Slipped capital femoral epiphysis: a physeal lesion diagnosed by MRI, with radiographic and CT correlation

Abstract Objective. To define and compare early lesions associated with slipped capital femoral epiphysis (SCFE) on magnetic resonance imaging (MRI), computed tomography (CT) and radiography.

Design and patients. Thirteen patients with 15 symptomatic hips due to SCFE underwent radiography and MRI; CT was performed in 12 patients. SCFE was graded on radiographs, head/neck angles and qualitative changes were evaluated on CT, and morphologic/signal abnormalities were determined on MRI.

Results. Physeal widening, apparent on T1-weighted MRI, was evident in every case of SCFE, including one presumed “pre-slip.” T2-weighted images demonstrated synovitis and marrow edema but obscured physeal abnormalities. CT head/neck angles ranged from 4–57° for symptomatic to 0–14° for asymptomatic hips. Physeal and metaphyseal changes were variably identified on both radiographs and CT in all cases of SCFE, but not in the pre-slip.

Conclusion. MRI clearly delineates physeal changes of both pre-slip and SCFE, and demonstrates very early changes at a time when radiographs and CT may appear normal.

Key words Slipped capital femoral epiphysis · Physeis · Magnetic resonance imaging

Introduction

Slipped capital femoral epiphysis (SCFE) may be the most common cause of adolescent hip disease [1] and, if left untreated, may result in continued pain and early osteoarthritis. The incidence is approximately 2 per 100,000 in the general population and more commonly affects males than females by a ratio of 2.5:1 [1]. The diagnosis is considered in an adolescent with dull hip pain that may radiate to the thigh or knee. A patient will present with an antalgic gait, diminished internal rotation of the hip, and external rotation of the thigh on flexion [1].

In acute SCFE, with symptom duration less than 3 weeks [2], pain and disability may be profound. Chronic slips, in which symptoms persist longer than 3 weeks, may manifest as more insidious, intermittent or vague pain. An acute on chronic slip implies exacerbation of symptoms with additional displacement of the femoral head in the setting of a pre-existing chronic slip. The term “pre-slip” has been used to describe cases of presumed SCFE in which metaphyseal and physeal changes are evident but without a demonstrable slip on conventional radiographs [1]. The implication is that, in the proper clinical setting, a slip may not yet have occurred, or may be so subtle as to be occult on conventional radiography. It is reasonable that physeal changes present at a histologic level may remain radiographically occult, but may be evident using more sensitive imaging modalities.

The purpose of this study was to compare the appearance of physeal, osseous and articular abnormalities associated with SCFE using conventional radiography, computed tomography (CT) and magnetic resonance imaging (MRI).
Materials and methods

As part of an orthopedic experimental protocol, all patients presenting to our institution between November 1993 and January 1996 with clinical symptoms suggestive of SCFE were imaged using conventional radiography and MRI. The study group initially included 15 patients with 18 symptomatic hips; subsequently, two patients with three symptomatic hips were found not to have SCFE and were excluded. The final study group consisted of five females (age range 9–11 years) and eight males (age range 12–15 years).

All patients were imaged using conventional radiography with anteroposterior (AP) and frog lateral projections. CT of both hips was performed in 12 of 13 patients, but was targeted to the symptomatic hip only in one patient. All CT images were performed with the patient supine, utilizing bone algorithm, a slice thickness of 3.0 mm and 140–280 mA. MRI of both hips was performed using one of two 1.5-T units: a GE Signa 5.3 (GE Medical Systems, Milwaukee, Wis.) or a Philips 1.5T ACS 2.0 (Philips Medical Systems, Eindhoven, The Netherlands). Each examination included axial and coronal T1-weighted (TR 300–750/TE 10–19) sequences, with additional Short Tau Inversion Recovery (STIR) (1400/20/120) and/or T2-weighted Fast Spin Echo (FSE; TR 2600–3900/TE 80–160) images obtained in both coronal and axial planes (5.0 mm slice thickness/1.0 mm gap).

All imaging of the 15 patients with 18 symptomatic hips was retrospectively reviewed by consensus by two musculoskeletal and two pediatric radiologists, masked to clinical information regarding laterality and duration of symptoms. As a group each modality was evaluated sequentially: first radiographs, followed by CT and MRI. Patient identity and diagnosis were withheld. Findings were tabulated using scoresheets designed to include all morphologic abnormalities catalogued on initial, masked review of all images.

Conventional radiographs, the basis for diagnostic confirmation, were evaluated for degree of SCFE, and morphologic features including physeal widening and indistinctness or irregularity of the metaphysis. Head/neck angle was measured according to the method described by Cohen et al. [3] on CT for both symptomatic and asymptomatic hips to determine quantitatively the degree of slip. Qualitative CT features of SCFE were assessed, including physeal widening or irregularity, metaphyseal lucency or sclerosis, metaphyseal beaking and epiphyseal sclerosis (Fig. 1). MRI studies were reviewed to determine the presence or absence of synovitis and bone marrow edema, and to describe and localize the morphologic features and signal characteristics of physeal abnormalities that might correlate with SCFE.

Results

Of thirteen patients with SCFE included in this study, all underwent surgical pin fixation. Three patients were pinned bilaterally. One patient had bilateral SCFE and one had a chronic left-sided slip but presented with a symptomatic right-sided pre-slip suggested only by MRI; one patient was prophylactically pinned on the symptomatic side. The patient with the pre-slip was pinned prophylactically, but was lost to clinical follow-up. All patients with SCFE were obese, though no endocrinopathy was identified in any of the patients. All were either Tanner stage III or IV, with the exception of one 11-year-old girl who was Tanner stage I [4]. Clinical follow-up for 10 patients ranged from 1 month to 2 years: all were asymptomatic with restored range of hip motion. Three patients were lost to follow-up. Two patients with three symptomatic hips were found not to have SCFE upon review of all imaging and clinical follow-up; one had bilateral postviral synovitis that resolved, and the second had ipsilateral Blount’s disease, ligamentous laxity and a psychotic disorder for which he was medicated.

Quantitative assessment of the degree of epiphyseal displacement and angulation in these patients using measurement of the CT head/neck angle demonstrated a range of 0–14° among 11 asymptomatic control hips, as compared with 4–57° for painful hips. The one symptomatic hip with a head/neck angle of 4° and no femoral head slip represented the only pre-slip; head/neck angles of the remainder ranged from 27° to 57° (median 37°). Of the 13 symptomatic hips due to SCFE imaged using CT in this series, morphologic changes included: physeal widening (92%), metaphyseal scalloping or irregularity (92%), metaphyseal sclerosis (100%) and posterior metaphyseal beaking (61.5%). Severe posterior metaphyseal beaking...