Clin Orthop Relat Res (2012) 470:3524–3529
DOI 10.1007/s11999-012-2450-0

Clinical Orthopaedics and Related Research®
A Publication of The Association of Bone and Joint Surgeons®

CLINICAL RESEARCH

Anterior Impingement Test for Labral Lesions Has High Positive Predictive Value

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Received: 29 December 2011 / Accepted: 13 June 2012 / Published online: 6 July 2012

Abstract

Background The anterior impingement test is intended to detect anterosuperior acetabular labral lesions. In patients treated for labral lesions its sensitivity is reportedly 95% to 100%, and in a small group of patients undergoing periacetabular osteotomy, its sensitivity was 59% and specificity 100%. However, the sensitivity, specificity, positive predictive value, and negative predict value of this test to detect these labral lesions in unselected patients with hip pain are unknown.

Questions/purposes We investigated these four parameters (1) in unselected patients with hip pain, and (2) in three subgroups of patients with dysplasia, femoroacetabular impingement (FAI), and with an intact joint space.

Methods We prospectively studied 69 patients (15 men and 54 women) with a mean age of 57.2 years (range, 27–81 years). One observer performed the anterior impingement test in all patients. We determined the presence or absence of an anterosuperior labral lesion with radial MRI in 107 hips (38 patients in both hips: 14 with pain, and 24 without pain). We also investigated the parameters in the three subgroups which consisted of 60 cases of dysplasia, 27 cases of FAI, and 80 cases with intact joint space; the third subgroup partially overlapped the first and second subgroups.

Results The four parameters in all hips were 50.6% (45/89), 88.9% (16/18), 95.7% (45/47), and 26.7% (16/60), respectively. Parameters in the three subgroups were similar to those of all cases.

Conclusions Although the sensitivity of the anterior impingement test did not reach a sufficient level for detecting anterosuperior labral lesions, we believe the high positive predictive value makes the test useful.

Level of Evidence Level III, diagnostic study. See the Guidelines for Authors for a complete description of levels of evidence.

One of the authors (TH) received funding from the Japan Labour Health and Welfare Organization.
Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.
All ICMJE Conflict of Interest Forms for authors and Clinical Orthopaedics and Related Research editors and board members are on file with the publication and can be viewed on request.
Each author certifies that his institution has approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

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Introduction

Acetabular labral lesions usually are associated with a structural abnormality in the hip [7, 37] such as developmental dysplasia or femoroacetabular impingement (FAI) [7, 17], and are considered to predispose the hip to the development of accelerated degenerative disease [22]. A high frequency (70%–80%) of these lesions is seen at the anterosuperior quadrant of the acetabular rim [2, 26, 32].

To diagnose a labral lesion at the anterosuperior quadrant of the hip, Klaue et al. described [14] the anterior impingement test and others subsequently described its use [18, 30]. The test is performed by passively moving the hip in flexion, adduction, and internal rotation. If groin pain occurs the test presumably is positive and a labral disorder should be considered, although further examinations and/or surgery may be required to confirm the presence of a labral lesion. When using any test such as the anterior impingement test it is important to understand its sensitivity, specificity, positive predictive value, and negative predict value. Several reports suggest a sensitivity of 95% to 100% in patients with labral tears diagnosed by hip arthroscopy or MRI [2–4, 12, 13]; none of these reports had false-positive or true-negative cases. One study with 18 patients who underwent periacetabular osteotomies reported sensitivity (59%, 10/17), specificity (100%, 1/1), positive predictive value (100%, 10/10), and negative predictive value (13%, 1/8) [35]. However, as the test is used in patients without a known diagnosis, it is important to know these parameters in an unselected group of patients with hip pain. In addition, to enhance our understanding of the anterior impingement test we presumed it would be useful to investigate its diagnosability in three subgroups: patients with dysplasia, with FAI, and with intact joint space, as classified by plain radiographs.

We therefore (1) determined the diagnosability of the anterior impingement test in patients presenting to an orthopaedic clinic with hip pain and (2) in three subgroups of patients with dysplasia, with FAI, and with an intact joint space.

Patients and Methods

We prospectively studied 80 patients presenting to our clinic with hip pain between May and October 2011. An anterior impingement test was used during all physical examinations. We excluded patients with acute injury. Eleven patients were excluded because they did not subsequently undergo MRI of the hip: two were diagnosed with a lumbar spine lesion and nine had severe degeneration of both hips and refused MRI. These exclusions left 69 patients (15 men, 54 women), with a mean age of 57.2 years (range, 27–81 years), who were evaluated in this study. Of these patients, 38 had examination of both hips: 14 with pain and 24 without pain. These additions resulted in a study of 107 hips. On the basis of one previous study of the anterior impingement test [35], we considered the number of hips in our study (more than 100 hips) was sufficient. The study was approved by the hospital scientific ethics committee and informed consent was obtained from all patients.

One orthopaedic surgeon (TH) performed the anterior impingement test in all patients. In addition, the patients were divided into three subgroups to investigate variation of diagnosability of the anterior impingement test: (1) the dysplasia group was defined by a center-edge (CE) angle less than 25° on plain radiographs [38]; (2) the FAI group was defined by the existence of radiographic signs of FAI such as the crossover sign [1, 9, 19], α angle greater than 50° [27], asphericity of the femoral head [6] such as a pistol grip deformity [34], or CE angle greater than 40° [11]; and (3) the intact joint space group was defined by a joint space greater than 3 mm on the plain radiograph because osteoarthritis (OA) was defined by a joint space less than 3 mm on plain radiographs [8, 23]. The test was performed by passively moving the hip in 90° flexion, abduction, and internal rotation according to the original description [14]. We did not investigate its interobserver variability. Martin and Sekiya reported a kappa value of 0.58 for this test [20]. The patients were asked whether they felt a sharp pain during the internal rotation. We did not control force of the internal rotation because the force was affected by weight of the lower limb of each patient. The impingement test was deemed positive when this posture produced groin pain as observed by the patients' grimacing.

The diagnosability of the anterior impingement test was investigated by using noncontrast 3-T radial MRI to diagnose the presence of an anterosuperior labral lesion. For detection of a labral lesion at the anterosuperior quadrant, noncontrast MR images were obtained using a 3-T scanner (MAGNETOM Verio 3T; Siemens, Munich, Germany) within 2 weeks of the patient first presenting to the outpatient clinic. A fat-suppressed transaxial three-dimensional gradient echo sequence (TR, 25 ms; TE, 25 ms; matrix, 256 × 256; field of view, 200 mm × 200 mm; slice thickness, 0.7 mm; slice gap, 0 mm; band width, 250) was used. Radial reconstructions were created from multiplanar image reconstructions, parallel to the acetabular rim, thus allowing for perpendicular sections through the acetabular labrum throughout the whole circumference. The reconstruction steps were described by Kubo et al. [15], who established noncontrast radial images. The radial reconstructions were performed in 10°-steps. The acetabulum was divided into four quadrants (anterosuperior, anteroinferior, posterosuperior, and posteroinferior). The inferior borderline between the anteroinferior and posteroinferior quadrants was located in the middle of the acetabular notch. The inferior borderline also divided the anterosuperior and posterosuperior quadrants. Another line, which passed through the acetabular center and was perpendicular to the inferior borderline, was made to divide the superior and inferior parts. We investigated whether the labrum in the anterosuperior quadrant had lesions (Fig. 1A) or not (Fig. 1B). Criteria for the labral lesions were displacement, absence, or hypertrophy of the labrum, outer surface, or inside of the labrum with an inhomogeneous intensity area or irregular shape of the outer surface of the labrum. The diagnosis of labral lesions observed on the radial reconstructed MR images was established by two orthopaedic surgeons (TH, YY) independently examining all 107 MR studies in a blinded fashion. We evaluated intraobserver and interobserver variabilities using kappa coefficients with Fisher's exact test. For the intraobserver variability (based on two measurements separated by a 3-week interval), the kappa was 0.83. For interobserver variability, the kappa was 0.76.

For the three subgroups, one of us (TH) diagnosed all hips with AP and cross-table lateral radiographs, and MR images with coronal and axial T1 turbo spin echo (TR, 450 ms; TE, 8.8 ms; slice thickness, 4.0 mm) and T2 turbo spin echo spectral adiabatic inversion recovery (SPAIR) (TR, 4000 ms; TE, 79 ms; slice thickness, 4.0 mm) sequences were performed to detect extraarticular or juxtaarticular lesions (Fig. 2). On the AP view, the joint space was defined as the narrowest distance between the cortical surface of the acetabulum and the bone contour of the femoral head at the weightbearing area. Patients with OA or intact joint space [8] were classified with a borderline of 3 mm of the joint space. Dysplasia was defined as a CE angle less than 25° [38]. If the joint diagnosed as being dysplastic also had OA, it was classified as dysplastic OA (Fig. 2). If the hip had a CE angle greater than 40° [11] and/or a crossover sign of the acetabular contour [1, 9, 19] on the AP view, the hip was diagnosed as having radiographic FAI of the pincer. If the femoral head had asphericity [6], such as a pistol grip deformity [34] observed on the AP view and/or an α angle greater than 50° [27] on the lateral view, the hip was diagnosed as having radiographic FAI of cam. If the joint was diagnosed as having FAI also had OA, it was classified as having FAI-related OA. According to previous reports regarding interobserver variability of the above parameters, those of

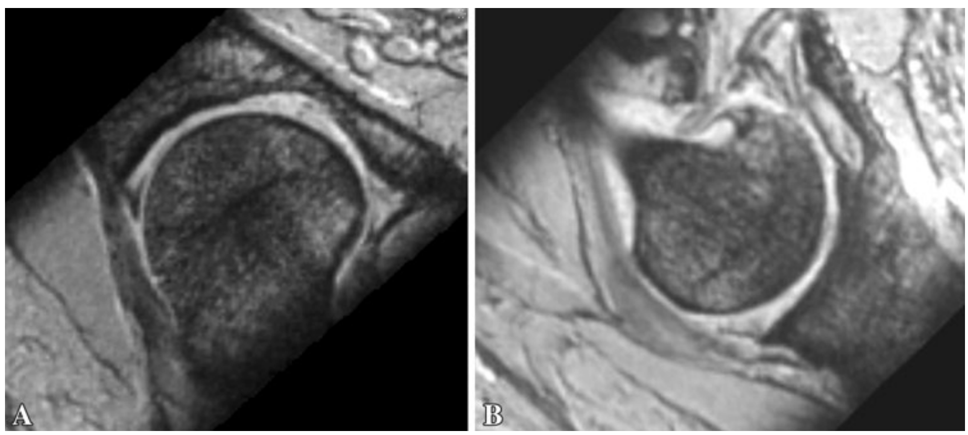

Fig. 1A–B A 3T noncontrast MR image of the hip shows the acetabular labrum at the anterosuperior quadrant. (**A**) An intact labrum is triangular with low signal intensity with an inside area of high signal intensity. (**B**) A labrum with a lesion has an irregular shape with mixed (low and high) signal intensity.

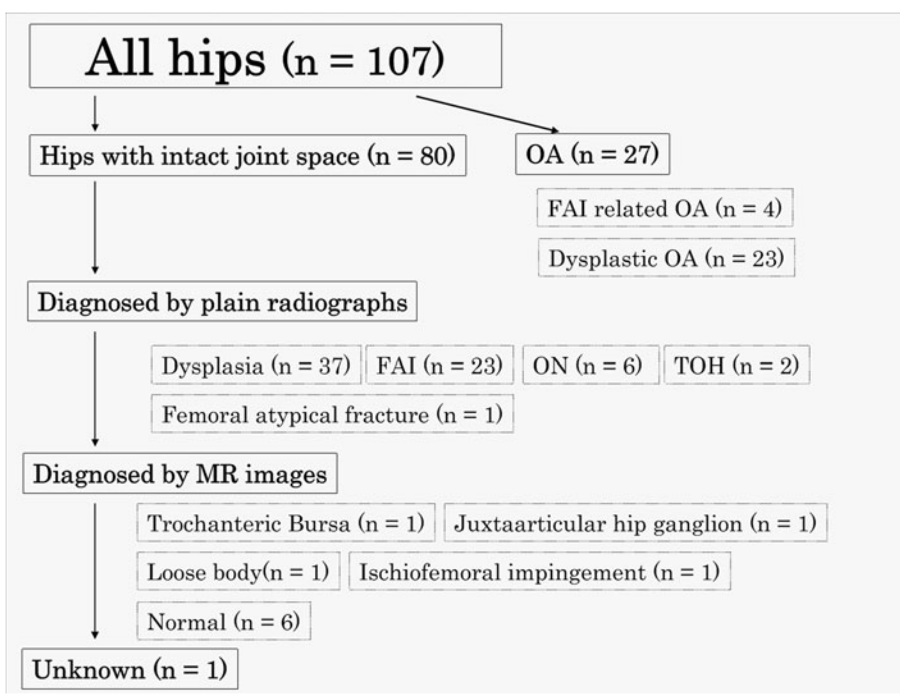

Fig. 2 The diagnostic flow in the current study is shown. OA = osteoarthritis; FAI = femoroacetabular impingement; ON = osteonecrosis of the femoral head; TOH = transient osteoporosis of the hip.

the CE angle, crossover, asphericity of the femoral head, and α angle were 0.64 to 0.92 [5, 21, 25, 33], 0.60 to 0.97 [7, 21, 33], 0.97 [6], and 0.83 [6, 21], respectively. One patient had two diagnostic characteristics: dysplasia (CE angle = 23°) and FAI (crossover sign); this patient was included in the dysplasia group. Of the patients with an intact joint space, transient osteoporosis of the hip, osteonecrosis of the femoral head, and minor fracture around the hip were diagnosed using the AP plain radiographs (Table 1; Fig. 2). Juxtaarticular hip ganglion, loose body, ischiofemoral impingement, and trochanteric bursa were diagnosed by MR images (Table 1; Fig. 2). There were six patients with normal hips and asymptomatic joints, for which diagnosis was made by plain radiographs and MR images (Table 1). Diagnosis for only one patient was not made with plain radiographs and MR images (Table 1).

We calculated sensitivity, specificity, positive predictive value, and negative predictive value to evaluate the diagnosability of the anterior impingement test for diagnosing labral lesions at the anterosuperior quadrant. The calculations were performed for all hips and in the three subgroups.

Table 1. Diagnosis of 107 hips by plain radiographs and noncontrast MR images

Condition	Number of hips
Symptomatic hips	
Dysplasia	51
Without osteoarthritis	28
With osteoarthritis	23
Radiographic femoroacetabular impingement	19
Without osteoarthritis	15
With osteoarthritis	4
Transient osteoporosis of the hip	2
Osteonecrosis	5
Femoral atypical fracture	1
Juxtaarticular hip ganglion	1
Loose body	1
Ischiofemoral impingement	1
Trochanteric bursa	1
Unknown	1
Asymptomatic hips	24
With dysplasia	9
With radiographic femoroacetabular impingement	8
With osteonecrosis	1
Normal	6

Results

Although the sensitivity in all patients was low (50.6%), the specificity (88.9%) and positive predictive value (95.7%) were high (Table 1). The negative predictive value also was low in all patients (26.7%) (Table 2).

In the three subgroups, the sensitivity (53.1%–56.0%), specificity (81.8%–100.0%), positive predictive value (92.9%–100.0%), and negative predictive value (15.4%–35.6%) were similar to those of all patients (Table 2).

Discussion

The anterior impingement test has been described for diagnosis of anterosuperior labral lesions [14]. Several reports [2–4, 12, 13] and one systematic review [16] showed the sensitivity of the anterior impingement test, but included only patients with known labral tears, and as a result, they did not report specificity, positive predictive value, and negative predict value. One other study [35] showed the four parameters in the diagnosability of the anterior impingement test (sensitivity, 59% [10/17]; specificity, 100% [1/1]; positive predict value, 100% [10/10]; and negative predict value, 13% [1/8]). However, the number of hips in that study was limited (18 cases) and the patients were selected patients who underwent periacetabular osteotomy. We therefore (1) determined the diagnosability of the anterior impingement test in patients presenting to an orthopaedic clinic with hip pain and (2) in three subgroups of patients with hip dysplasia, with FAI, and with an intact joint space.

Table 2. The diagnosability of the anterior impingement test

Anterior impingement test	All hips (n = 107)	Dysplasia (n = 60)	Femoroacetabular impingement (n = 27)	Intact joint space (n = 80)
Sensitivity	50.6 (45/89)	53.1 (26/49)	56.0 (14/25)	53.2 (33/62)
Specificity	88.9 (16/18)	81.8 (9/11)	100 (2/2)	88.9 (16/18)
Positive predictive value	95.7 (45/47)	92.9 (26/28)	100 (14/14)	94.3 (33/35)
Negative predictive value	26.7 (16/60)	28.1 (9/32)	15.4 (2/13)	35.6 (16/45)

We note several limitations to our study. First, the distribution of diseases among outpatients is not always constant. If the number of patients with hip pain caused by extraarticular disease is larger, the rate of the labral lesion may decrease. This change might result in the change of the diagnosability of the anterior impingement test. In addition, although patients older than 60 years do not always have labral lesions [29], the rate of patients older than 60 years may affect the diagnosability of the anterior impingement test. Second, the labral lesion was detected by 3T radial MR images without contrast. Thus, findings of noncontrast radial MR images were not verified by hip arthroscopy or open surgery. According to some studies, noncontrast 1.5 T MRI will detect 89% to 97% of labral lesions [10, 24]. Furthermore, a comparative study between 1.5 T MRI with contrast and 3T MRI without contrast indicated that a noncontrast 3T MRI could detect a labral defect as well as a contrast 1.5 T MRI [31]. We found high intraobserver and interobserver reliability with noncontrast 3T MRI and therefore believe it is reasonable for detecting labral lesions. Third, we did not investigate interobserver variability of the anterior impingement test. One study showed a kappa value of 0.58 [20]. Although the value almost reached the moderate strength of agreement (0.6–0.8) [20] and was similar to that of other physical examinations (FABER [flexion-abduction-external rotation], 0.63; log roll, 0.61; trochanteric tenderness, 0.66) [20], this kappa value may not be so high. In general, however, the kappa value is influenced by the prevalence of the attribute, in this case a positive anterior impingement test. As the prevalence of the positive test in the study was 0.76 [20], we think this kappa value is related to prevalence. Furthermore, as the percent agreement of the impingement test as another index for interobserver variability in the study [20] was 91%, we believe the anterior impingement test is reliable. Fourth, there were two issues regarding the radiographic parameters. We did not evaluate interobserver variability of the radiographic parameters. Classification of the three subgroups was accomplished partly by observation of the plain radiographs, resulting in some effects on the diagnosability of the impingement test. To address this, we added information regarding interobserver error from previous reports [5–7, 21, 25, 33]. Furthermore, one of our patients had dysplasia and FAI. We included this patient in the dysplasia group. Although this coexistence has been reported [28], we think diagnosis of FAI by only radiographic signs needs more consideration.

Given the sensitivity of the anterior impingement test in all hips was 50.6%, the impingement test alone cannot identify all hips with a labral lesion at the anterosuperior quadrant. Some studies regarding the diagnosability of the anterior impingement test [2–4, 12, 13] showed high sensitivity (95%–100%) of the impingement test. However, the subjects in those studies already had been diagnosed as having a labral tear by MR arthrography, arthroscopy, or open surgery. Therefore, true sensitivity in those studies cannot be properly evaluated because a group in each report did not have any patients with "test negative and labral lesion", and "test negative and no labral lesion". The one prospective study reporting patients with hip pain not diagnosed before the study [35] found a sensitivity of 56%, which is similar to what we found.

We suspect the ability of a physical examination to detect labral lesions depends on the condition of the acetabular labrum (ie, the extent of the labral tear or degeneration) and the pain tolerance of the patient, and suspect these are reasons the sensitivity of the test was low in our study. Additional study is needed to determine whether the size, area, shape, or location of the labral lesion affects the diagnosability of the anterior impingement test. We believe a high positive predictive value (95.7%) makes the anterior impingement test useful and means the labrum probably has some lesions, and additional investigations can be done if the test is positive. The value in our study is similar to that in a previous study (100%) [35]. Because the specificity was high (88.9%), but not 100%, and the negative predictive value was low (26.7%), we think these two parameters are not very useful.

The anterior impingement test was originally described to detect labral lesions in patients with dysplasia [14]. More recently the impingement test has become popular in FAI studies [2, 3, 12, 13]. Another investigation showed correlation between severity of the labral lesion and narrowing of the joint space [36]. In our three subgroups, all four parameters for diagnosability of the test were similar. Thus, our observations suggest that when the anterior impingement test is positive it indicates whether the labrum has a lesion. Although the sensitivity of the anterior impingement test does not appear sufficient to detect anterosuperior quadrant labral lesions in this general group of patients with hip pain, we believe the high positive predictive value makes the test useful.

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