Correlation Between Cam-Type Femoroacetabular Impingement and Radiographic Osteitis Pubis

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abstract

A mechanistic link has been suggested between cam-type femoroacetabular impingement and increased stress on the symphysis pubis. This retrospective study was conducted to determine whether there is an increased prevalence of osteitis pubis, as evidenced by imaging, in patients with femoroacetabular impingement compared with age-matched control subjects. Search of a radiologic database of a large academic health institution for all patients with cam-type femoroacetabular impingement diagnosed by magnetic resonance imaging or magnetic resonance arthrogram between January 2000 and October 2013 identified 46 cases. Two radiologists reviewed these cases independently and confirmed the presence of femoroacetabular impingement based on alpha angle and other characteristics of cam morphology. The imaging studies were further evaluated for characteristics of osteitis pubis, with severity graded from minimal to severe on a 4-point Likert scale. A control group composed of age-matched subjects without diagnosed femoroacetabular impingement was also evaluated for osteitis pubis. A statistically significant increase in the prevalence of osteitis pubis was found in patients with femoroacetabular impingement compared with age-matched control subjects, with a prevalence of 43.48% in the femoroacetabular impingement group compared with 12.77% in the control group (P=.0012). On the 4-point Likert scale, the average severity of osteitis pubis in the group with femoroacetabular impingement was 1.5 (minimal to mild) compared with 0.53 (no osteitis pubis to minimal findings) in the control population. This significant increase in osteitis pubis in patients with femoroacetabular impingement supports the clinical link between these 2 processes.

Femoroacetabular impingement is a well-characterized cause of hip pain that results from abutment of the femoral neck against the acetabular rim. This disorder has been recognized in many young adults with intra-articular hip pathology, and it causes labral tears, cartilage delamination, early onset of osteoarthritis, and increased pain that significantly disrupts activities of daily living. A clinical link has been suggested between femoroacetabular impingement and both osteitis pubis and athletic pubalgia. Osteitis pubis is a painful and chronic condition that affects the pubic symphysis and parasympyseal bone and develops after athletic activity. It is a common cause of extra-articular groin pain.

Multiple studies have suggested an association between intra-articular hip pathology and groin pain with symphysis pubis abnormalities. The association between femoroacetabular impingement and symphysis pubis pain has been attributed to increased “upstream” stress of the “kinetic chain” of the hip. That is, stiff...
ness in 1 link of a series of coordinated segments causes increased demands on subsequent links. A study found an association between limited hip range of motion and the development of symptomatic groin pain, and this finding supports this kinetic chain theory. Furthermore, a “sports hip triad” of rectus abdominis, adductor, and hip pathology has been suggested in football players. A report linked femoroacetabular impingement with osteitis pubis, but this study was limited in scope because it reported only a single case.

Imaging correlation for these observations is unavailable or incomplete or focuses only on radiographic findings. The current study was conducted to identify an association between osteitis pubis and femoroacetabular impingement in adults with evidence of femoroacetabular impingement on magnetic resonance imaging (MRI) or magnetic resonance arthrography in a large academic health institution. The study also attempted to determine whether the association between osteitis pubis and femoroacetabular impingement is found in the general population and not only in elite-level athletes. Because MRI studies assessing hip pain are not routinely evaluated for pathology at the pubic symphysis, many cases of osteitis pubis may be missed. The study hypothesis was that patients with cam-type femoroacetabular impingement would have an increased prevalence of osteitis pubis compared with age-matched control subjects.

**MATERIALS AND METHODS**

A retrospective cohort study was conducted to assess patients with and without femoroacetabular impingement for radiographic evidence of osteitis pubis. Patients with femoroacetabular impingement were identified with a radiology database that included accession numbers and radiology reports for all patients at a large academic health institution. Institutional review board approval was obtained, and a search was created using the terms “femoroacetabular impingement,” “pincer,” and “cam” limited to magnetic resonance arthograms and MRI studies obtained between January 1, 2000, and October 22, 2013. The study included all patients who were at least 18 years old and had femoroacetabular impingement diagnosed by MRI or magnetic resonance arthrogram and radiologic images that provided adequate assessment of both the femoral acetabular joint and the pubic symphysis. Patients with previous hip surgery, severe osteoarthritis, or dysplasia in either hip were excluded because these factors may lead to independent changes in the pubic symphysis. The initial search yielded 203 radiographic reports, and these were read by 1 author (E.P.) to exclude reports that did not meet the inclusion criteria and those that found no femoroacetabular impingement because they were captured by search terms for other pathology (Figure 1). For example, the search term “cam” led to many reports that mentioned the shoulder procedure CAM (comprehensive arthroscopic management), and these reports were subsequently excluded. A total of 93 patients met the criteria for MRI scan review.

Images were reviewed in the picture archiving and communication system. A fellowship-trained musculoskeletal radiologist (V.K.) and a musculoskeletal fellow (A.W.) reviewed all images to confirm the presence of femoroacetabular impingement, particularly in cases that were considered borderline by the initial radiologist, and to exclude cases with underlying hip dysplasia or severe osteoarthritis. The radiologists then completed a predetermined data abstraction form assessing the presence of cam-type femoroacetabular impingement and osteitis pubis in a subject database. When an axial oblique sequence was available, an alpha angle of greater than 55° was used.

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**Figure 1**: Flowchart of the search and selection process for the radiology report. Abbreviations: FAI, femoroacetabular impingement; MR, magnetic resonance; PACS, picture archiving and communication system.
as 1 criterion to determine the presence of femoroacetabular impingement. In these cases and in cases without an axial oblique sequence, other characteristic findings, including an osseous bump at the anterolateral head and neck junction, synovial herniation pits, labral tears, cartilage lesions, subchondral cysts, and subchondral bone marrow edema, were used to make a final decision about the diagnosis of cam-type femoroacetabular impingement. The same cases were also evaluated for abnormalities of the symphysis pubis, namely, osseous irregularity or fracture, sclerosis, bone marrow edema, fatty change, osteophytes, effusion, or capsular hypertrophy, findings that are consistent with osteitis pubis. When available for comparison, plain films of the pelvis were used to help with the assessment of osteitis pubis. Severity was graded on a 4-point Likert scale, from minimal to severe (0=normal, 1=minimal, 2=mild, 3=moderate, 4=severe). When differences of opinion in grading arose, the 2 radiologists reviewed the cases together to reach a consensus.

A group of age-matched control subjects without radiographic evidence of femoroacetabular impingement was identified and evaluated for the prevalence of osteitis pubis on imaging. The same radiology database was used to search for all MRI scans of the pelvis obtained between January 1, 2010, and March 11, 2013, and the first 47 reports that matched the age and sex distribution of the study subjects were included. These control subjects had to meet all of the inclusion criteria except that they could not have evidence of femoroacetabular impingement. In the control group, most women underwent MRI for gynecologic indications and most men were assessed for inflammatory bowel disease or malignancy. The 2 radiologists similarly assessed for osteitis pubis and cam morphology in the control group and graded the severity of osteitis pubis on the same 4-point Likert scale that was used for the femoroacetabular impingement group.

Fisher’s exact test was used to determine whether there was a statistically significant difference in the prevalence of osteitis pubis in the femoroacetabular impingement and control groups. In each group, patients who had no or minimal findings of osteitis pubis were compared with those with mild to severe osteitis pubis. An odds ratio was calculated for the prevalence of osteitis pubis in the femoroacetabular impingement vs control groups. The mean difference in the severity of osteitis pubis on the 4-point Likert scale was also compared.

**RESULTS**

A total of 49 patients met the study inclusion criteria, including 46 cases of cam-type femoroacetabular impingement and 3 cases of pincer-type femoroacetabular impingement. Only the cases of cam morphology were included in the final analysis because the effect on the pubic symphysis has been studied primarily in these cases and the sample size of the pincer cases was too small to allow a final conclusion. The imaging modalities used in the cam-type femoroacetabular impingement group included magnetic resonance arthrogram (n=24) and MRI (n=22), and 32 of these cases also had plain films available for comparison in the assessment of osteitis pubis. In the age-matched control group, MRI scans from an additional 47 patients were included.

Of the patients with femoroacetabular impingement (n=46), 34 were men (73.91%) and 12 were women (26.09%). The control group (n=47) included 32 men (68.09%) and 15 women (31.91%) (Table). Average age in the group with confirmed femoroacetabular impingement was 34.50 years (range, 20-59 years), and average age in the control group was 35.32 years (range, 20-57 years), with no significant difference (P=.7233). The average alpha angle of patients with femoroacetabular impingement was 63.23°. Predominant findings in the femoroacetabular impingement cohort were labral tears (85%), cartilage lesions (61%), subchondral cysts (46%), osteophytes (35%), bone marrow edema (24%), and synovial herniation pits (19%).

A statistically significant increase in the prevalence of osteitis pubis was found in patients with cam-type femoroacetabular impingement vs age-matched control subjects. When patients with no evidence of osteitis pubis or only minimal findings were compared with those with mild to severe osteitis pubis, there was a prevalence of 43.48% in the femoroacetabular impingement group compared with 12.77% in the control group (P=.0012, Fisher’s exact test). The odds ratio for the presence of osteitis pubis in patients with femoroacetabular impingement vs control subjects was 5.26 (95% confidence interval, 1.86-14.82), showing a significant increase in osteitis pubis in patients with femoroacetabular impingement. Figure 2 and Figure 3 show MRI scans of 2 subjects with both cam-
type femoroacetabular impingement and osteitis pubis.

On a 4-point Likert scale, the average severity of osteitis pubis in patients with femoroacetabular impingement was 1.5 (minimal to mild) compared with 0.53 (no osteitis pubis to minimal findings) in the control population. The mean difference between the 2 groups was 0.97 (95% confidence interval, 0.60-1.36). Distribution of the severity of osteitis pubis is shown in Figure 4. The most common findings in patients with osteitis pubis in both the femoroacetabular impingement and control groups were osseous irregularity (88% of all patients with osteitis pubis), sclerosis (62%), osteophytes (38%), bone marrow edema (15%), capsular hypertrophy (19%), fatty change (15%), and osseous fragmentation (4%).

**DISCUSSION**

This study evaluated a group of patients from the general population with hip pain and MRI findings of cam-type femoroacetabular impingement. These patients had a higher prevalence of radiographic osteitis pubis than age-matched control subjects. Most of the patients in the current study who had femoroacetabular impingement had minimal or mild osteitis pubis. However, this finding is not surprising because these patients are not elite athletes, to the authors’ knowledge, are young, and likely did not have groin or pubic pain as a chief complaint. Nevertheless, the difference in the prevalence of osteitis pubis is statistically significant, and this finding supports recent studies suggesting an association between cam lesions and symphysis strain.4,5,7,8 Because patients from the general population were studied, the current findings also suggest that abnormalities of the symphysis pubis and intraarticular hip pathology are more likely to be truly related injuries rather than independent injuries seen in athletes. Both cam lesions and osteitis pubis may be expected to occur more frequently in elite athletes, and these patients have been the focus of previous studies examining this association.

Cam-type lesions lead to earlier contact of the femoral neck with the acetabulum in the normal arc of functional motion, which results in decreased physiologic internal rotation of the hip and increased repetitive loading of the labrum and hemipelvis.3 Repetitive loading of the pubic symphysis and surrounding structures and the resulting hypermobility of the pubic symphysis are believed to contribute to osteitis pubis.12,13 A cadaveric study by Birmingham et al14 found that a simulated cam lesion at the femoral head and neck junction resulted in a statistically significant increase in rotational motion at the pubic symphysis. The authors suggested that increased rotational motion and chronic repetitive loading could cause overuse injury of the pubic symphysis, contributing to the development of osteitis pubis. A correlation between femoroacetabular impingement and osteitis pubis, as was found in the current study, may provide further indirect support for this proposed mechanism.

The current findings suggest that recognition of possible osteitis pubis in patients with femoroacetabular impingement may have important consequences for patient management. Larson et al8

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**Figure 2:** Coronal T1-weighted image of the pelvis showing signs of bilateral femoroacetabular impingement with osseous bumps at the femoral head and neck junctions and a synovial herniation pit on the left (arrow), a right sublabral cyst (dashed arrow), and small marginal osteophytes (arrowheads) in a 43-year-old male soccer player who had a 7-month history of pubic pain with ambulation (A). Coronal fluid-sensitive magnetic resonance image with bone marrow and soft tissue edema about the symphysis pubis, associated with osseous proliferation, in keeping with acute-on-chronic osteitis pubis (B).

**Figure 3:** Axial oblique fat-saturated T1-weighted image of a magnetic resonance arthrogram showing signs of femoroacetabular impingement, including an increased alpha angle (82°), an anterior labral tear (arrow), and small marginal osteophytes (dashed arrow) in a 46-year-old man with chronic left hip pain (A). Coronal T1-weighted image showing mild osteitis pubis with osseous irregularity on both sides of the symphysis pubis (arrows) (B).
showed that isolated management of either symptomatic intra-articular hip pathology or athletic pubalgia in athletes led to suboptimal results. However, when both disorders were surgically managed, 89% of patients had unrestricted return to sporting activity.

Limitations

This study had the limitations associated with a retrospective study design, including a lack of clinical patient information, such as baseline activity level and physical examination findings. Another limitation was the lack of blinding of the radiologists to which patients had femoroacetabular impingement during assessment for osteitis pubis, leading to the possibility of bias, although this was mitigated by independent review of the cases by 2 radiologists. Further, an alpha angle of 55° was chosen to indicate cam morphology. The sensitivity and specificity of this precise value in discerning true cam lesions are controversial, but this value is most widely used in clinical practice.11,15

Additionally, there is no objective rating scale for the severity of osteitis pubis. The current study used a 4-point Likert scale, but a standardized rating scale that can be used across multiple institutions is needed. This scale could be based on common characteristics of osteitis pubis (ie, osseous irregularity or fracture, sclerosis, bone marrow edema, fatty change, osteophytes, effusion, and capsular hypertrophy).

Information on patients’ medical history that may have contributed to the radiographic findings (eg, previous injuries, childbirth) was not available. Because the diagnosis of osteitis pubis was made on the basis of imaging alone, without knowledge of whether groin pain was present, the clinical significance of these findings is not known. Further studies are needed to examine whether the findings of osteitis pubis on imaging correlate with a history of pubalgia and whether they predate clinical manifestations.

Further studies are also needed to establish whether osteitis pubis has the same manifestations and clinical consequences in the general population as in elite athletes. Currently, more data are available on elite athletes.

CONCLUSIONS

Patients with hip pain and cam-type femoroacetabular impingement have a higher prevalence of osteitis pubis, supporting the association between these 2 processes and helping to further the understanding of the pathophysiology of hip and pubic pain. This finding underscores the importance of recognizing concomitant imaging changes to the pubic symphysis in the presence of femoroacetabular impingement so that patients can receive appropriate care.

REFERENCES


