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SLIPPED UPPER FEMORAL EPIPHYSIS

Clinical Study on Aetiology

By

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INTRODUCTION

The exact aetiology and pathogenesis of slipping of the upper femoral epiphysis have not yet been elucidated. Generally, the cause is assumed to be hormonal imbalance during puberty combined with mechanical strain on the epiphyseal cartilage.

First, an attempt will be made to sum up our present knowledge:

1. *Sex and Age*

Slipping of the upper femoral epiphysis occurs around puberty, most often between 13–17 years of age in boys and between 11 and 15 in girls. Boys are more often affected. *Jerre* (1950) found 83 per cent boys among 166 patients, *Oram* (1952) 77 per cent among 147, and *Wilson et al.* (1965) 71 per cent among 240.

2. *Endocrine Disorders*

The occurrence of dyshormonal conditions in these patients may be explained in a very simplified way as follows: If the pituitary gonadotrophin production starts too late or is reduced, the production of sex hormone will be delayed, and a condition reminiscent of adiposogenital dystrophy (Frölich's syndrome) results. If the pituitary growth hormone production keeps high, while that of the antagonistic sex hormones is normal, pituitary giantism may occur. Both conditions are transient.

Harris (1950) administered growth hormone to castrated male and female rats and compared the histological changes in the epiphyseal

cartilage with an untreated series and a series treated only with oestrogen. In the first-mentioned group a widening of the layer of hypertrophied cartilage cells in the epiphyseal plate was noted. This layer represents a mechanically weak zone which the slip always affects. Thus, an increased quantity of growth hormone will further weaken this zone.

Slipping of the upper femoral epiphysis may occur in obese boys with a feminine distribution of fat and the characteristics of hypogonadism—but rarely in the form of a pure Frölich type—, in rapidly growing, thin, in some cases very tall patients, and in normal boys (*Key* 1926, *Shands* 1957, *Jackson Burrows* 1957, *Newman* 1958). The reported frequency varies widely, in the first type for instance from 20.4 per cent (*Oram* 1952) to 65 per cent (*Howorth* 1957). *Howorth* found the height or weight to be significantly above average in 65 per cent, half of whom were of the Frölich type. *Jackson Burrows,* comparing height and weight with the normal values, found endocrine defect to be probable in 42 per cent. In another 12 per cent he found a moderate overweight, which was unusual, and 4 per cent of the patients were unusually tall. *Wilson et al.* (1965) reported obesity in 75 per cent, and a Frölich-like appearance in 22 per cent. There are even transitions from the pure Frölich type to normality. Hypogonadism cannot be assessed accurately, and the diagnosis is often based upon an estimate. *Jackson Burrows* reported that the menarche had occurred in only 2 of 38 girls before the slip was diagnosed.

Skeletal development, judging by X-rays of the hands and wrists, was normal in 29 of *Jackson Burrows'* patients.

Hormone analyses on the 24-hour urine (17-ketosteroids, androgens, oestrogens, and gonadotrophin) have not revealed abnormalities except in a few instances (*Oram* 1952, *Jackson Burrows* 1957). Pituitary disorders and hypothalamic tumours have been reported as solitary cases in large series of patients (*Jerre* 1950, *Löfgren* 1953) and as an isolated case (*Bruns* 1960).

Jackson Burrows characterized 30 per cent of the patients as normal.

3. *Poisoning*

Aminonitriles, present int. al. in sweet peas (*Lathyrus odoratus)* may induce a typical histological appearance in animals (*Ponseti et al.* 1954, *Ponseti* 1957). The toxicity is greatly increased by simultaneous administration of growth hormone and reduced by hypophysectomy (*Selye et al.* 1957). *Ferguson & Howorth* (1931) diagnosed the majority

of their cases of slipped upper femoral epiphysis in July-November, viz. 66 per cent. *Andrén & Borgström* (1959) diagnosed 54 per cent of their cases in June-September. They assumed that in the pastures the cows might ingest aminonitriles which were passed on to the patients through the milk.

4. *Mechanical Factors*

Local mechanical factors must be decisive, since slipping occurs in fact only in the upper femoral epiphysis, while hormonal disturbances, if any, would be expected to affect all epiphyseal plates.

a) *Side affected:* Both hips are involved in 20–25 per cent (*Jerre* 1950: 22.9 per cent of 166 pts.; *Oram* 1952: 21.8 per cent of 147; *Wilson et al.* 1965: 25 per cent of 240 pts.), but it is only in about half the cases that the slip occurs simultaneously on both sides. *Unilateral* slipping affects the *left* hip significantly more often than the right, viz. in 73.4 per cent of 128 unilateral cases (*Jerre*). Correspondingly, *Howorth* (1941) has reported 56 per cent of 113, *Oram* 65.5 per cent of 115, and *Wilson et al.* 60 per cent of 180 cases. *Jerre* found the left hip to be affected in 75 per cent of boys and in 64 per cent of girls. *Oram* found the corresponding values to be 67 per cent and 58 per cent, and *Jackson Burrows* 70 per cent and 50 per cent of 128, 115, and 77 pts.

b) *Trauma:* Direct or indirect injuries are fairly uncommon, in most cases mild and rarely of decisive importance. *Oram* found single injuries in 27.8 per cent, as a rule falls or kicks, repeated injuries in 7.4 per cent, but in 75 per cent of the patients the symptoms had started before the trauma occurred. *Jackson Burrows* found relevant injuries prior to the onset of symptoms in 20 per cent, simultaneously in 20 per cent, and after in 12 per cent. *Wilson et al.* found injuries in 26 per cent.

In slipping of the upper femoral epiphysis, the femoral head gradually becomes displaced, medially, posteriorly, and distally. During walking, the centre of gravity moves from side to side, and this entails a shearing strain almost parallel to the epiphyseal plate. This also happens when the leg is carried forward. In games and physical exercises the left leg is the one which right-handed persons use to take off.

5. *Familial Occurrence*

The disease is rarely familial. Among the siblings of the patients

Jerre found 2 per cent and *Oram* 3 per cent, while *Wilson et al.* found 5 per cent in the immediate family.

PRESENT MATERIAL

An attempt was made to elucidate the aetiological problems by examining all young patients with slipped upper femoral epiphysis seen in the Orthopaedic Hospital, Aarhus, during the period 1957–1964, a total of *101 patients*.

1. *Sex and Age*

The material comprises 76 boys and 25 girls (25 per cent). The sex ratio and age distribution correspond exactly to those found by others (cf. Figure 2).

2. *Endocrine Disorders*

(a) The height and weight were recorded in all cases when the slip was diagnosed and at later follow-up visits until cessation of growth. Values for height and weight from the age of 7 were obtained from the school doctors' health cards in 95 cases (6 cards had been destroyed).

Table 1 gives the weight and height at the time of diagnosis of the slip. The weight is compared with the average weight for the height concerned in normals, for each sex separately, and the height is compared with the average height for the age concerned, also for each sex separately (*Døssing* 1950). Both sexes show a marked tendency to obesity. 26 boys (34 per cent) and 7 girls (28 per cent) weighed at least 15 per cent more than the average. There was less variation in height. In 89 per cent of the boys and in 84 per cent of the girls it was within 0 ± 9 per cent and none above 14 per cent, *i.e.* slipping of the upper femoral epiphysis does not occur particularly in very tall patients. Figure 1 shows that very few were tall and thin. This figure illustrates the great variation in the weight, with a tendency to obesity in both sexes.

To assess abnormalities of growth, all the height and weight measurements from the age of 7 years are plotted on a special growth diagram (*Døssing* 1952). It applies to the 26 obese boys and 7 obese girls that they had been fat for many years (Table 2). Their obesity had been fairly constant; they had not gained in connection with their disease and the consequently restricted physical activity. The weight curve was normal for 30 boys and 7 girls with constant height-weight

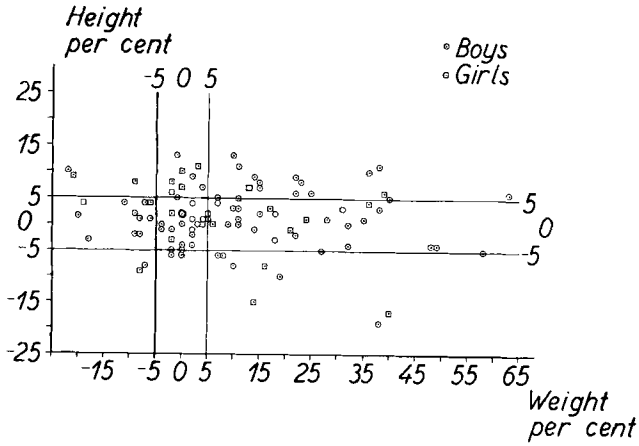

Figure 1. Height and weight of 101 patients when slipping of the upper femoral epiphysis was diagnosed, in per cent of the average for normal children of the same age and sex.

Table 1. Body weight in per cent of the average weight for the height concerned, separately for each sex, when slipping of the upper femoral epiphysis was diagnosed. Height in per cent of the average height for the same age and sex (height measured at the same time as the weight) at the time of diagnosis.

	Above average in %					*N*	*Below average in %*		
Per cent	25–63	20–24	15–19	10–14	5–9	+4 to −4	−(5–9)	−(10–14)	−(15–22)
Weight:									
76 boys	16	4	6	11	6	22	7	1	3
25 girls	3	2	2	3	3	8	2		2
Height:									
76 boys				6	15	44	9	1	1
25 girls				2	8	11	2		2

ratio and a normal weight from the age of 7 years until growth was completed. 7 boys and 2 girls were slightly, and constantly, overweight (around 10 per cent), 2 boys and 3 girls slightly and constantly underweight. In 7 boys and 4 girls the curve altered from being normal to showing, after the slip was diagnosed, a gain of about 10 per cent and thereafter a further gain. A short-lasting weight loss of about 5 kg, continuing from a few months before until a few months after the slip had been diagnosed, was observed in 15 boys and 4 girls (8 and 3 of the

Table 2. Obesity (at least 15 per cent in excess of the average weight) in 26 boys and 7 girls: Duration. (Broadly speaking unchanged height/weight ratio).

Obesity present prior to age (scale: age in years)	4	5	6	7	8	9	10	11	12	13	16 years
26 boys			1	9	2	2	2	5	1	3	1
7 girls			1	1	2	1	1		1		
Duration of obesity so far, at least (years)											
26 boys	1	6	5	3	2	3	1	2	3		
7 girls		2	1		1	2	1				

obese ones, 2 and 1 of those showing about 10 per cent overweight, and in 5 boys having an otherwise normal curve).

(b) *The adolescent growth spurt:* The annual increment in height is normally increased in relation to the preceding years in boys from 12 to 15 and in girls from 10 to 13, but this adolescent growth spurt varies in degree and duration (*Tanner* 1962).

By plotting all the heights on graph paper, the annual height increment was calculated and the adolescent growth spurt dated and compared with the age at which slipping of the upper femoral epiphysis was diagnosed. In 75 patients (59 boys and 16 girls, or 78 per cent and 64 per cent) the condition was diagnosed during the first, middle, or last part of the growth spurt, viz. in 6, 15, and 38 boys and in 1, 6, and 9 girls. In 12 boys and 6 girls the growth spurt was indistinct, and in 5 boys and 3 girls a few necessary measurements were lacking.

(c) *Skeletal development:* In all 101 cases the skeletal age was determined on the basis of *Greulich & Pyle's* atlas (1950, 1959), in 60 pts. at the time of diagnosis and in 41 6 months to 3 years after. In 2 growth had been completed. In 67 pts. 2–5 examinations were performed before completion of growth, at average intervals of 14 months. In 45 the result was the same every time, in 20 one of the examinations differed by 1 standard deviation (S. D.) from the others, and in only 2 pts. did the skeletal age land in 3 groups, each differing by 1 S. D. from each other. In 44 pts. the maximum difference between the determinations was 0–6 months, in 15 it was 7–12 and in 9 pts. 13–33 months. As there was no tendency to normalization or increasing divergence, but an even dispersion, the mean value from several examinations was used as a

Table 3. Skeletal age for 99 patients with slipping of the upper femoral epiphysis, stated as: (1) deviation from chronological age in standard deviations, (2) average deviation from the chronological age in months and the variation within the individual groups, (3) skeletal age for overweight patients and for patients who had the lowest weight and the greatest height.

Standard deviation	−(4–13)	−(3–4)	−(2–3)	−(1–2)	0 ± 1	+(1–2)
74 boys	0	5	12	26	30	1
25 girls	5	1	0	8	10	1
Percental distribution						
74 boys		17 = 23%		35%	40%	
25 girls	6 = 24%			32%	40%	
Average deviation (months)						
74 boys		42	29	18	−3	(14)
25 girls	58	24		12	−2	(10)
Range (months)						
74 boys		38–45	22–37	12–25	+6/−10	
25 girls	31–84			9–20	+3/−3	
Overweight (≧ 15%)						
26 boys		1	5	6	13	1
7 girls	1			1	5	
Total 33: % distribution (boys—girls)		21%		21%	55%	
Tall, *thin:*						
12 boys			3	6	3	
8 girls	1			4	3	
Total 20		20%		50%	30%	

basis. According to *Greulich & Pyle* 1 S. D. for boys is 10–13 months and for girls 7–12, depending upon age.

Table 3 gives the skeletal age in S. D. divergence from the chronological age. Only 40 per cent of each sex showed less than 1 S. D. and only one of each sex + 1–2 S. D. In all the other patients there was a delay of at least 1 S. D. According to *Greulich & Pyle* 0 ± S. D. should normally include 90 per cent of the pts., but in this material it included only 76 per cent. In 23 there was a delay of at least 2 S. D. In Denmark, where social conditions are favourable and medical prophylaxis extensive, there is no basis for assuming that this might be due to nutritional

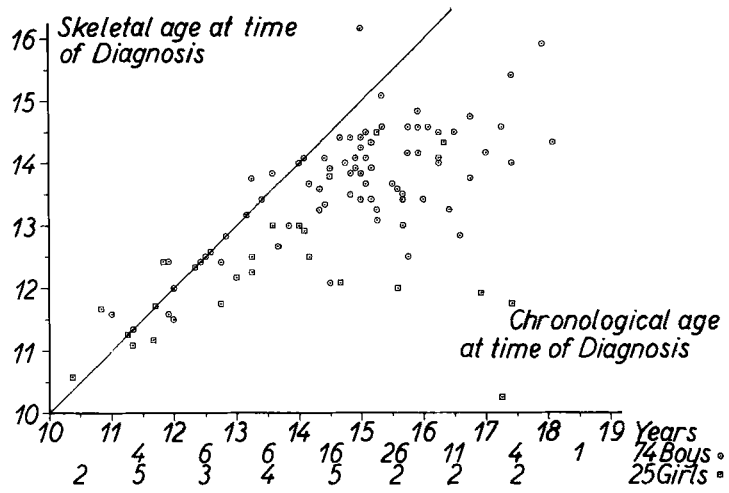

Figure 2. Chronological age of 99 patients when slipping of the upper femoral epiphysis was diagnosed and the skeletal age at that time. The delay in skeletal development is clearly apparent, as the same age units and the same starting point are used on the abscissa and ordinate, so that all the values would be on the oblique 45° line, if the skeletal age were normal.

causes or diseases. If anything, there ought to be an influence in the positive direction.

Figure 2 gives the chronological age at diagnosis and the skeletal age at this juncture, providing a constant divergence during the subsequent 3 years for the 39 pts. examined later. This has been confirmed by the repeated examinations. There is a marked dispersion of the chronological age (93 months), but far less (about 44 months) of skeletal age. Thus, the slipping of the epiphysis must arise during an interval which from the point of view of skeletal development is narrow. At diagnosis the average skeletal age in boys was 13^8 years(13 years 8 months) and in girls 12^3, with a mean divergence of 10 and 16 months. In other words, slipping of the upper femoral epiphysis was diagnosed 16 and 9 months before closure of the epiphyseal lines normally starts in the hand. (In the distal phalanges this closure starts in boys at 15^0 years and in girls at 13^0 years, and continues rapidly in the remaining finger bones).

Figure 2 shows equally large age units on the abscissa and ordinate to illustrate clearly the delay in skeletal development. Up to the age of 13½ years in boys and 12 years in girls the values are distributed uniformly around the 45° line, but thereafter all values for girls and

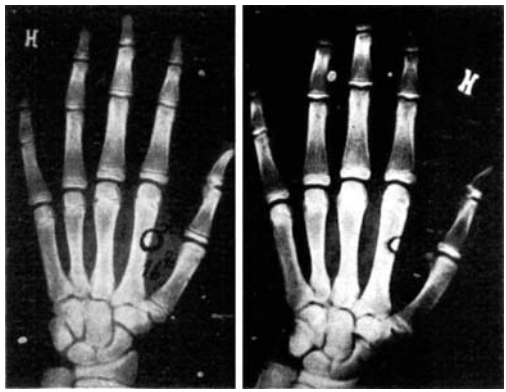

Figure 3. X-rays of the hand and wrist of a boy aged 16^{2} years in whom the skeletal development is delayed by 3 years. At the age of 17^{11} years the skeletal development is still 2^{7} years delayed, being now 15^{4} years (closure of the epiphyseal plates in most distal phalanges). Slipping of the upper femoral epiphysis was diagnosed at the age of 16^{0} years (Case 67).

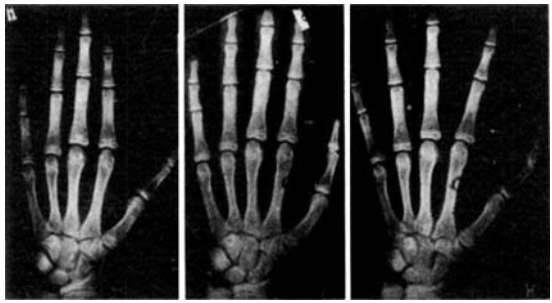

Figure 4. X-rays of the hand and wrist of a boy at the ages of 17^{5}, 18^{6}, and 19^{2} years. The delay in skeletal development amounts to 3^{0}, 3^{6}, and 3^{5} years respectively. Slipping of the upper femoral epiphysis was diagnosed at 17^{5} years of age (Case 8).

all but 5 for boys are below. The typical abnormality consists in failure of the epiphyseal plates to close. This can be easily and definitely assessed radiographically (Figures 3 and 4). As is apparent from Table 3, the deviation from the chronological age is of no slight order of magnitude.

Investigations of the skeletal age in 103 adolescent patients with Scheuermann's juvenile kyphosis from the same district had revealed no significant divergence from the normal values (*Sørensen* 1964).

The time of epiphyseal closure was controlled by comparing it with *Hansman's* findings (1962). A comparison could be performed in 50

pts. with slipped upper femoral epiphysis, 14 of whom could be assessed on 2 different films taken at average intervals of 10 months. The difference in skeletal age, according to *Greulich & Pyle* and according to *Hansman,* averaged only 4 months (22 pts.: 0–3; 20 pts.: 4–7; 8 pts.: 8–11 months) and was in all cases below 1 S. D. according to *Greulich & Pyle.*

The skeletal age of the 33 obese patients (26 boys and 7 girls) was compared with the skeletal development in the 20 tallest and thinnest patients (Table 3). This shows a slight tendency towards normalization in obese patients and to further delay in the other group, but no significant difference. In this group, as well as in the total series, there is no sex difference in skeletal development, so that the influence upon the epiphyseal plate must be the same in both sexes. There can hardly be a question of gonadal action, as gonadal function has not properly started when the slipping of the epiphysis occurs.

(d) *Menarche:* In 3 pts. the menarche had not yet occurred at the ages of 19^{1}, 21^{0}, and 24^{7} years. In 3 pts. it could not be expected to have occurred. For the remaining 19 girls the time of the menarche is accurately known and may be read from Figure 5. The average age was 14^{0} years, or 5 months in excess of the expected 13^{7} years (*Bojlén et al.* 1954). The well-known, extremely accurate correlation between the menarche and skeletal development (*Simmonds & Greulich* 1943) is seen here too: the later the menarche the greater the delay in skeletal development. Slipping of the upper femoral epiphysis was diagnosed in close time relation to the menarche, on an average 11 months prior to the menarche. In 5 pts. the menarche occurred before the slip was diagnosed, in 14 later, and in 6 it has not yet occurred. There is very little dispersion of skeletal age at the time of the menarche; it ranged from 12^{2} to 14^{1} years, average 13^{0} years, in all but one patient.

Two boys had cryptorchism; in one the testes descended after hormone therapy. No attempt was made to assess hypogonadism, if any, on the basis of the size and development of the genitalia.

(e) *Hormone analyses:* In 65 boys and 20 girls fractionated 17-ketosteroid determination was done on the 24-hour urine by chromatography isolating 4 fractions (*Johnsen* 1956). By this method the *total value of 17-ketosteroid* (17-KS) is about 30 per cent above the value found by the current methods. The total 17-KS was low in 17 boys over 15^{0} years of age (averaging 6.8 mg/24 hours (1.8–8.9)). In 8 of these

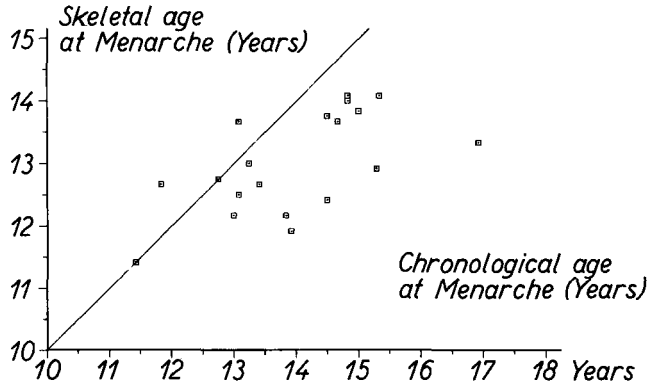

Figure 5. Age at menarche for 19 girls and skeletal age at the same juncture. Same age units as used in Figure 2.

boys the androgen fraction was low, averaging 18 per cent of the total value as compared with 28 per cent in the other 9. The skeletal age in 15 of the 17 boys was delayed by at least 1 S. D., average 24 months. Of these 17 boys 8 were obese and 3 were thin. In 7 pts. under 15 years of age the total 17-KS were presumably low, but for this age no normal values have been reported. Hypogonadism may have been present in these 17 boys, and possibly in others too. Correspondingly, 5 girls over 15 years of age had low total 17-KS, including 2 with a low androgen fraction. One was obese. The skeletal age was delayed by an average of 42 months, and in all cases by at least 1 S. D.

The 24-hour output of *dehydroisoandrosterone,* which is a pure adrenal metabolite, was found to be constant in both sexes and normal from the age of 12 to 18 years.

The amount of *androgen* in the 24-hour urine in the 12–17-year group was found to be elevated for all age groups in both sexes, and androgen was demonstrated 2 years before the normal time in the girls. The mean values were elevated from 15 per cent up to 3 times the value normal for the age and also, in a somewhat jumpy way, with increasing age. If the assessment is based upon skeletal age, the values are even more elevated. By this analytical method at least 90 per cent of the urinary androgen activity ought to be demonstrated. An increased influence of androgen upon the epiphyseal plates ought to tend to earlier closure, but we found the reverse. In recent years, however, it has become a well-known clinical experience that determination of the 17-KS excretion and fractionation is a poor and insufficient parameter

of androgen status (*Lindholm* 1967). New, improved analytical methods have been developed. As the named investigations are from 1957–1964, nothing definite can be concluded from the analyses.

(f) *Special abnormalities* (case reports): (1) A girl with slipping of the right upper femoral epiphysis, aged 17^{3} years. Skeletal age -7^{0} years. At the age of 20 she was found to have calcific deposits around the sella turcica which was quite small. No gonadotrophin in the 24-hour urine, very low oestrogen values, genitalia hypoplastic, but ovaries seen in an appendicectomy. At the age of 24^{7} years her skeletal age was -11^{1} years, no menarche. Diagnosis: Primary hypoplasia of the pituitary gland.

(2) A girl with slipped right upper femoral epiphysis, age 17^{5} years, skeletal age -5^{5} years. At 21 years of age the sella turcica was found to be normal, the 17-KS were low (1.6 mg/24 hours), no oestrogens or gonadotrophin, genitalia very hypoplastic, no menarche, skeletal age -5^{8} years, sex chromatin: female. B.M.R.: +20 per cent. Diagnosis: ?Absence of ovaries.

(3) A girl with slipped left upper femoral epiphysis, age 16^{11} years, skeletal age -4^{6} years, height/weight 135 cm/43 kg (—17/+40 per cent). At 17^{10} years: Low 17-KS (3.7 mg/24 hours), no oestrogen demonstrated, gonadotrophin normal. At 19^{1} years the menarche had not yet occurred, skeletal age -5^{10} years, height/weight 139/50. Diagnosis: Dwarfism (primary ?).

(4) A boy with slipped upper femoral epiphyses on both sides, age 16^{10} years, skeletal age -2^{10} years, height/weight 139 cm/44 kg (—19 per cent/—38 per cent), hypogenital, reduced gonadotrophin (below 3 mouse units/24 hours), very low 17-KS (1.3 mg/24 hours) and no increase following administration of metopirone, B.M.R. — 16 per cent. At 18^{3} years: Skeletal age -3^{6} years, height/weight increased to 149/57 after treatment with gonadotrophin, thyroid, and cortisone. Diagnosis: Pituitary dwarfism.

Thyroid diseases were not present among the patients. The paternal aunts of 3 boys and of 2 girls had been operated upon for goitre, probably toxic.

Diabetes mellitus was present in the mother of one girl. Otherwise, there were no cases of diabetes in the families (pts., siblings, or parents).

3. *Poisoning*

The symptoms had been present for an average of 5 months, for an equal length of time in both sexes, when slipping of the femoral epiphysis was diagnosed, ranging from 1 day to more than a year. Table 4 lists the time of the year at which the symptoms started in 61 pts. with a history shorter than 6 months in whom this juncture could be established with most accuracy. Moreover, it gives the time at which the diagnosis was made. The symptoms set in in June-September in 36 per cent of the boys and in 59 per cent of the girls (43 per cent of the total series). During the same period the diagnosis was made in 33 per cent of the boys and 48 per cent of the girls (37 per cent of the total series). The month of birth was June–September for 33 per cent of the patients and might just as well be used as a basis when considering how narrow is the skeletal age interval in which the disease starts.

Table 4. I: Time of year at which the symptoms of slipped upper femoral epiphysis started. (Length of history 0–25 weeks). II: Time of year at which the diagnosis was made. III: Birth month.

	Jan.	Feb.	Mar.	Apr	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
I:												
44 boys	3	2	1	4	2	1	7	2	6	2	6	8
17 girls	1	1		1	1	3	1	4	2	2	1	
II:												
76 boys	7	9	5	8	5	7	1	6	11	5	6	6
25 girls	2	2	1	1	2		1	5	6	3	2	
III:												
76 boys	10	8	4	9	8	12	5	7	2	2	4	5
25 girls	2	2	3		3		3	1	3	4	1	3

The period July–November does not show any major accumulation. The diagnosis was made in 38 per cent of the boys and 68 per cent of the girls; 26 per cent and 48 per cent were born during these months.

During the months July-December the symptoms had started in 70 per cent of the boys and 59 per cent of the girls having a history shorter than 6 months (total series 63 per cent boys and 50 per cent girls). In 46 per cent of the boys and 68 per cent of the girls the diagnosis was made, and 33 per cent and 60 per cent were born, during these months.

In other words, there is not in the present material any relationship between the season and the onset of the disease.

4. *Mechanical Factors*

(a) *Side affected: Both* hips were affected in 22 boys and 3 girls (25 per cent). In 13 the disease in the second hip was diagnosed when the patients were first seen and in 12 an average of 12 months later. In 12 patients the second hip was not causing any symptoms, but the slipping of the epiphysis was diagnosed on routine X-rays of both hips. When taking the *hip diagnosed first,* the right and the *left* hip was affected in 26 and *50* boys or in 34 and 66 per cent, in the girls in 12 and 13 respectively. Out of 22 boys with bilateral involvement 11 (50 per cent) were obese (of the unilateral cases 34 per cent), and 1 out of 3 girls.

(b) *Trauma:* In 23 patients the symptoms had set in after a trauma, most often a fall, and in another 10 there had been a trauma after the symptoms had been present for some time. In 7 cases the symptoms had started after an everyday event. Not even the initial traumas were great and can only in exceptional cases have caused the disease. Four years prior to the slipping of the femoral epiphysis, 1 patient had had traumatic slipping of the distal tibial epiphysis. Apart from that, there had been no epiphyseal diseases.

The side affected also fails to indicate a causal relationship. The initial injuries elicited symptoms from the left hip in 13 and in the right hip in 5 boys, *i.e.* the same ratio as in the total series. The injuries were evenly distributed on the months of the year.

The increased tendency to obesity, combined with the delay in epiphyseal closure, will *per se* entail an increased mechanical stress on the epiphyseal cartilage at the very age while activity in games is at a maximum.

5. *Familial Occurrence*

Three boys had brothers in whom slipping of the upper femoral epiphysis was demonstrated radiographically. One is included in the present series. Two fathers had osteoarthritis of the hip following slipping of the upper femoral epiphysis at puberty, with typical radiological findings. Thus, familial occurrence is rare and of no aetiological significance.

6. *Other Diseases*

One girl had a history of congenital dislocation of the opposite hip (Case 3) which was normal now. One girl had osteogenesis imperfecta, and 2 had laxity of the joints and obesity.

DISCUSSION

The results are in keeping with the literature in respect to age distribution, sex ratio, side affected, frequency of bilateral involvement, trauma, and familial occurrence.

On the other hand, the present material did not show the reported seasonal accumulation.

The very marked variation in body weight, with even transition from normal weight to very pronounced obesity, showing uniform dispersion of the values, as well as the normal height with but little dispersion, are not comparable with other investigations. The fact is that generally only the frequency of obesity is stated giving the impression that a special group of patients is clearly distinguished from a normal group. But this is not so. Nor do the patients become overweight after they have developed the disease, with its consequent restriction of physical activity. Their height/weight ratio is, broadly speaking, constant, at least from the age of 7 years until growth is completed. This applies to normal- as well as to over-weight patients.

The significant delay in skeletal development demonstrated in the present study, the same for both sexes, with delayed closure of the epiphyseal plates, combined with the finding that the slipping occurs during the adolescent growth spurt, indicates an increased production of growth hormone, *i.e.* increased activity of the anterior pituitary, and thus accords with the findings of *Harris* (1950). This is, moreover, in agreement with the fact that slipping of the upper femoral epiphysis occurs in a narrow skeletal-age interval during which the epiphyseal cartilage seems to be particularly vulnerable.

Fractionated 17-ketosteroid determination on the 24-hour urine did not afford information that can explain the delay in skeletal development or the tendency to obesity.

SUMMARY

After a brief review of the literature on our present knowledge concerning the aetiology and pathogenesis of slipped upper femoral epiphysis, a material of 101 young patients is analysed. This analysis con-

firmed the reported findings in respect to the age and sex distribution, the disease occurring around puberty and the ratio boys/girls being 75 per cent/25 per cent. Bilateral involvement was found in 25 per cent, and a left-sided preponderance in the unilateral cases among boys (66 per cent), but not among girls. Familial occurrence is rare (3 per cent). 25 per cent had a history of initial trauma, but usually too mild to have caused the slip.

There is a very marked variation in body weight, with a pronounced tendency to obesity, but with an even transition from normal weight to marked overweight and with an even distribution, whereas height was normal, with but little dispersion. Height and weight measurements from the age of 7 years until the cessation of growth showed for all the patients, and in particular for the overweight ones, that broadly speaking the height/weight ratio remained constant. It is demonstrated that the slipping of the epiphysis occurs during the adolescent growth spurt.

Determination of skeletal age on the entire material, in most cases repeatedly, revealed a significant delay in skeletal development, alike in both sexes, the closure of the epiphyseal plates being delayed. Slipping of the upper femoral epiphysis occurs during a narrow skeletal-age interval, and in girls almost exclusively prior to the menarche. The correlation between the menarche and skeletal development is confirmed.

Hormone analyses, including fractionated 17-ketosteroid determination on 24-hour urines, gave no aetiological or pathogenetic information.

The tendency to obesity and delay of epiphyseal closure entails an increased stress on the epiphyseal plate at the upper end of the femur at the very age during which the young people are keen on games and at which there is a considerable gain in body weight.

RESUME

Après un court compte rendu de la littérature sur les connaissance que nous avons actuellement de l'étiologie et de la pathogénèse de l'épiphysiolyse de la tête fémorale, il est analysé un matériel de 101 jeunes malades. La littérature confirme le répartition selon l'âge et le sexe. On constate, en effet que l'épiphysiolyse de la tête fémorale se manifeste à l'âge de la puberté dans 75 pour cent des cas chez les garçons et dans 25 pour cent chez les filles. Elle est bilatérale dans 25 pour cent

des cas avec dans les cas unilatéraux une prépondérance pour le côté gauche chez les garçons (66 peur cent), mais non chez les filles. Il est rare que maladie ait un caractère familial (3 pour cent). Chez un quart des malades, on trouve un trauma initial, mais souvent si léger qu'il ne peut pas être à l'origine de la maladie.

On constate une très grande dispersion du poids avec une tendance marquée à l'adipose, avec transition régulière du poids normal au poids très élevé et une répartition égale des masses graisseuses, tandis que la hauteur de la taille est généralement normale. Le contrôle de la hauteur de la taille et du poids à partir de l'âge de 7 ans et jusqu'à la fin de la croissance montre bien pour tous les malades et en particulier pour ceux qui ont un poids trop élevé que le rapport entre la hauteur et le poids est dans l'ensemble resté constant. Il est démontré que l'épiphysiolyse apparaît dans la dernière phase de la croissance de l'adolescent.

La détermination de l'âge des os, effectuée chez tous les sujets pour la plupart, à plusieurs reprises, montre qu'il y a un retard marqué dans le développement des os, qui est le même pour les deux sexes, le fermeture des plaques épiphysaires étant retardée. En ce qui concerne l'âge des os, la maladie se manifeste dans un intervalle de temps limité et chez les filles pour ainsi dire exclusivement avant la première menstruation. Un rapport entre la menstruation et le développement des os est confirmé. Des analyses d'hormones avec la détermination au 17 ketosteroïd fractionné de l'urine de 24 heures n'a pas donné de nouveaux renseignements susceptibles d'élucider l'étiologie et la pathogénèse.

La tendance à l'adipose et le retardement de la fermeture épiphysaire entraînent une pression accrue sur la plaque épiphysaire de l'extrémité fémorale supérieure justement à l'âge où il est courant de pratiquer du sport et où le poids du corps augmente considérablement.

ZUSAMMENFASSUNG

Nach einer kurzen Litteraturübersicht über unser gegenwärtiges Wissen der Äthiologie und Pathogenese der Epiphyseolysis capitis femoris (ecf) wird ein Material von 101 jungen Patienten (ptt) analysiert und die Litteraturangaben hinsichtlich des Alters und der Geschlechtsverteilung werden bestätigt, indem ecf um die Pubertät in 75 Prozent der Fälle bei Knaben und in 25 Prozent bei Mädchen auftrat. Ecf tritt beiderseitig in 25 Prozent mit linksseitigem Übergewicht in den einseitigen Fällen bei Knaben auf (66 Prozent), aber nicht bei Mädchen.

Familiäres Auftreten ist selten (3 Prozent). Bei ¼ findet man Traumen, die jedoch oft so leicht sind, dass sie nicht als Ursache angesehen werden können.

Man weist eine sehr starke Gewichtszunahme mit ausgesprochener Neigung zur Adipositas aber mitgleichmässigem Übergang von normalen Gewicht zu schwerem Übergewicht und mit gleichmässiger Verteilung nach, wogegen die Grösse normal, mit nur geringer Zunahme, verbleibt. Grösse und Gewitchtmessungen vom 7 Jahrs Alter bis zum Wachstumsabschluss zeigen für alle ptt und besonders für die Überwechtigen, dass das Grösse-Gewichtsverhältnis im grossen-ganzen konstant war. Man weist nach, dass die ecf sich während des beschleunigten adolescenten Wachtums entwickelt.

Knochenalterbestimmungen im ganzen Materiale, bei den meisten mehrfach ausgeführt, haben gezeigt, dass eine bezeichnende Verzögerung der Knochenentwicklung besteht, gleich bei beiden Geschlechtern, indem die Schliessung der Epiphysenscheiben verspätet ist. Ecf tritt in einem knochenaltermässig knappen Zeitraum auf und bei Mädchen beinahe ausschliesslich vor der Menarche. Die Beziehung zwischen der Menarche und der Knochenentwicklung wird bekräftet.

Hormonbestimmungen mit fraktionierter 17-ketosteroidbestimmung des Tagurins haben keine neuen Aufklärungen gegeben, die zur Klarlegung der Äthiologie und Pathogenese beitragen könnten.

Die Neigung zur Fettleibigkeit und die Verspätung Epiphysenschlusses führten zur vermehrten Belastung der Epiphysenscheibe am obersten Femurende gerade in einem Alter wo Sportausübung sehr ausgebreitet ist und in dem das Körpergewicht bedeutend zunimmt.

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