



## Surgical technique

## Elephant's ear sign: a new radiographic finding indicative of acetabular retroversion

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## ABSTRACT

Acetabular retroversion is a relatively common condition affecting the hip that can result in symptoms in some patients. Diagnosis of acetabular retroversion relies on obtaining a proper anteroposterior radiograph of the pelvis. Cross-over, posterior wall, and ischial spine signs are usually present in patients on the radiographs of patients with acetabular retroversion. In this illustrative case report, we describe an additional radiographic sign, elephant's ear sign, associated with acetabular retroversion that we have seen to be present in patients with acetabular retroversion. A review of 26 acetabular retroversion case series by 2 independent reviewers showed 100% consensus on the presence of elephant's ear sign in patients with evidence of all other radiographic signs of this hip abnormality. This simple and previously unreported radiographic Elephant's ear sign, in which flared iliac wings appear as elephant's ears, highlights the presence of acetabular retroversion.

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## Introduction

Acetabular retroversion, and in particular cranial retroversion, has been associated with dysplasia of the hip (DDH) and is considered a risk factor for hip pain, femoroacetabular impingement (FAI), and hip osteoarthritis [1–7]. Recognition and early assessment of acetabular retroversion is important to allow implementation of appropriate management. The conventional anteroposterior (AP) radiographs are widely used to recognize and assess acetabular retroversion. There are several radiographic markers to identify and quantify acetabular retroversion in AP radiographs. These include the cross-over sign (COS), the posterior wall sign (PWS), and the prominence of the ischial spine (PRIS) sign. The COS and PWS were first described in 1999 by Reynolds et al [1] and the PRIS sign was

first introduced in 2008 by Kalberer et al [8]. Although the latter radiographic signs are very useful, most patients with acetabular retroversion may present with cross-sectional images that demonstrate acetabular labral tear and evidence of FAI. The treating physician needs to keep a high index of suspicion for the presence of acetabular retroversion and request a proper AP radiograph of the pelvis that may reveal the presence of acetabular retroversion. The management of patients with acetabular retroversion may differ from that of patients with FAI and no evidence of dysplasia.

In this case report, we describe an additional radiographic sign that appears to be less affected by the rotation of the radiographic images, which is present in patients with acetabular retroversion. We will describe the case of a patient with classical acetabular retroversion who, like many others, presented with labral tear and FAI.

## Office tip

We present a new radiographic sign, the “Elephant's ear sign”, to help aid in the diagnosis of acetabular retroversion.”

## Case example

A 23-year-old female patient presented with the complaint of right hip pain that had started 4 months prior. The pain was in the

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groin region that was exacerbated by activities such as running, sitting, or rotational movement. The pain radiated to buttock region also. The patient described the pain as dull ache that was 7/10 on the visual analog scale. The patient works a 4- to 5-hour shift on a daily basis and has pain at the end of the day. There was also a complaint of occasional catching in the hip joint. The pain in the hip had been getting progressively worse. She was asymptomatic on the left side.

She had an intra-articular local anesthetic injection with arthrogram that provided relief for a period of only 4 hours. On physical examination, the patient's gait was normal. Bilateral lower extremities were in neutral alignment and equal in length. Hip range of motion was slightly restricted in the right hip compared with the left with flexion to 90 degrees and internal rotation of 30 degrees on the left and 10 degrees on the right. Impingement test was strongly positive. The external rotation of the right hip was 40 degrees without pain. FABER (flexion in abduction and external rotation) and FADIR (flexion in adduction and internal rotation) both produced pain in the groin on the right side but no pain on the left. Stinchfield's test was negative bilaterally. The neurovascular examination was normal within the confines of hip examination.

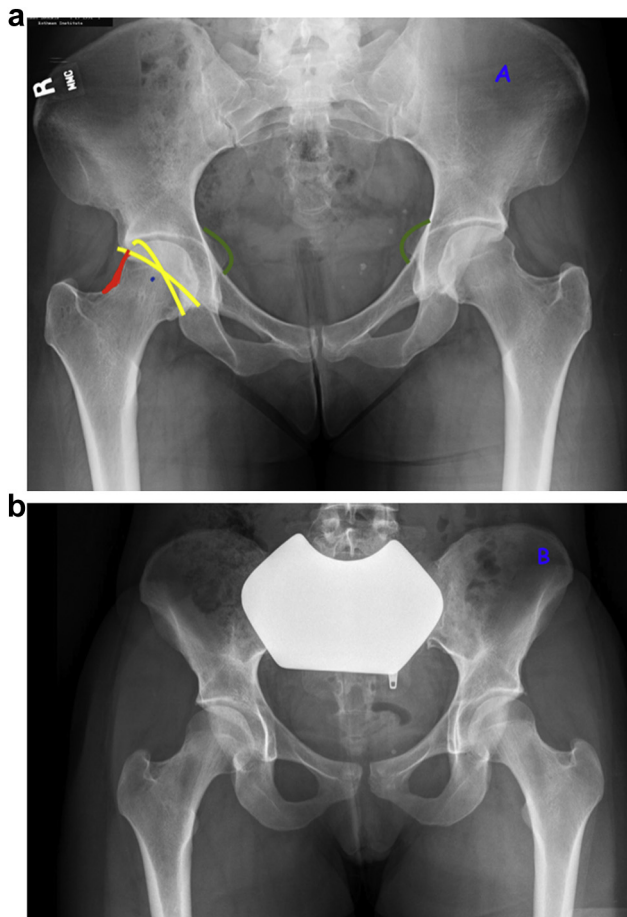
Standard AP and lateral radiographs of the pelvis and hip and MR arthrogram were reviewed. Radiographs demonstrated classical picture of acetabular retroversion bilaterally (Figs. 1 and 2). The COS, PWS, and PRIS sign were all present, and the patient has outward flaring of iliac wings appearing as elephant's ears (Figs. 1 and 2). Her

joint space is normal. The patient has a cam lesion on the femoral head that is notable. Magnetic resonance imaging (MRI) confirms a labral tear. A cyst at the femoral head and neck junction is noted. The patient has a large bump with the alpha angle measuring 74 degrees. Patient underwent femoroacetabular osteoplasty procedure with acetabular labral repair by using mini-open approach. At the latest follow-up (4.6 years postoperatively), her modified Harris Hip Score increased from 61.2 preoperatively to 92.2.

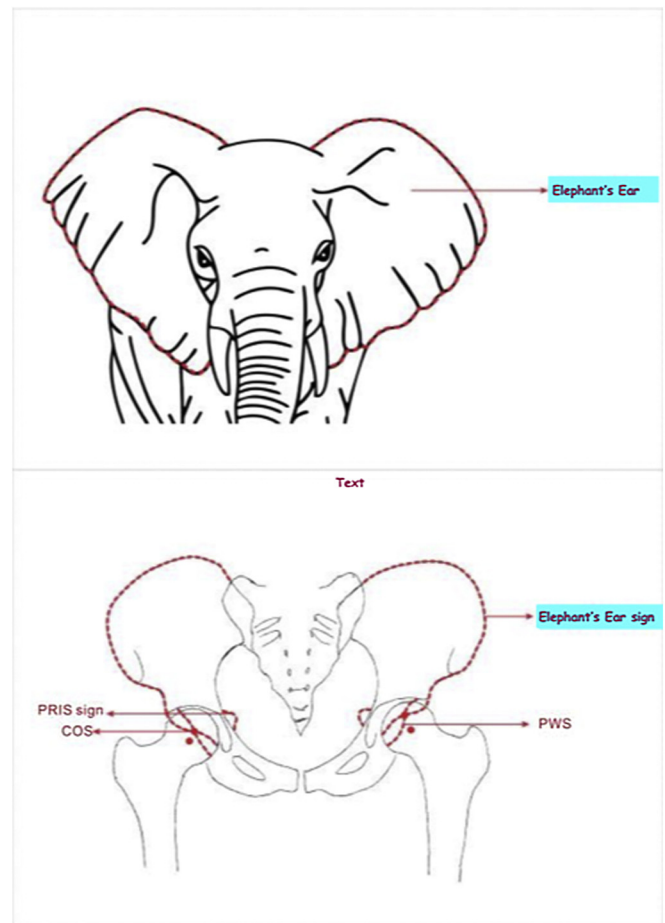
To validate our new radiographic sign, 2 independent reviewers evaluated the AP pelvis radiograph of 26 patients who were diagnosed for acetabular retroversion from our prospectively collected hip preservation database. All patients had evidence of all 3 signs of acetabular retroversion (COS, PWS, and PRIS). There was 100% consensus between both reviewers regarding the presence of elephant's ear sign on plain AP radiograph of all 26 patients. AP pelvic radiograph of 78 FAI patients from our institutional hip preservation database were reviewed as comparison group. None of the patients in the comparison group showed elephant ear sign in their AP pelvic radiograph based on both reviewers' evaluation. Written informed consent was obtained for inclusion of patient details and radiographs for this case report and the images.

## Discussion

Acetabular retroversion is accepted as a variant of developmental DDH, which can result in symptoms of pain and functional



**Figure 1.** (a) Radiograph shows classical picture of acetabular retroversion bilaterally with outward flaring of iliac wings appearing as elephant's ears. Positive COS (yellow lines), PWS (blue dot), PRIS (green lines), cam lesion (red line). (b) Normal radiograph without elephant ear sign for comparison.



**Figure 2.** Schematic diagram of elephant's ear appearance and a depiction of positive COS, PWS, and PRIS sign and elephant's ear sign.

limitations for some patients [3]. In this condition, there is a relative over-coverage of the femoral head anteriorly and undercoverage posteriorly. Although acetabular retroversion is thought to be common and asymptomatic, being present in 18% of patients, it can result in acetabular labral tears and symptoms in some patients [9].

Diagnosis of acetabular retroversion is usually made on plain radiographs that may demonstrate COS [1], PWS [1], and PRIS sign [8]. Most patients with acetabular retroversion present with a labral tear and signs of FAI [10–13]. Thus, diagnosis of acetabular retroversion may be missed in some patients unless the radiographs are carefully scrutinized.

Distinction between acetabular retroversion resulting in labral tear or other symptoms and labral tear resulting from classical FAI without DDH is important as the treatment modality for these patients differs. Patients with severe acetabular retroversion may require reorientation osteotomy of the pelvis that has been demonstrated to have excellent outcome in properly selected patient populations [10,11]. Isolated labral repair in patients with moderate to severe DDH is likely to fail and result in accelerated arthritis of the hip [12,13]. Patients with acetabular retroversion and positive PWS are best treated with reorientation osteotomy such as reverse periacetabular osteotomy [11–13]. Thus, identification of patients with acetabular retroversion is of paramount importance in allowing implementation of the most appropriate treatment.

In this report, we describe an additional radiographic sign that can help identify patients with acetabular retroversion. In this case when the COS, PWS, and PRIS sign are simultaneously present, the iliac wings are flared and appear as elephant's ears, so we named it "Elephant's ear sign." This appearance shares similarities to the "Mickey mouse pelvis" descriptor used in the setting of Down syndrome and achondroplasia. To our knowledge, this is the first time this description relating to the appearance of the iliac wings has been specifically associated with adult acetabular retroversion.

In contrast to the established radiographic markers of acetabular retroversion (COS, PWS, and PRIS sign), the elephant ear sign is less affected by common minor tilts in taking AP pelvic radiograph. However, significant pelvic tilt due to technical error or lumbosacral deformity can potentially affect the accuracy of elephant ear sign. The presence of each conventional radiological marker for retroversion is influenced by the inability to perceive the three-dimensional structure of the acetabulum within a single 2-dimensional radiograph. Interpretation becomes even more difficult when these measurements depend on radiographic technique, rotation, and quality. As radiographic markers for acetabular retroversion, the ability of COS in distinguishing focal from true acetabular retroversion or normal acetabulum depends on the reliability of plain radiographs. The reliability of COS can be affected by small changes in pelvic tilt and rotation [8,14–18]. Even with properly positioned and aligned pelvic radiographs, variable morphology, size, and location of the anterior inferior iliac spine may contribute to the appearance of a radiographic COS [19]. In addition, the quality of radiograph is important, especially if the observer is not used to reviewing AP pelvic radiographs and the radiographs in which exposure of the film does not clearly show the outline of the acetabulum, particularly the anterior and posterior walls, the ischial spine, the sclerosis of the acetabular roof, and the lateral edge of the acetabulum. The limitations of plain radiographs also apply to computed tomography (CT) and MRI.

and MRI are not used in the primary diagnosis, and CT exposes patients to a higher and additional dose of radiation.

The new radiographic marker Elephant's ear sign is simple and easy to identify acetabular retroversion. Furthermore, it is less prone to the limitations associated with previously described radiographic parameters. While viewing the radiographs of patients with acetabular retroversion, we found that not every acetabular retroversion has the Elephant's ear sign, but when the Elephant's ear sign is present in plain AP pelvis radiograph, the acetabulum is more likely to be retroverted. We are performing a new study with the purpose of determining the validity and reliability of the radiographic Elephant's ear sign to detect acetabular retroversion.

## Summary

In conclusion, this simple and previously unreported radiographic Elephant's ear sign, in which flared iliac wings appear as elephant's ears, highlights the presence of acetabular retroversion. In addition to the ease of identification, it is less prone to the limitations associated with previously described radiographic parameters, such as COS, PWS, and PRIS sign.

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