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Title: Prevalence of Femoroacetabular Impingement in Asymptomatic Patients



PREVALENCE OF FAI IN ASYMPTOMATIC PATIENTS

BACKGROUND

Osteoarthritis of the hip is a debilitating and painful condition that affects many Canadians. Changes in hip morphology due to congenital anomalies, childhood hip disease, inflammatory or systemic arthropathies, trauma or surgery have long been associated with the development of secondary OA of the hip¹⁻⁶. A second category of idiopathic OA is known to account for approximately 40-50% of cases^{3,5,6}. Recent studies have shown that idiopathic OA is often caused by subtle, and often radiographically occult, abnormalities at the femoral head-neck junction or acetabulum that result in abnormal contact between the femur and acetabulum^{2,3,7-13}. This condition, known as femoroacetabular impingement, exists in two forms. In CAM type impingement, abnormal excess bone at the antero-superior surface of the femoral head neck junction results in reduced clearance during flexion, adduction and internal rotation^{7,14-16}. Repeated abutment of the femoral neck and acetabular rim causes labral tears and eventually chondral damage and OA. In Pincer type impingement, overcoverage of the femoral head commonly due to acetabular retroversion leads to linear contact between the acetabular rim and femoral head-neck junction which can result in labral tears and eventual degenerative arthritis^{7,17}.

FAI is a widely accepted cause of early OA of the hip⁷⁻¹³. Much research has been focused on early diagnosis of this condition in patients with hip and groin pain. The importance of early and accurate diagnosis of FAI stems from the fact that there are effective treatments available to alleviate the symptoms of FAI and correct the underlying anatomic abnormality with relatively minor surgery. There is evidence to support that both arthroscopic and open surgery for FAI with excision osteoplasty in CAM impingement and periacetabular osteotomy in Pincer impingement are effective in relieving the symptoms of FAI¹⁸⁻²⁷. The hope is that these procedures will circumvent the progression to labral tears and OA in patients with FAI and ultimately eliminate the need for joint replacement surgery in this population.

The association between patients presenting with hip pain, signs of impingement on physical exam and abnormalities of the femoral head-neck junction is clearly outlined in the literature⁷⁻¹⁶. However, there is currently no published information on the prevalence of abnormalities of the femoral head-neck junction in the general population. This information is vital to properly understand the course of this disease. Firstly, knowledge of the prevalence of femoral head-neck junction abnormalities in an asymptomatic group will aid in determining the clinical significance of the radiographic findings seen in patients with FAI. Secondly, there is no prospective data on patients with the anatomic abnormality associated with FAI to determine what percentage of people will go on to develop labral tears and OA. This information is required to determine if joint preserving procedures should be offered to all patients with clinically diagnosed FAI, a subgroup of these patients or perhaps none.

The aim of this project is to examine the incidence of femoral head-neck abnormalities associated with CAM type FAI in patients without hip pain or pre-existing hip disease using non-contrast MRI.

STUDY DESIGN:

A review of current literature from January 1966 to October 2006 was performed in all languages within Medline and Embase using the following keywords: "femoroacetabular or femoro-acetabular or femoral acetabular impingement", "cam or pincer impingement", "hip impingement", "alpha angle", "hip joint or hip dislocation", "idiopathic or primary osteoarthritis or oa", "prevalence", "cohort studies", "MRI", "femur head or femur neck or femur" and "acetabulum or acetabular". To our knowledge there is no published information on the prevalence of anatomic abnormalities of the femoral head-neck junction associated with FAI in an asymptomatic population. One paper by Ganz et al, makes reference to an unpublished study which found a high incidence of FAI in patients with coxa profunda when compared to a group of patients with normal asymptomatic hips⁷. However, no data on the incidence of impingement in the control group of asymptomatic patients is cited. Meyer et al examined 21 intact femurs from desiccated skeletons without signs of OA or sequelae of childhood hip disease and found that 11 had an aspherical femoral head-neck junction which is one of the findings in CAM type FAI²⁸. Ezoc et al reported the prevalence of acetabular retroversion to be 6% in a control group²⁹.

In one German paper by Leunig et al, the prevalence of FAI is estimated to be between 10-15%³⁰. Experts in the field feel that the prevalence may be significantly higher than this. Our hypothesis that the prevalence of femoroacetabular impingement will be 20% in asymptomatic patients. In order to detect a prevalence of 20% with 95% confidence intervals, we will need to image 200 hips.

Historically, investigation of hip pain begins with plain radiographs. The initial abnormal configuration of the femoral head-neck junction seen in patients with idiopathic OA was described on plain film⁶. The most common abnormality is an osseous bump at the anterosuperior head-neck junction which is best seen on lateral radiographs^{28,31}. The head-neck offset ratio can be assessed on cross table lateral views of the hip with the joint in internal rotation. The ratio of the femoral head diameter and the offset between the femoral head and neck is examined and generally a value of less than 0.15 indicates risk of impingement³². Notzli et al also described a method of evaluating the femoral head-neck configuration on MRI whereby a line is drawn between the centre of the femoral head and neck and a second line between the centre of the femoral head and the point A, at which the radius of the femoral head diverges from the neck⁹. The angle between these two lines is called the alpha angle and a value of greater than 50-55 degrees is considered large and associated with risk of impingement^{9,16,33}. There are a number of studies which have used the alpha angle as an indicator of FAI which have shown consistently that an alpha angle greater than 50 degrees is indicative of risk of impingement^{16,33-34}. The alpha angle is easy to measure on MRI with good inter and intraobserver reliability^{9,16,33-34}. It is currently accepted as an accurate and reliable measurement of the anterior concavity of

the femoral head-neck junction in both the radiologic and orthopedic literature^{9,16,33-35}. Beaulé and Zaragoza also described the posterior concavity of the hip joint on CT using the beta angle³³. They examined the relationship between the alpha and beta angles and found that an alpha-to-beta ratio of greater than 1.25 was 100% sensitive for FAI. Their work suggested that the alpha-to-beta ratio may have increased sensitivity in detecting FAI than using the alpha angle alone.

While plain radiography can offer much valuable information regarding the relationship of the femoral head and neck, as well as, the orientation of the acetabulum, there are several limitations associated with this modality. The main problem with plain hip radiographs is that they vary considerably depending on patient positioning making assessment of acetabular morphology and alpha angle measurements unreliable^{9,11,16,31-34}. Siebenrock et al described criteria for evaluating adequacy of pelvic radiographs³⁶, however, patients that do not meet the Siebenrock criteria are generally excluded from studies. A method for computer correction of the degree of pelvic tilt was described by Tannast et al, however, this software requires a spherical acetabulum³⁷. MRI is a desirable alternative to plain radiography as positioning is not affected by alignment of the femoral neck or joint contractures provided that the thigh is horizontal^{9,16}. There is also no exposure to ionizing radiation. MRI also allows multiplanar acquisitions and reformats to be performed which are often necessary to accurately assess reduced femoral head-neck junction. As many authors have pointed out, the abnormality in FAI occurs in the sagittal and axial planes and are therefore often missed on plane films^{1,9,11,16}. While MR arthrography is the modality of choice to assess for labral tears, there is evidence to suggest that non contrast MRI has similar accuracy to MRA in diagnosing labral tears³⁸. Also, MRA is an invasive test requiring intra-articular contrast injection and is not considered ethical in an asymptomatic population.

Patients will be recruited from outpatient upper limb clinics at the Ottawa Hospital General Campus where they will be approached about participating in the study by a research coordinator. The inclusion criteria include age under 50, no hip or groin pain, no history of childhood hip disease, no prior hip surgery, no arthritis in any joint, no contraindication to MRI and BMI less than 30. The study procedure will be fully explained at this time and informed consent obtained. Patients will then be contacted regarding scheduling for hip MRI.

Just prior to MRI, patients will be examined for hip ROM and signs of impingement by a physician. MRI of the hip will be performed without contrast and will include a fat suppressed T2 weighted 3D isotropic voxel acquisition of the pelvis (targeting both hips) with multiplanar and radial reformats. The acquisition time for the scan is approximately 20 minutes.

The MRI images will be reviewed independently by 2 MSK radiologist and the following information recorded: alpha angle, beta angle, alpha-to-beta ratio, presence of acetabular retroversion and presence of degenerative changes.

CLINICAL IMPLICATIONS AND FOLLOW-UP STUDIES:

Prevalence of FAI will be calculated in asymptomatic patients as determined by abnormal alpha angle and abnormal alpha-to-beta ratio. Once this population is identified, further research in the form of a prospective study to determine which patients go on to develop symptoms and labral or chondral pathology and in what time frame this progression occurs can be performed.

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