement (FAI) in 17 cases.

Methods: Plain radiographs of the pelvis, 3-D CT, and MRI of the hip were made on 17 patients with groin pain, which was worse with prolonged sitting (i.e. hip flexion). There was no history of trauma or childhood hip disorders in the patients who did not complain of any other joint problems or neurologic symptoms. All patients had positive anterior or posterior impingement test. Plain radiographs included an antero-posterior (AP) view of the hip and a cross table lateral view with slight internal rotation of the hip. CT scan was performed with the Lightspeed 16 row spiral (General Electric Company, USA) at 1.25 mm slice reconstruction. MRI scan was performed on the Siemens Avanto (Siemens Company, Germany)1.5T supraconduction magnetic resonance meter. The CT and MRI scans were taken from 1 cm above the acetabulum to the lesser trochanter in 5 series.

Results: The plain radiographs of the pelvis showed that among the 17 patients, 12 (70.59%) had “Cam” change of the femoral head, 6 (35.29%) had positive “cross-over” sign, and 17 (100%) had positive “Pincer” change of the acetabulum. The 16 row spiral CT noncontrast enhanced scan and 3-D reconstruction could discover minus femoral offset and ossification and osteophyte of the acetabulum labrum in all the 17 cases (100%). The MRI noncontrast enhanced scan could discover more fluid in the hip joint in 15 cases (88.33%), subchondral ossification in 3 cases (17.6%), and labrum tears in 3 cases (17.6%).

Conclusions: Plain radiographs can provide the initial mainstay for the diagnosis of FAI, 3-D CT can tell us the femoral offset, while MRI can show labrum tears in the very early stage of FAI. Basically, X-ray examination is enough for the early diagnosis of FAI, but 3-D CT and MRI may be useful for the treatment.

Key words: Femur; Tomography scanners, X-ray computed; Magnetic resonance imaging

Objective: Femoro-acetabular impingement (FAI) is very common in clinic, especially in young adults. FAI is associated with cartilage damage, labral tears, early hip arthritis, hyperlaxity, sports hernias, and low back pain. Mostly, a supine antero-posterior (AP) pelvic view and a hip cross table lateral view are sufficient for the diagnosis of FAI, but what the roles of three-dimensional computed tomography (3-D CT) and magnetic resonance imaging (MRI) are in the early diagnosis of FAI has not been answered. In this study, we made a perspective study to compare the radiographs with MRI and 3-D CT in the early diagnosis of FAI.

METHODS

A complete history should focus on the exact location of pain, nature of discomfort, timing of the onset of symptoms, predisposing factors of the symptoms, and physical examination, which should be done in five different positions: standing, seating, supine, lateral, and prone.
Seventeen male patients, aged from 32 to 55 years with the mean age of 41 years, suffered from groin pain for 3-27 years (15 years on average), which became worse with prolonged sitting, i.e. hip flexion. They had no history of trauma, childhood hip disorders, any other joint problems or neurologic symptoms. Anterior or posterior impingement test was positive in all the patients.

Plain radiographs included an AP view of the hip and a cross table lateral view with slight internal rotation of the hip. CT scan was performed with Lightspeed 16 row spiral (General Electric Company, USA) at 1.25 mm slice reconstruction. MRI scan was performed on the Siemens Avanto (Siemens Company, Germany) 1.5T supraconduction magnetic resonance meter. The CT and MRI scans were taken from 1 cm above the acetabulum to the lesser trochanter in 5 series.

Plain radiographs
Plain radiographs of an AP view and a cross table lateral view with slight internal rotation of the hip were performed in all the 17 patients by the same technician and interpreted by 5 senior doctors.

3-D CT
CT scanning was performed in all the 17 patients with Lightspeed 16 row spiral CT using 1.25 mm thickness and 3-D images were reconstructed in Advantage Windows 4.1 Medical System (General Electric Company, USA) by the same technician and interpreted by 5 senior doctors.

MRI
MRI was done with a 1.5T superconducting imaging system manufactured by Siemens Avanto. All the patients received 5 series of scannings: (1) axial time of spin echo (TSE) T₁W₁ time of repetition (TR) of 560 ms, time of echo (TE) of 11 ms, window of 380 mm×380 mm, section thickness of 8 mm, and sections of 15; (2) axial flash T₁W₁ TR of 500 ms, TE of 17 ms, window of 380 mm×380 mm, section thickness of 8 mm, and sections of 15; (3) axial flash T₂W₁ FS TR of 500 ms, TE of 17 ms, window of 380 mm×380 mm, section thickness of 8 mm, and sections of 15; (4) coronal TSE T₁W₁ TR of 734 ms, TE of 23 ms, window of 360 mm×360 mm, section thickness of 5 mm, and sections of 15; and (5) coronal flash T₂W₁ FS TR of 735 ms, TE of 17 ms, window of 360 mm×360 mm, section thickness of 5 mm, and sections of 15.

RESULTS
Plain radiographs of the pelvis showed that among the 17 patients, 12 (70.59%) had "Cam" change of the femoral head, 6 (35.29%) had positive "cross-over" sign, and 17 (100%) had positive "Pincer" change of the acetabulum. The 16 row spiral CT noncontrast enhanced scan and 3-D reconstruction could discover minus femoral offset, ossification and osteophyte of the acetabulum labrum in all the 17 cases (100%). The result of MRI noncontrast enhanced scan discovered more fluid in the hip joint in 15 cases (88.33%), subchondral ossification in 3 cases (17.6%), and labrum tears in 3 cases (17.6%).

Typical case
A 54-year-old male had a 28-year history of pain in the bilateral hips but without any trauma. The pain had been constant over the past several years with increased severity and was accompanied with limp occasionally after long standing or long sitting but released completely after rest. The pain was always found in the groin area and would occasionally radiate down to the knees. The patient did not complain of any other joint problems or neurologic symptoms.

On physical examination, there was no leg discrepancy in this patient though he had a slight antalgic gait. Ranges of motion for the hips were described as follows: flexion: 110° in the left side (L) and 120° in the right side (R); adduction: 15° (L) and 15° (R); internal rotation: 30° (L) and 35° (R); and abduction: 10° (L) and 10° (R), respectively. Anterior and posterior impingement tests were positive in both hips, i.e. flexion, adduction and internal rotation reproducing knife-like pain in the groin. However, the motor power was normal.

The AP view of the pelvis (Fig.1) showed that oval shape of both femoral heads could be seen. Abnormal convex and ossification due to repeated impingements can be seen in the transit part from the femoral head to the femoral neck and the acetabular lip. Spiral CT scanning of the hip (Fig. 2) showed ossification in both hips. 3-D CT scanning reconstruction showed the non-round femoral head and an abnormal convex directly (Fig. 3). MRI of the hips reminded us of liquid in the hip joint and lip tears (Fig. 4).
DISCUSSION

FAI is induced by excessive friction in the hip joint and is common in young active individuals. Basically, the femoral head rubs the acetabulum abnormally, thus creating damage to the hip joint. The damage often occurs in the articular cartilage and the labrum. FAI can be divided into three types: Cam, Pincer, and mixed. The Cam type describes the relationship between the femoral head and neck as aspherical or not perfectly round. This loss of roundness contributes to the abnormal contact between the head and the socket.

The Pincer type describes the situation that the acetabulum has excessive coverage of the ball or femoral head. This over-coverage typically exists along the front-top rim of the acetabulum and results in “pinched” labral cartilage between the rim of the acetabulum and the anterior femoral head-neck junction. The Pincer type of the impingement is typically secondary to “retroversion”, a turning back of the acetabulum, or “profunda”, too deep acetabulum. Most of the time, the Cam and Pincer types would combine together.¹

Most FAI patients can be diagnosed by a good history, physical examination, and plain x-ray films. A patient’s history generally involves complaints of hip pain (front, side, or back) and loss of hip motion. Physical examination generally confirms the patient’s history and eliminates other causes of hip pain. Positive anterior or posterior impingement test may be specifically useful for the diagnosis of FAI.

In most cases, a supine AP view of the pelvis and a hip cross table lateral view of x-ray are sufficient. The AP view of the pelvis should be taken so that the coccyx projects 1.5 cm above the symphysis pubis. The lateral view should be made with the lower extremity internally rotated for 15°. In this study, the plain X-ray films are used to determine the shape of the ball and the acetabulum as well as to assess the amount of joint space in the hip primarily. There are 70.59% of positive “Cam” and “Pincer” changes both in the femoral head and the acetabulum, which means that the mixed type accounts for more than half of the group, but the most common type should be “Pincer” type. “Cross-over” sign² is very special for the diagnosis, but only 35.29% in the group have positive results.

CT scan is often helpful to understand the anatomy of the bones of the hip joint but not essential to the diagnosis of FAI, therefore, CT is not recommended in clinic. However, 3-D CT should be recommended after X-ray and before operation. In our study, we discovered minus femoral offset³ in 17 cases, which is very useful in the determination of operation, especially for femoral osteochondroplasty. And ossification around the acetabulum can remind us FAI indirectly.

MRI of the hip is used to confirm a labral tear or damage to the joint surface. MRI is much helpful in eliminating certain causes of non-FAI hip pain including avascular necrosis (dead bone) and tumors. In our study, more than 80% had much fluid in the hip joint and more than 17% had labral tear, which need repair.
Finally, from this study we can conclude that plain radiographs can provide initial mainstay for the diagnosis of FAI, 3-D CT can tell us the femoral offset, while MRI can show labrum tears in the very early stage of FAI. Basically, X-ray examination is enough for the early diagnosis of FAI, and 3-D CT and MRI may be useful for the treatment.

REFERENCES


(Received February 5, 2009)