Diagnosing slipped upper femoral epiphysis

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The key to diagnosing slipped upper femoral epiphysis is a high index of suspicion. This article summarizes the important clinical features of the disorder and points out the pitfalls in diagnosis.

Slipped upper femoral epiphysis (SUFE) is a disorder of the hip in which the epiphysis appears to 'slip' off the metaphysis (*Figure 1*). This is usually a gradual process reflected in the insidious onset of the symptoms, but sudden slips also occur.

SUFE is an unusual condition in that while it can present with a confusing spectrum of symptoms, it occurs in a predictably narrow age group; it is the age of the patient that gives away the diagnosis. Patients with florid symptoms usually cause no diagnostic problems, but those with subtle clinical features are harder to spot, and delays in diagnosis are not infrequent (Ledwith and Fleisher, 1992). As well as causing prolonged suffering to the patient, there is evidence that diagnostic delay leads to a poorer outcome (Cowell, 1966). Therefore, it is important to be aware of which patients are 'at risk' and to be familiar with some of the less common clinical scenarios that result from a slip.

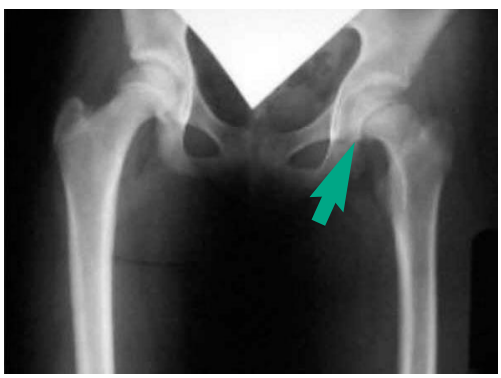
PATHOLOGY

A slip occurs through a physis (or growth plate) that has structurally failed, although the precise reasons for this are not fully understood. It may fail because of increased loads upon it, e.g. in the obese in whom SUFE is more common (see below). It may fail because certain anatomical variants, such as retroversion of the femoral neck (Gelberman et al, 1986) or a vertical slope to the physis (Mirkopulos et al, 1988), render it more susceptible to shear forces; these variants are more common in affected patients than in the normal population.

Inherently weakness of the physis probably also plays a role. Microscopic studies demonstrate a widened physis with disorganization of the normal orderly columns of cartilage and their fibrils (Agamanolis et al, 1985) as well as an almost universal synovitis (Howorth, 1949). However, it is difficult to know whether these changes are causes or effects of the condition. Physeal plate strength is known to be reduced by certain endocrinopathies (McAfee and Cady, 1983). There is a small group of patients with these conditions in whom the association is clear, but the role that hormone 'imbalance' plays in the majority with no clinical endocrinopathy remains to be determined.

Low energy traumatic episodes, such as falls, are frequently associated with SUFE (Wilson et al, 1965), but this is in contrast to a Salter–Harris type fracture of the proximal femur, which is a high-energy injury.

Figure 1. A slipped upper femoral epiphysis (arrow). Note the widening of the physis compared with the normal side.



EPIDEMIOLOGY

SUFE is rare, but it is the commonest hip condition of adolescence. The incidence is between 1 and 3 per 100 000, less than Perthe's disease for example. There is geographical variation, with a high incidence in Scandinavia (Hagglund et al, 1984) and among Afro-Americans in parts of the USA (Kelsey et al, 1970), and a low incidence in eastern Japan (Namoiya et al, 1976).

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It is a condition of puberty. Males usually present between the ages of 10 and 16 years (average 13.5 years) and females slightly earlier between 10 and 14 years (average 11.5 years). Seventy-eight per cent of cases occur during the adolescent growth phase (Sorenson, 1968). In affected females, SUFE almost exclusively precedes menarche.

In the rare occasional patients who present outside this fairly narrow age range, it is important to be alert to the possibility of an endocrinopathy, several of which are known to be associated with SUFE (*Table 1*). Clinically, such patients may be of short stature, which can be ascertained in clinic by plotting their height on standard height-for-age charts. The other useful clinical screening tools are testing for a slowly relaxing ankle jerk reflex (hypothyroidism) and visual field defects (pituitary adenoma), but often the diagnosis will already have been made biochemically.

Males predominate in the ratio 2.4 to 1, and the left hip is twice as commonly affected as the right. Bilateral disease is common: its incidence has been found to be as high as 80% as demonstrated by radiological follow-up studies of the unaffected hips of affected patients (Billing and Severin, 1959). The incidence of bilateral symptomatic involvement during the adolescent years is lower, however, at around 25%, suggesting that a large proportion of slips occur asymptomatically.

Brenkel et al (1989), among others, have drawn attention to the association of obesity with SUFE. They showed 73% of affected males and 52% of affected females were above the 90th centile in weight-for-height profiles. Such individuals also present at a younger age (Loder et al, 1993a). Whether there is a discrepancy between chronological and skeletal age is controversial. Some studies have suggested that patients with SUFE are in general skeletally immature relative to their chronological age (Sorenson, 1968), with the skeletal age lagging behind by up to 20 months. Loder et al (1993b) dispute this. They report a more or less uniform skeletal age for all patients, with the young children skeletally advanced in age and the older patients relatively skeletally immature. In other words, there is a 'window' of skeletal age during which SUFE is likely to occur.

TABLE 1.
Conditions associated with slipped upper femoral epiphysis

Hypothyroidism
Panhypopituitarism
Hypogonadal conditions
Renal osteodystrophy
Growth hormone treatment

CLINICAL FEATURES

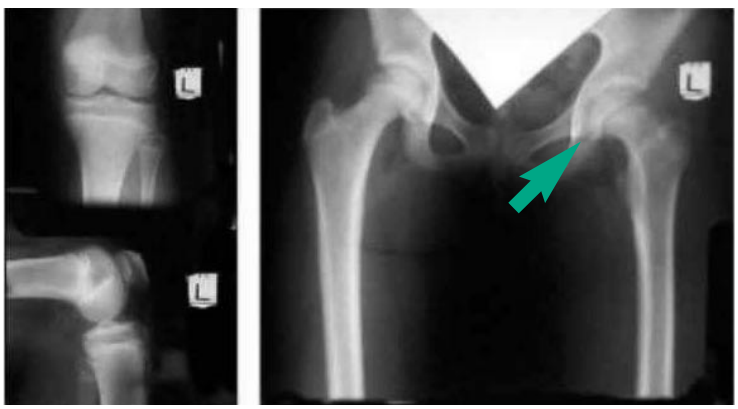
The usual mode of presentation of SUFE is with one or both of the following:

1. Pain in the affected hip, groin, proximal thigh or knee
2. A gait abnormality.

Matava et al (1999) found that 85% of their patients described primarily hip, groin or proximal thigh discomfort. The remaining 15% had a primary complaint of distal thigh or knee pain or both at initial presentation, illustrating the phenomenon of referred pain along the sensory distribution of the obturator nerve, which is seen in a variety of hip disorders. They found that such patients were more likely to receive a misdiagnosis, to undergo unnecessary or uninformative X-rays, to experience a longer delay to diagnosis and to have slips of significantly greater radiographic severity than those patients with 'classical' symptoms. As a result, they were also more likely to require a proximal femoral osteotomy as treatment for their slips, which is a complex procedure with potentially severe complications.

Therefore, it is important to be suspicious that the adolescent with knee pain may be suffering from SUFE. *Figure 2* shows a not infrequent sequence of radiographs: a normal knee film, followed by the film of the pelvis demonstrating a moderately severe slip. Some patients get as far as undergoing a diagnostic knee arthroscopy, and the authors have experience of one such patient in whom the diagnosis of SUFE was made during this procedure, because the

Figure 2. Normal radiographs of the left knee, followed by a later film of the pelvis showing a left-sided moderate slipped upper femoral epiphysis (arrow).



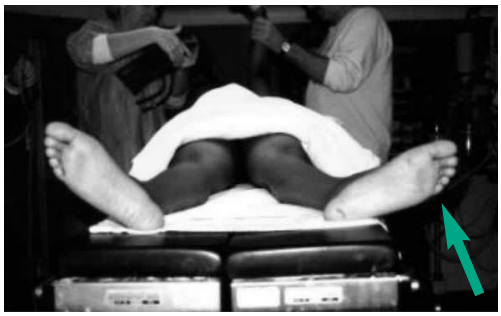


Figure 3. Out-toeing of the left foot (green arrow) resulting from a left-sided slipped upper femoral epiphysis.

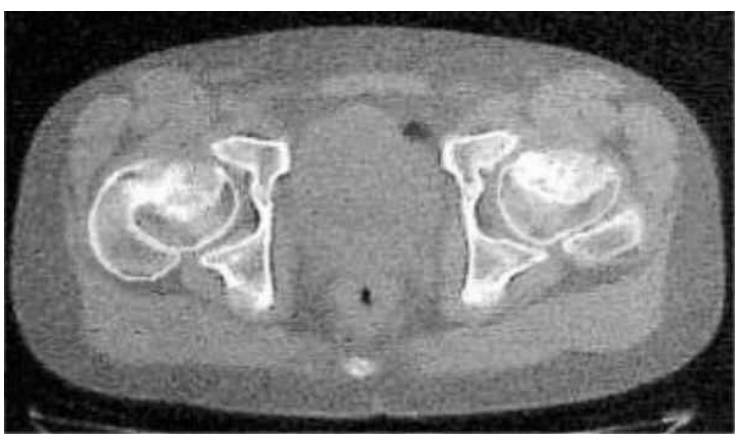
restricted hip rotation made visualization of the knee joint so difficult.

It may be patients or their parents who notice an abnormality of gait. Often this is a limp of an antalgic nature, which is frequently episodic and related to exertion. Patients may recognize this and complain of 'weakness' of the affected limb. In addition, there is a decrease in internal rotation and abduction of the hip as well as increased external rotation of the affected limb, which manifests itself clinically as progressive out-toeing of the gait (*Figure 3*). The patient in *Figure 4*, an 18-year-old, complained that his feet were progressively 'turning out'. His out-toeing gait was the result of bilateral slips, which had caused his femora to externally rotate. As mentioned above, it is important to be alert to the possibility of endocrinopathy in a patient who presents at an unusual age. This patient indeed had hypopituitarism secondary to a pituitary adenoma.

CLASSIFICATION

Traditionally, SUFE was classified according to the duration of symptoms into 'acute' (less than 3 weeks) or the much more common 'chronic'.

Figure 4. Axial computed tomography scan showing bilateral slipped upper femoral epiphysis. Note how the epiphyses face posteriorly as a result of the slipping.



A small 'acute-on-chronic' group, who had a sudden increase in their pain on a background of grumbling symptoms, was also recognized.

This classification was unsatisfactory for a number of reasons and has now been superseded by the classification of Loder et al (1993c) into the common 'stable' and the rarer 'unstable' slips as follows:

- Stable: the patient can walk with or without crutches
- Unstable: the patient's pain precludes walking, even with crutches.

This is a simple, common-sense classification with important implications for management. Loder et al (1993c) showed that unstable slips have a far higher incidence of avascular necrosis compared with the stable slips (47% *vs* 0%) — a devastating complication. What this means in practical terms is that the unstable slips are a surgical emergency, requiring immediate referral and hospitalization, whereas the stable slips can be dealt with on an urgent elective basis. The unstable slips seem to be pathologically distinct from the stable slips, as recent work is beginning to show (Stanitski et al, 1996), sharing some of the clinical features and complications of subcapital femoral neck fractures. Ultrasound is becoming increasingly common in the investigation of SUFE, and Kallio et al (1995) have identified the presence of a joint effusion as characteristic of the unstable slip; the presence of an effusion on ultrasound therefore should prompt a guarded prognosis.

INVESTIGATIONS

The investigation of choice to clinch the diagnosis of SUFE is a plain anteroposterior and lateral radiograph of the pelvis and hips on which the displacement of the epiphysis relative to the metaphysis is usually obvious. Such a film allows comparison of the two hip joints.

The lateral plain radiograph shows the degree of displacement more accurately and is of crucial importance in planning treatment. The problem is that a true or cross-table lateral radiograph is difficult to obtain in the obese patient, while a frog-leg lateral film runs the risk of increasing displacement of the epiphysis during positioning on the X-ray table. The best film to request is the Billing's view, which involves positioning the abducted thigh at 25° to the table (this must be measured) with the tibia parallel to the floor. This is a safe and reproducible method (Billing, 1954) (*Figures 5* and *6*).

In the case of early slipping, the radiological signs are subtle and include a widening of the physis, an apparent loss of epiphyseal height and

a crescent-shaped area of increased density in the proximal femoral neck as a result of the double shadow created by the posteriorly displaced epiphysis behind the metaphysis (*Figure 7*). This is called the blanch sign of Steel, after Steel (1986), although Capener originally described this sign in the 1950s. One simple test is to draw a line along the superior basal margin of the femoral neck on the anteroposterior radiograph (the Trethowan or Klein line). Normally, this line intersects the lateral aspect of the epiphysis, and its failure to do so strongly suggests that a slip has occurred (*Figure 8*).

Figure 5. Positioning the patient for a Billing's view lateral radiograph. Angle between leg and bed is 25°.

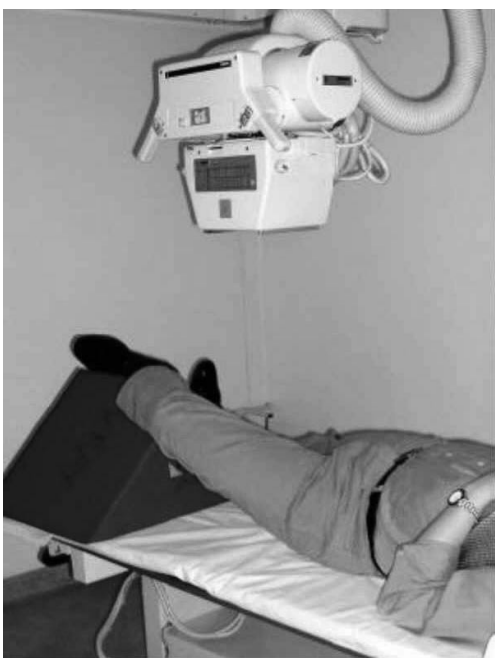
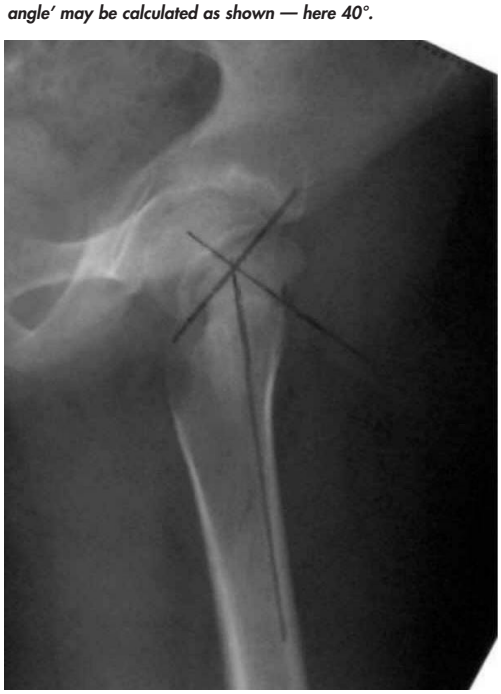


Figure 6. The resulting Billing's view lateral radiograph. The 'slip angle' may be calculated as shown — here 40°.



TREATMENT

The goals of treatment are to alleviate symptoms and to arrest the process of slipping, because the evidence is that the greater the degree of slipping, the poorer the outcome. In practice, this means that the majority of slips will be 'pinned in-situ', i.e. accepting mild or moderate degrees of slipping (when the epiphysis is displaced by less than 50% of the width of the femoral neck) but inserting screws across the physis to prevent the slip getting any worse (*Figure 9*).

The treatment of severe slips is controversial. When the degree of slipping is great (i.e. when the epiphysis is displaced by greater than 50% of the femoral neck), there may be implications for the long-term function of the hip if the epiphysis is fixed in that position. On the other hand, attempts at reducing the degree of slip-

Figure 7. Steel's sign. Note the area of increased density in the metaphysis (green arrows).

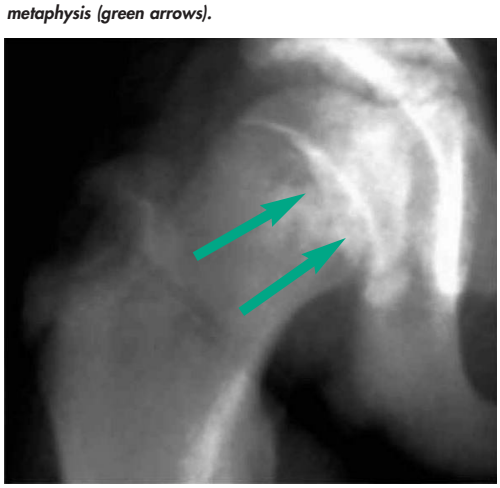
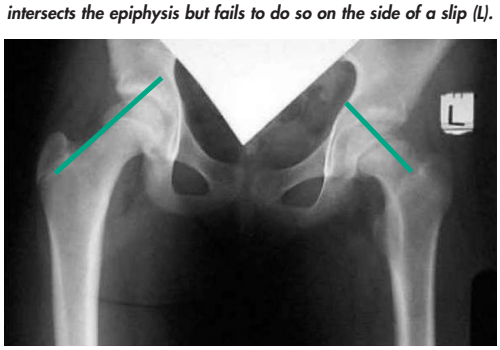


Figure 8. A line drawn along the normal superior femoral neck intersects the epiphysis but fails to do so on the side of a slip (L).



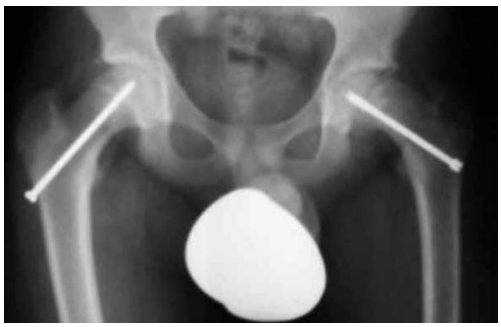


Figure 9. A mild slipped left upper femoral epiphysis pinned in-situ. The contralateral side has also been pinned as a prophylactic measure.

ping carry with them the risk of severe complications. Some surgeons perform open reduction and fixation of severe slips, arguing that it is important to restore normal biomechanics to a young patient's hip; others prefer to perform the safer operation of pinning milder slips in-situ on the basis that the priority is to avoid complications. Two complications are recognized as potentially devastating: avascular necrosis of the epiphysis (referred to above) and chondrolysis. Chondrolysis is characterized by pain and limitation of movement of the joint together with a diminution of the 'joint space'. The cause remains unknown and the prognosis variable, but in almost all cases, it is iatrogenic in origin in that it is extremely rare in the untreated case.

CONCLUSION

SUFE is the commonest condition of the adolescent hip. The challenge for the clinician is to be aware of the possible presentations and to have a high index of suspicion in this age group. Diagnostic delays still occur, and there is evidence that this may result in a poorer outcome for the patient. One common pitfall is failure to appreciate the significance of knee or distal thigh pain, which occurs in a minority of patients with SUFE. A plain radiograph is usually sufficient to make the diagnosis.

KEY POINTS

- Slipped upper femoral epiphysis is the commonest condition of the adolescent hip.
- The key to diagnosis is a high index of suspicion.
- Knee or distal thigh pain as the primary symptom occurs in a significant minority.
- Diagnostic delay leads to a poorer outcome.
- Patients outside the classical age range may have an endocrinopathy.
- Unstable slips require emergency referral.

A simple classification now exists that divides slips into stable (the majority) and unstable. The unstable slips are at much higher risk of the severe complication of avascular necrosis and require emergency referral.

SUFE can and does occur outside the typical age group, in which case evidence for an endocrinopathy should be sought. HM

Conflict of interest: none.

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