Slipped Capital Femoral Epiphysis in Atypical Patients

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ABSTRACT

When patients who are thin present with knee pain, it can be easy to overlook the possibility of slipped capital femoral epiphysis (SCFE). Although 80% of patients with a “slip” are obese, thin children are not immune to this problem. Endocrinopathies, especially hypothyroidism, can be associated with SCFE. This article describes guidelines for evaluating patients for a slip and highlights some important considerations for the atypical SCFE. Patients with open growth plates with thigh or knee pain should routinely have a hip examination as part of the evaluation. Plain radiographs, with an emphasis on obtaining a frog lateral image, are usually sufficient to make the diagnosis of SCFE. Patients diagnosed with SCFE should be immediately referred to an orthopedic surgeon because treatment for this condition is always surgical.

Slipped capital femoral epiphysis (SCFE) is not an uncommon diagnosis. It usually occurs in obese adolescent children; however, atypical cases can occur. This article highlights how abnormal presentations of SCFE can present and outlines the algorithm required to make the correct diagnosis.

ILLUSTRATIVE CASE

A previously healthy 13-year-old girl presented to a pediatric orthopedist with a 2-month history of intermittent right knee pain. She associated her symptom onset to a collision with another player during a soccer match. Her parents had given her ibuprofen, and she used ice packs periodically to no avail. One week after the injury, the patient was seen by her pediatrician, who completed a physical examination and X-rays, which were unremarkable. Close observation was recommended, and as her symptoms worsened, the patient was referred to pediatric orthopedics.

Upon presentation, the patient said her knee discomfort had been getting progressively worse with pain now in the mid-thigh. Past medical history was unremarkable. Physical examination revealed a thin, well-appearing teenager in no acute distress. Her height was 4’11” and weight 95 lbs. The patient ambulated with an antalgic gait with the right foot in slight external rotation. Range of motion of the right hip was limited with decreased internal rotation relative to the contralateral side. Anteroposterior (AP) and frog lateral X-rays of the hip showed bilateral slipped capital femoral epiphyses (more severe on the right) (Figure 1). She underwent percutaneous fixation of both hips with a cannulated screw. Further tests revealed elevated thyroid-stimulating hormone with low free thyroxine levels. She was referred to pediatric endocrinology; however, repeat thyroid studies were within normal limits.

SLIPPED CAPITAL FEMORAL EPiphYSIS

SCFE is a common disorder in adolescents that can be frequently missed upon initial presentation. The pathology is localized to the proximal aspect of the femur, but the symptoms are often felt in the knee or the thigh, thus misleading the physician. Due to a combination of biomechanical and biochemical conditions, the physis (or growth plate) becomes weakened, allowing the metaphysis of the femoral neck to migrate in an anterosuperior direction relative to the epiphysis of the femoral head. The analogy for SCFE is that of a scoop of ice cream (the femoral head) sliding off the cone (the femoral neck). The incidence of SCFE in the northeastern United

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States is 10 cases per 100,000 patients with variations in prevalence among different ethnic groups.\textsuperscript{1}

The typical age at presentation for SCFE is 13.5 years for boys and 12 years for girls.\textsuperscript{1,2} The most common patients who present with a slip are African-American boys, and more than 50\% of patients diagnosed with SCFE are over the 95th percentile for weight for their age.\textsuperscript{1} However, atypical presentations do exist and children who are not overweight can also develop a slip. The physician may not think about SCFE as a cause of knee pain in a thin patient, leading to a delayed or missed diagnosis. It is vital for the clinician to be aware of these atypical presentations to ensure diagnosis in a timely fashion, and to allow for further evaluation and treatment. Treatment of SCFE in its early stages is more simple and is associated with a better long-term prognosis. However, even with appropriate diagnosis, slip severity predisposes these patients to an increased risk of long-term complications such as osteonecrosis of the femoral head and early-onset arthritis.

There are two commonly used classification systems for SCFE. One system classifies the slip based on chronicity of symptoms. If symptoms have been present for less than 3 weeks, the slip is classified as acute. If symptoms have been present for longer than 3 weeks, the slip is classified as chronic. If patients have had long-standing symptoms with acute worsening of their pain, the slip is classified as acute on chronic. The more prognostically relevant classification system characterizes the slip as either stable or unstable.\textsuperscript{3} In a stable slip, the patient is able to bear weight on the affected extremity with or without the use of an assistive device (crutch, walker). If the patient is unable to bear weight despite assistive device or support, the slip is classified as unstable. Unstable slips have up to a 50\% risk of osteonecrosis, whereas the risk is decreased to 0\% with stable slips.\textsuperscript{1,3}

The child with SCFE can present with complaints of pain in the groin, hip, thigh, or knee. Any adolescent child with open proximal femoral physes presenting with groin, hip, thigh, or knee pain should undergo a hip examination to screen for SCFE; the examination is quick and easy to perform. The child should be observed during ambulation if possible. If the patient can bear weight with or without assistance, an antalgic gait (or limp) may be evident. Oftentimes if the slip is severe, the affected extremity will be externally rotated during ambulation. If they are completely unable to ambulate, even with assistance, concern for a severe slip should be high. In addition to difficulty with ambulation, pain will be reproduced with passive hip range of motion, specifically with internal rotation of the hip. Internal rotation of the hip will not only be limited relative to the contralateral side (if unilateral slip), but it will also be painful. If a bilateral slip is present, internal rotation may be decreased bilaterally so the clinician should bear this in mind. For severe slips, passive hip flexion will produce obligate external rotation of the hip. This means that as the hip goes into flexion, the femur will begin to externally rotate and the heel of the foot will move closer to the midline of the body. This is due to the abnormal shape of the proximal femur after slippage. The migrated metaphysis will impinge on the acetabulum with hip flexion; external rotation of the femur allows for increased hip flexion by rotating the abnormally shaped proximal femur away from the acetabulum.

Figure 1. (A) Anteroposterior and (B) frog-lateral views of a patient with bilateral slipped capital femoral epiphysis (more severe on the right hip). Note the double-density of the proximal femoral metaphysis on the anteroposterior view (red arrows) and loss of the normal contour of the femoral head-neck junction on the frog-lateral views.
Diagnosis is confirmed with plain X-rays. AP views of the pelvis and frog lateral views of the hips should be obtained. The AP view will show the characteristic anterosuperior migration of the metaphysis relative to the phy- 

sis. In a severe slip, this is easily seen on the AP view (Figure 2). However, in a mild case, this may not be so obvi- 

ous. One clue to a mild SCFE on the AP radiograph is the double density of the proximal femoral physis. This radi- 

graphic double density is known as the “blanch sign of Steel,” and is due to overlapping of the ends of the physis 

that occur as the metaphysis migrates superiorly relative to the epiphysis (Figure 1). Another radiographic pa- 

rameter to evaluate on both the AP and frog lateral view is Klein’s line. It is a line drawn along the superior 

femoral neck and should intersect the lateral border of the epiphysis. When the epiphysis slips, this line lies at 

the lateral border of the epiphysis or misses it completely. Figure 3 shows AP and frog lateral views of bilateral 

SCFE; note that Klein’s line on the left completely misses the epiphysis, but on the right it intersects the lateral border. However, caution should be taken when evaluating Klein’s line, as it can be normal in mild slips (Figure 4). Frog lateral X-ray is preferable to a single view of the hip if possible as it provides a quick and easy way to evaluate and compare both hips. The slip is usually most evident on the frog lateral films with obvious deformity of the proximal femur (Figure 1 and Figure 2). The normal contour of the proximal femur on the frog lateral view should look like a golf ball (femoral head) on a tee.
(femoral neck). When the metaphysis begins migrating relative to the epiphysis, this normal contour is lost. Epiphysiodesis, or widening of the physis, can be seen on both AP and frog lateral views of the hips and can be an obvious sign of SCFE (Figure 5).

Diagnosis of SCFE should be high on the differential analysis when young overweight adolescents present with insidious onset of hip, groin, thigh, or knee pain. However, the pediatrician should still maintain a high index of suspicion for the atypical patient, as they can frequently be misdiagnosed with a simple muscle strain. It is thought that SCFE is the result of a combination of both biochemical (hormones) and biomechanical (weight, femoral neck anatomy) factors. It has been shown that estrogen decreases physeal height and increases physeal strength, whereas testosterone decreases physeal strength. This may account for the increased male predominance, especially at adolescence. There have also been accounts of increased incidence of SCFE in children with hypothyroidism, children undergoing growth hormone supplementation, Down syndrome, and in children with hypogonadal states. Although the relationship between SCFE and weight is widely known and well recognized, the relationship between SCFEs and endocrinopathy or metabolic disorders can often be missed. SCFE can be characterized as idiopathic or atypical. Idiopathic SCFEs occur in the overweight adolescent child between ages 10 and 16 years. Atypical SCFEs are those associated with endocrinopathy, radiation therapy, or renal osteodystrophy. Patients presenting with an atypical SCFE should undergo further diagnostic evaluation for metabolic or endocrine abnormalities. It has been shown that age and weight are the...
most important predictors of determining the presence of an atypical SCFE. The age-weight test is a useful tool to help guide pediatricians in the evaluation of patients presenting with a possible atypical SCFE. Patients presenting with SCFE who are younger than age 10 years or older than age 16 years, regardless of weight percentile, would screen positive for the age-weight test. In addition, patients with a SCFE who present between the ages of 10 and 16 years, regardless of weight percentile, would screen positive for the age-weight test.
and who are below the 50th percentile for weight, also screen positive for the age-weight test. Patients who screen positive for the age-weight test have a 52% chance of having an atypical SCFE and should undergo further diagnostic testing. Conversely, patients who screen negative for the age-weight test have a 93% chance of having an idiopathic SCFE and thus require no further evaluation. Therefore, patients younger than age 10 years or older than age 16 years with weight below the 50th percentile for age should be further evaluated for a cause of their atypical SCFE. Loder and Greenfield produced an algorithm for the diagnostic evaluation of these patients (Figure 6) that may guide the metabolic screening for patients presenting with atypical SCFE. The most common endocrinopathy associated with SCFE is hypothyroidism followed closely by growth hormone (GH) deficiency. Other possible diagnoses include panhypopituitarism, craniopharyngiomas, hypogonadism, hyperparathyroidism, GH excess, multiple endocrine neoplasia, Turner’s syndrome, and optic gliomas.

TREATMENT

Once the diagnosis has been confirmed, treatment consists of urgent referral to a pediatric orthopedist for surgical intervention. The patient should be instructed to remain non–weight-bearing to the affected extremity. If a bilateral slip is diagnosed, a wheelchair should be used for patient transport. The goal of surgical intervention is to prevent progression of the slip and decrease the risk of developing long-term morbidity from the slip. Complications of SCFE depend on slip severity and can range from mild hip pain to femoroacetabular impingement (FAI) to avascular necrosis; patients may also be completely asymptomatic after their slip. According to Novais and Millis, the abnormal morphology of the proximal femur after SCFE predisposes to FAI and early onset osteoarthritis due to abnormal contact between the femoral head-neck junction and acetabular labrum and/or articular cartilage. With regard to avascular necrosis (AVN) as a complication of SCFE, Loder et al. found that patients with unstable slips had a 9.4-fold greater relative risk of developing AVN compared to patients with stable slips. In addition to slip severity, delayed diagnosis can predispose to increasing slip severity and, subsequently, poorer outcomes. A study by Kocher et al. looked at factors contributing to delays in diagnosis of SCFE. They found that patients presenting with knee and thigh pain had longer delays in diagnosis (15 weeks) versus those who presented with hip or groin pain (6 weeks). They also found an increase in the delay to diagnosis in patients with Medicaid (12 weeks) versus private insurance (6.5 weeks) and stable (8 weeks) versus unstable (6.5 weeks) slips. Surgery for SCFE involves percutaneous placement of screws across the physis to stabilize the slip. The contralateral hip may be fixed prophylactically in the absence of an overt slip in select cases (eg, very young child, patient with an endocrinopathy). Figure 7 shows postoperative plain X-rays of patients treated with hip pinning for unilateral and bilateral SCFE.

CONCLUSION

In conclusion, SCFE is a diagnosis that should be high on the differential analysis when adolescent children present with hip, groin, thigh, or knee pain. Diagnosis is confirmed with plain radiographs. Although usually seen in obese children, patients with “normal” body mass index are not immune to the development of SCFE. If the diagnosis of an atypical SCFE is made, the patient should undergo further testing for

Figure 7. Anteroposterior views of patients who underwent unilateral and bilateral pinning for slipped capital femoral epiphysis.
an endocrine or metabolic disorder. After diagnosis, the patient should be made non-weight-bearing on the affected extremity and urgent referral to orthopedics should be made to ensure timely stabilization of the slip.

REFERENCES