FROM THE UNIVERSITY OF LUND, SWEDEN (ROENTGEN DEPARTMENT, MALMÖ ALLMÄNNA SJUKHUS, MALMÖ. HEAD: PROFESSOR SÖLVE WELIN)

PELVIC INSTABILITY IN UPPER FEMORAL EPIPHYSEOLYSIS

By

GEORG THEANDER

The condition known as slipped upper femoral epiphysis, or epiphyseolysis, is characterized by a more or less gradual separation of the femoral diaphysis from the capital epiphysis, which remains in the acetabulum. A bending or fracture through the upper femoral epiphyseal plate and contiguous trabeculae of bone seems to be an essential regular finding observed on microscopic examination of specimens taken shortly after the commencement of slipping (*Sutro* 1935; *Howorth* 1941, 1949; *Ponseti & McClintock* 1956). In practice the diagnosis is based on the recognition of the displacement, but it is widely agreed that the fracture as well as the actual slipping, or epiphyseolisthesis, is merely the final result of some abnormality of the epiphyseal plate. The common absence of any known trauma strongly supports this conception. There is much evidence that some hormonal disorder (*Key* 1926, and others), poisonous agent (*Ponseti & McClintock* 1956, and others) or a combination of both (*Andrén & Borgström* 1958, and others), is involved in the causation of the disease.

Little is known with certainty of the metaphyseal changes preceding the epiphyseolisthesis. It has been claimed by many authors (e.g., *Ferguson & Howorth* 1931; *Brailsford* 1933, 1953), though denied or doubted by others (e.g., *Waldenström* 1940; *Watson-Jones* 1955) that a preslipping stage of the disease can be clinically distinguished, but the histologic picture referred to this stage seems to be fairly uncharacteristic. *Howorth* (1941, 1949) observed decalcification and hypervascularity at the junction of the neck and the epiphyseal disc together with villous formation, oedema, hypervascularity, and some perivascular cell infiltration of the joint soft tissues. Roentgenographic changes said to precede slipping have been reported by *Ferguson &*

Howorth (1931) and *Brailsford* (1933, 1953). According to *Brailsford* (1933), "the metaphysis may be thickened in part or throughout the whole of its width. In such cases the metaphyseal periphery of the epiphysis will be well defined .....; the diaphyseal border on the other hand will be ill defined and woolly in appearance."

A gradual slipping of other epiphyses is known to occur (e.g., *Greene* 1954) but seems to be rare. This does not necessarily mean that the metaphyseal abnormality supposed to underlie epiphyseolisthesis is usually restricted to the upper femoral ends. With a corresponding degree of reduction in its shearing strength any other epiphysis would probably be less apt to slip than that of the upper femoral end because of the oblique position of the epiphyseal plate there. Though it would certainly be of interest to ascertain whether upper femoral epiphyseolisthesis is the manifestation of a merely local or a general metaphyseal abnormality, this problem has apparently received little attention. A fairly thorough search in the literature thus revealed only one statement, with no further details that "skeletal surveys of patients with slipped upper femoral epiphysis have shown some widening and irregularities in the outlines of other epiphyseal plates" which suggests that the lesions are not restricted to the upper portion of the femur (*Ponseti & McClintock* 1956; *Ponseti* 1957). The present paper is concerned with the question whether the primary lesion also involves connective tissues other than those of the metaphyses of bones.

MATERIAL, METHODS AND RESULTS

The material included 28 cases of upper femoral epiphyseolysis in the slipping or postslipping stage. The essential data are summarized in Table 1. The sex ratio was somewhat unusual, since only 12 of the 28 were boys, but in no other respect did the series seem to differ from others on record. In 5 cases (Nos 1 to 5) roentgenographic examinations were performed for the purpose of ascertaining whether the bony pelvis was stable or not. In the others, the study was retrospective and had to be based on the review of films taken only to establish the diagnosis of slipped upper femoral epiphysis or to reveal any changes in this condition following treatment. For comparison, 11 apparently healthy youths (3 boys and 8 girls aged 10 to 18 years) were also examined for pelvic instability.

The study was prompted by observations made on roentgenographic examination of a 12 year old girl (Case No. 1) for upper right femoral

TABLE 1

Slipped upper femoral epiphysis: sex and age distribution, side of hip affected, and observed symphyseal gliding (G).

Case No.	Sex	Age in years	Hip affected	G
1	F	12	R	+
2	F	14	R	+
3	F	14	L	—
4	M	16	L	—
5	M	14	R	—
6	F	11	L	+
7	F	12	L	+
8	F	12	L	+
9	F	10	L	+
10	F	13	L	+
11	F	13	R,L	—
12	F	13	R	—
13	F	13	R	—
14	F	12	R	—
15	F	11	L	—
16	F	12	R,L	—
17	F	12	L	—
18	F	13	L	—
19	M	14	R,L	+
20	M	13	L	+
21	M	14	L	+
22	M	17	L	—
23	M	15	L	—
24	M	14	L	—
25	M	13	L	—
26	M	10	L	—
27	M	13	R	—
28	M	11	R.L.	—

epiphyseolysis suggested by symptoms of 2 months' duration. This diagnosis was confirmed and, in addition, the pubic symphysis was found to be remarkably skew, the end of the left pubic bone being in the recumbent position situated more cranially than that of the right one. Further examination in the erect position revealed a definite instability of the pelvis, the symphyseal ends of the pubic bones gliding on one another on transfer of the body weight from one leg to the other. On re-examination 15 months later, the symphyseal skewness persisted but pelvic instability was no longer demonstrable. Of 4 further patients

with unilateral upper femoral epiphyseolysis (2 boys and 2 girls; Cases Nos 2 to 5) who were examined in the same manner, mutual gliding of the pubic bones was demonstrated in one. In the others no such movement was observed but, in 2 of them, the symphysis was skew.

The 23 cases of upper femoral epiphyseolysis which were studied in retrospect only (Nos 6 to 28) had been repeatedly examined roentgenographically but, as mentioned, not for any pelvic instability and only in the recumbent position. On comparison of the films available it was nevertheless apparent that a mutual gliding of the pubic bones had occurred in 8 of the cases. In the remaining 15 cases the pubic bones were not seen to have moved in relation to one another after the first film had been taken, but in 7 of them the symphysis was skew.

Symphyseal gliding was thus observed to occur in 10 out of the 28 cases of epiphyseolysis studied, and in 9 of those with no observed gliding the symphysis was skew (Tables 1 and 2). Extensive investigations on pelvic instability and its sequelae seem to indicate that such skewness is per se a reliable sign that the pelvis is, or has been, unstable (*Kamieth & Reinhardt* 1955; *Kamieth* 1959).

TABLE 2

Symphyseal skewness related to side of slipping in upper femoral epiphyseolysis with no observed symphyseal gliding, r=right, l=left pubic bone situated more cranially.

Case No.	Hip affected	Symphyseal skewness
3	L	r
4	L	l
5	R	–
11	R,L	l
12	R	r
13	R	–
14	R	l
15	L	r
16	R,L	–
17	L	l
18	L	–
22	L	r
23	L	–
24	L	–
25	L	r
26	L	–
27	R	–
28	R,L	–

Of the cases of unilateral epiphyseolysis, the pubic bone situated more cranially was contralateral to the hip affected by slipping in 5, and ipsolateral in 3 (Table 2). In this respect, there was thus no constant relationship between the side of the slipping and the type of symphyseal skewness observed.

In the apparently healthy youths examined for comparison the symphysis was symmetrical and no mutual gliding of the pubic bones was observed on shifting body weight from one leg to the other. This is consistent with the statement of *Kamieth & Reinhardt* (1955) that pelvic instability is rare in children and adolescents of both sexes.

DISCUSSION

Though some of the cases available for the present study had been incompletely examined, the information obtained would seem to be sufficient to indicate that pelvic instability is a common occurrence in upper femoral epiphyseolysis. The question arises whether this instability can be explained by the impaired function of the clinically affected hip. Pelvic instability is known to occur in unilateral hip joint disease and is then ascribed to static abnormalities (*Kamieth & Reinhardt* 1955). It is claimed to be characteristic of the symphyseal skewness in such cases that the pubic bone situated more cranially is always the one contralateral to the abnormal hip (*Kamieth & Reinhardt* 1955). The absence of such a relationship in the present material seems to suggest that the pelvic instability observed was not provoked by the manifest epiphyseolysis. More probably the instability was due to involvement of pelvic connective tissue by the pathologic process underlying epiphyseolisthesis. If thus inherent in the disease, the condition would seem to deserve attention from diagnostic as well as theoretical points of view. If developing early the instability might be helpful to recognize epiphyseolysis in the preslipping stage and thereby add to the information wanted to understand better the nature of the disease.

Discussing the theoretical aspects of pelvic instability being inherent in epiphyseolysis, it is necessary to deal in some detail with current conceptions of the etiology of the diasease. Various factors have been considered to be responsible for the underlying metaphyseal abnormality. These include, i.a., unrecognized traumatic injuries and habitual overloading (*Caffey* 1950; *Kaiser* 1953; *Rennie* 1960), inflammation (*Ferguson & Howorth* 1931) and renal ricketts (*Brailsford* 1933), but most attention is being paid to a hormonal dysfunction first suggested

by the characteristic sex and age distribution of the disease (roughly 10 to 16 years; boys more often than girls) and by its relatively common occurrence in individuals growing rapidly or affected with the adiposogenital syndrome (*Key* 1926). Experimental studies of the influence of growth hormone, oestrogen and testosterone on the shearing strength of the upper tibial epiphysis in rats seem to indicate that epiphyseolisthesis can result from an imbalance between the growth and sex hormones (*Harris* 1950; *Hillman* & coll. 1957). Further support is given to this view by the slipping of the upper femoral epiphysis reported to occur in some cases of craniopharyngeoma (*Mason* 1954; *Bruns* 1960), tumour of the hypophysis (*Löfgren* 1953) or hypophyseal dwarfism (*Schlüter & Peter* 1956), and by the small size of the sella turcica observed in several cases of slipped upper femoral epiphysis (*Löfgren* 1953). On the other hand, epiphyseolysis is far from always associated with any demonstrable hormonal disorder, and in an extensive study of a hundred cases of the disease *Burrows* (1957) failed to reveal any fundamental difference in the natural history of those with manifest endocrine defects and those without.

A further possible etiologic factor was suggested by the observation that epiphyseolisthesis as well as many other pathologic conditions can be induced in animals by oral administration of aminonitriles (*Ponseti & Shepard* 1954, and others). Histologically, the lesions thus obtained in the epiphyseal plates are similar to those observed in the slipped upper femoral epiphysis in humans (*Ponseti & McClintock* 1956; *Ponseti* 1957). Since the onset of symptoms in the latter condition shows a distinct seasonal variation (*Ferguson & Howorth* 1931; *Andrén & Borgström* 1958), the period of increased frequency coinciding with the months the cows are out to pasture, and since many patients with slipped upper femoral epiphysis are known to be heavy milk drinkers (*Kocher* 1894; *Andrén & Borgström* 1958), it has been assumed that traces of aminonitriles may be supplied with the milk and favour epiphyseolysis in rapidly growing individuals (*Andrén & Borgström* 1958). This assumption is supported by an observation made by *Selye* & coll. (1957) that the toxicity of aminoacetonitrile is markedly enhanced by simultaneous injection of growth hormone, even in doses too small demonstrably to stimulate growth.

It would seem to be in line with, and even in support of, the conceptions related above if the pathologic process supposed to underlie epiphyseolisthesis were found to involve other structures as well as the metaphyses of bones, since the hormones and poisons referred to are

pluripotent in action. The inherence of pelvic instability in the disease, as suggested in the present investigation, is nevertheless puzzling. It is well known that such instability can be experimentally provoked, and is physiologically produced during pregnancy, by the combined or alternate action of relaxin and oestrogen *(Hall* 1956, and others); even in old men pelvic instablitiy may follow treatment with stilbene (*Bücher & Kamieth* 1956). The pelvic laxity, including marked instability of the symphysis, recently discovered in congenital dislocation of the hip (*Andrén* 1960) is also due to some disorder of oestrogen metabolism (*Andrén & Borglin* 1960). But in the metaphyses of bones, as represented by the upper tibial ends in rats, oestrogens cause an increase in the shearing strength (*Harris* 1950; *Hillman &* coll. 1957). A decrease can, on the other hand, be provoked by the growth hormone (*Harris* 1950), but as far as is known, pelvic instability can not be induced by overexposure to growth hormone. The controversy of evidence thus apparently present might suggest a more complicated interaction of causal factors in epiphyseolysis than hitherto supposed.

SUMMARY

Pelvic instability was found to occur in at least 10 out of 28 cases of upper femoral epiphyseolysis studied. The condition was considered to be inherent in the abnormality underlying epiphyseolisthesis, and the theoretical aspects of the observation are discussed on the basis of current conceptions of the etiology of the disease.

RESUME

On a constaté une instabilité pelvique dans au moins 10 cas d'une série de 28 observations d'épiphyseolyse fémorale supérieure. Cet état a été considéré comme une anomalie inhérente á celle de l'épiphyseolisthése. Les aspects théoriques de cette observation sont discutés sur la base des conceptions ordinaires de l'étiologie de cette maladie.

ZUSAMMENFASSUNG

Beckeninstabilität war zumindest in 10 von 28 Fällen, die wegen Epiphyseolyse der oberen Femurepiphyse untersucht worden waren, vorhanden. Der Zustand wurde als an die zugrundeliegende Anomalie der Epiphyseolisthesis gebunden, angesehen und die theoretische Seite

der Beobachtung wird auf grund der geläufigen Auffassung der Ursache der Erkrankung besprochen.

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