Acetabular retroversion in post slipped capital femoral epiphysis deformity

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Abstract

Purpose While the femoral deformity in post slipped capital femoral epiphysis (SCFE) hips has been implicated in the development of femoral acetabular impingement, little has been studied about the acetabular side. The purpose of our study was to determine the frequency of morphologic changes suggestive of acetabular retroversion in patients who have sustained a SCFE.

Methods IRB approval was obtained and the records of patients from 1975 to 2010 were searched for ICD-9 codes for SCFE. A total of 188 patients were identified for the study. Two observers evaluated AP radiographs for evidence of acetabular retroversion as characterized by the presence of either an ischial spine sign or a crossover sign. Demographic data, date of onset, and treatment were recorded. For analysis, the right hip was used in patients with bilateral involvement.

Results Of the 188 patients identified, 5 patients had an incorrect diagnosis and 41 patients had missing or inadequate films, leaving 142 patients (284 hips) for review. 57 patients (114 hips) had bilateral SCFE and 85 patients had unilateral SCFE. 79 % ($n = 45$) of the right hips with bilateral SCFE and 82 % ($n = 70$) of the unilateral involved hips had at least one sign of retroversion. Uninvolved hips had at least one sign of retroversion 76 % ($n = 65$) of the time.

Conclusions When compared to previously published values for normal patients, patients with SCFE appear to have an increased incidence of acetabular retroversion.

Keywords Slipped capital femoral epiphysis · SCFE · FAI · Retroversion · Pincer lesion · Cam lesion

Introduction

Deformity of the hip joint after a slipped capital femoral epiphysis (SCFE) has been implicated as a cause of femoral acetabular impingement [1]. Leunig showed that the femoral metaphysis after a SCFE abuts the acetabular rim, causing damage to both the acetabular cartilage and labrum [2]; however, the degree of slip deformity does not always correlate with patient symptoms [3]. Acetabular retroversion has been implicated as a cause of hip pain leading to a pincer-type femoral acetabular impingement [4]. The prevalence of acetabular retroversion varies throughout the literature, as does its definition and diagnosis. Retroversion has been reported to range from 6 % in normal individuals to 18 % in developmental dysplasia of the hip [5] and 31–49 % in patients with Legg–Calvé–Perthes disease [6–8]. Werner showed that in a group of 2,925 patients, 48 % had “some minimal overlap” [9]. One study evaluated CT scans of patients with SCFE for retroversion [10], and a recent study by Sankar et al. [11] showed an increased prevalence of acetabular retroversion in the uninvolved hip in patients with SCFE. The purpose of our study was to see if acetabular retroversion was present in patients with SCFE, which may lead to a combined or mixed-type femoroacetabular impingement.

Methods

Institutional review board (IRB) approval was obtained to review the records of patients with ICD codes pertaining

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to SCFE. A total of 188 patients were identified who had received treatment at our institution from 1975 to 2009. Medical records were reviewed to obtain demographic information, diagnosis, and date of onset. Two fellowship-trained surgeons evaluated AP radiographs of the pelvis for signs of acetabular retroversion, including the ischial spine sign and crossover sign [12, 13]. Radiographic inclusion criteria included radiographs that were obtained after skeletal maturity, centered above the symphysis, and where the coccyx was within 1–3 cm of the top of the symphysis. When the tip of the coccyx was not visible, the sacrococcygeal joint line was used as a marker (this was described by Siebenrock et al. [14] to be 32 mm in males and 47 mm in females from the symphysis). Additionally, patients were excluded if shielding or penetration precluded adequate visualization.

Statistical methods

All variables were either dichotomized or assigned a narrow-range ordinal value (0–2). Bivariate associations were computed by constructing 2×2 and 3×3 tables using Cramer's V and Spearman's correlation coefficients, respectively. In order not to falsely inflate the number of sides by including both sides in the analysis, the left and right sides were compared using a paired *t* test. No statistical difference was found between the sides, so the right side was randomly chosen for analysis. Statistical significance was tested using Pearson's χ^2 . Data were analyzed using SPSS v.20 (IBM, Chicago, IL, USA), and significance was set at $p < 0.01$.

Results

A review of the records revealed a total of 188 patients with a history of a SCFE; however, 5 had an incorrect diagnosis and 41 patients had either inadequate radiographs (shielding, rotation, tilt, or penetration) or did not have radiographs at skeletal maturity. Of the 142 patients for final review, 85 patients had unilateral involvement and 57 patients had bilateral involvement. When comparing the unilateral group to the bilateral group, only the right hip was analyzed. For patients with bilateral involvement, analysis of both right and left hips ($n = 114$) showed that 80.7 % ($n = 92$) had at least one sign of retroversion (Table 1).

The right hip in the patients with bilateral involvement had at least one sign of retroversion in $n = 45$ hips (78.9 %). The involved hip in the unilateral cases had at least one sign of retroversion in $n = 70$ (82.4 %) and the uninvolved had $n = 65$ (76.5 %). For the patients with unilateral involvement, the number of signs in the involved

Table 1 Number of signs of retroversion for both the bilateral and unilateral groups

	Bilateral (right hip)	Unilateral	
		Involved	Uninvolved
No signs	21.1 % ($n = 12$)	17.6 % ($n = 15$)	23.5 % ($n = 20$)
≥ 1 sign	78.9 % ($n = 45$)	82.4 % ($n = 70$)	76.5 % ($n = 65$)
2 signs	36.8 % ($n = 21$)	41.2 % ($n = 35$)	30.6 % ($n = 26$)

Table 2 Crossover sign and ischial spine sign in the bilateral and unilateral groups

	Bilateral (right hip)	Unilateral	
		Involved	Uninvolved
Crossover	71.9 % ($n = 41$)	74.1 % ($n = 63$)	70.6 % ($n = 60$)
Ischial spine	50.9 % ($n = 29$)	49.4 % ($n = 42$)	37.6 % ($n = 32$)

hip and the number of signs in the uninvolved hip were significantly related ($p < 0.001$). Therefore, a child with unilateral SCFE with one sign would be likely to have one sign in the uninvolved hip (Spearman's correlation of 0.68; $p < 0.0001$). Stated another way, upon comparing the involved to the uninvolved hips for patients with unilateral SCFE, 65/85 children were found to have the same number of signs on their involved and uninvolved sides.

In the group with unilateral SCFE, the crossover sign was present in 74.1 % ($n = 63$) in the involved hips and in 70.6 % ($n = 60$) in the uninvolved (correlation of 0.68; $p < 0.001$; Table 2). The ischial spine sign was present in 49.4 % ($n = 42$) of the involved and 37.6 % ($n = 32$) of the uninvolved hips (correlation of 0.74, $p < 0.001$). For the patients with bilateral involvement, the right hip had a positive crossover sign in 71.9 % ($n = 41$) and a positive ischial spine sign in 50.9 % ($n = 29$). Analysis of both right and left hips ($n = 114$) showed that 73.7 % ($n = 84$) of the hips had a positive crossover sign and 48.2 % ($n = 55$) had a positive ischial spine sign.

The number of positive signs of acetabular retroversion did not differ significantly between the group with unilateral involvement and the group with bilateral involvement ($p = 0.5446$).

Discussion

Deformity of the femoral neck after a SCFE leads to a decreased head neck junction with a resultant cam-type lesion that corresponds to the severity of the slip [1]. These changes have been found to cause both labral pathology and articular cartilage damage [2]. Retroversion of the acetabulum has been implicated as a source of hip pain and

may lead to femoroacetabular impingement [4, 13]. Our study looked at the presence of a mixed-type lesion where there is both a cam lesion from the SCFE deformity as well as a pincer-type lesion from retroversion of the acetabulum, as a previous study showed that slip severity is not correlated with symptoms [3].

While the diagnosis of femoroacetabular impingement relies on both radiographic and clinical history and the exam, the diagnosis of acetabular retroversion is largely a radiographic one. The radiographic criteria include the presence of an ischial spine sign, a crossover sign, or the posterior wall sign. The crossover sign, as described by Reynolds [13], is positive when the rim of the posterior wall of the acetabulum crosses over the rim of the anterior wall of the acetabulum. This has shown to be a reliable marker for retroversion but is sensitive to pelvic tilt [14]. Jamali et al. [15] has shown the crossover sign to have good intra and interobserver reliability. The ischial spine sign was described by Ganz [12] and is indicative of acetabular retroversion when the ischial spine is present on an AP radiograph. It has been shown to be reliable even when the radiograph is either tilted or rotated [16]. We chose well-centered radiographs to limit the effects of rotation and tilt. When patients are skeletally immature, it is difficult to clearly see the anterior and posterior rims of the acetabulum, so we only evaluated patients for whom we had radiographs with ossification of the anterior and posterior walls. This limited the total number of patients with adequate films. Others were excluded as they did not adhere to guidelines for rotation, tilt, and exposure. Intraobserver and interobserver reliability for the crossover sign have been shown to range from 0.46 and 0.39 to 0.71 and 0.77, respectively [12, 15]. Intraobserver and interobserver reliability for the ischial spine sign range from 0.77 and 0.91 to 0.62 and 0.92, respectively [12].

The ischial spine sign has been used to measure retroversion in patients with Perthes disease [17]. Using a similar methodology to our study, Kawahara evaluated 91 patients with Perthes disease using AP radiographs and assessed retroversion according to the presence of the crossover sign and ischial spine sign [7]. Both of these studies validate our methodology for measurement of acetabular retroversion.

Stanitski et al. evaluated 60 patients who had sustained a SCFE using computed tomography (CT) scans [10]. They did not find a significant difference between acetabular anteversion measurements for those patients and standard values. However, they analyzed the acetabular version and did not look at the cranial-most aspect of the acetabulum, and thus may have missed some focal overcoverage. Similarly, a study of 22 patients with 3D reconstruction of their CT scans showed no increase in anteversion and no correlation with the degree of slip [18]. More recently, Sankar et al. [11] studied the normal hips of 50 patients

with unilateral SCFE deformity and found that there was an increased rate of retroversion based on the presence of the crossover sign and posterior wall sign. A study by Monazzam et al. [19], which used a computerized measurement of retroversion in patients with SCFE deformity, found an increase in the version of the superior dome of the acetabulum compared to the control group. They found no difference between affected and unaffected hips.

There were a few other limitations of the present study. We found patients by searching for specific ICD-9 codes, which may have missed some patients with a diagnosis of SCFE. Another limitation was that the observers could not be blinded. Additionally, we relied on a control population based on the literature. This paper was not designed to study causation of SCFE, merely to identify the concomitant pathology that may lead to further treatment implication when treating a patient with a post-SCFE deformity. Many of our patients with unilateral SCFE had signs of retroversion in their uninvolved hip but did not develop a slip when followed to maturity.

Conclusion

When treating a patient with post slipped capital femoral epiphysis deformity, it is important to be aware of the acetabular morphology of both the involved and the uninvolved hips.

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