Acta orthop. scand. 46, 234–245, 1975

Department of Orthopaedic Surgery, University Hospital, Umeå, Sweden.

THE ROENTGENOLOGICAL END RESULTS AFTER CALIPER TREATMENT OF COXA PLANA WITH VARYING DEGREES OF EPIPHYSEAL INVOLVEMENT

SVEN FRIBERG

Accepted 23.xii.74

When the major reports of the roentgenological results after various forms of treatment for Legg-Calvé-Perthes disease or Coxa Plana are compared no method is found to be clearly superior to the others (Table 1). A possible explanation for this apparent similarity in the results of the various forms of treatment could be that the disease has a predestined course that is not decisively altered by treatment. The lack of major differences in the results could also be due to insufficient classification of the disease and a different representation of patients in the various materials. Support for the latter theory can be found from the observations made by O'Garra (1959), and further evaluated by Catterall (1971, 1972), that deformation of the proximal femoral epiphysis is rare in cases where only isolated segmental necrosis occurs. This observation suggests that the primary involvement of the epiphysis by the necrotic process might have a strong influence on the roentgenological results. For a relevant and comparable evaluation of results after treatment of Coxa Plana it would then be necessary to take into consideration the extent of primary necrosis in each individual case.

This paper reports the results after caliper treatment (Thomas' splint) of patients with Coxa Plana. The extent of epiphyseal involvement in each individual case has been taken into account. The aim was to study if the degree of necrosis of the epiphysis had any influence on the roentgenological end result.

MATERIAL AND METHODS

During the period 1959 to 1970, 45 hips with Coxa Plana in 39 patients were treated with calipers in the form of Thomas' splints at the department of Orthopaedic Surgery at the University Hospital in Umeå, Sweden.

Table 1. Radiographic results after various forms of treatment.

Investigator	No. of cases	Treatment	Results in % good	fair	poor
Treatment by non-weightbearing					
Mindell & Sherman (1951)	28	bed rest	53	18	29
Herndorn & Heyman (1952)	33	bed rest	61	39	0
Helbo (1953)	61	bed rest	82	16	2
Hauge (1957)	132	bed rest	33	40	27
Evans & Loyd-Roberts (1958)	52	bed rest	29	40	31
Katz (1967)	112	traction + bed rest	53	27	20
Range of results after bed rest			29–82	16–40	0–31
Evans & Loyd-Roberts (1958)	24	crutches + Snyders sling	58	17	25
Mindell & Sherman (1951)	32	crutches + caliper	72	16	12
Wansbrough et al. (1959)	76	caliper (Taylor)	75	12	13
Wansbrough et al. (1959)	16	caliper (Thomas' splint)	25	50	25
Mose (1964)	71	caliper	45	17	38
Range of results after crutches or caliper			25–75	12–50	12–38
Treatment by containment of the head					
Katz (1967)	110	brace and bed rest	48	46	6
Harrison et al. (1969)	12	splint	28	36	36
Petrie & Bitenic (1971)	60	plaster of Paris	60	31	9
Catterall (1972)	36	splint	50	22	28
Range of results after conservative treatment			28–60	22–46	6–36
Craig & Pinder (1969)	100	subtrochanteric osteotomy	43	39	18
Canale et al. (1972)	15	pelvic osteotomy	33	47	20
Axer et al. (1973)	32	subtrochanteric osteotomy	53	13	3
Haraldsson (1973)	12	subtrochanteric osteotomy	75	25	0
Range of results after operative treatment			33–75	13–47	0–20
Symptomatic treatment					
Catterall (1972)	95		57	19	24

All patients were treated with strict non-weightbearing in the calipers. The children were only allowed to remove their calipers in water or in bed. A short period (1–2 weeks) of bed rest with traction was used initially if acute symptoms were present at the time of the diagnosis. The mean duration of treatment was 2.4 years (0.5–4.5).

The material was grouped (1–4) according to the degree of involvement of the epiphysis as outlined by Catterall (1972). The criteria for the different groups are given in Figures 1 and 2. The distribution of patients in the different groups in relation to age and sex is shown in Figure 3.

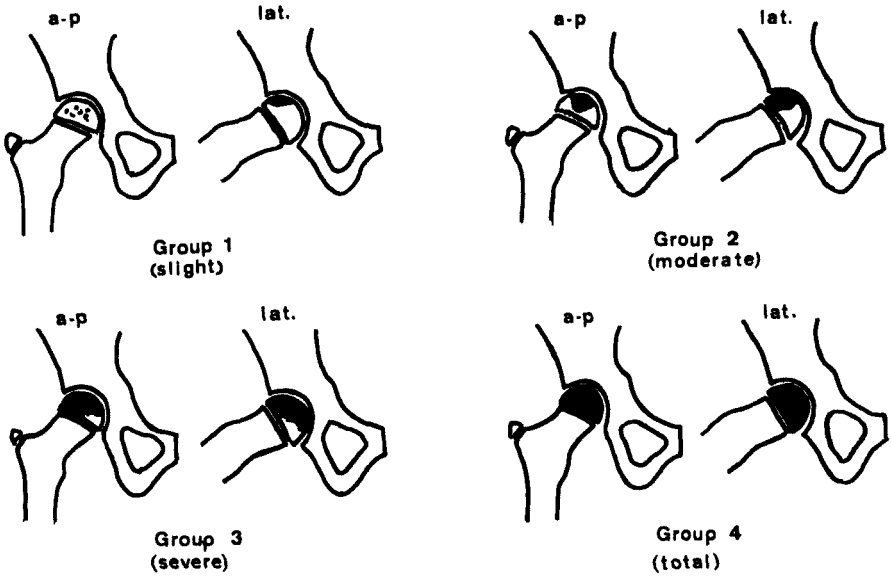


Figure 1. Schematic drawings of the radiological features in the various groups with different degrees of epiphyseal involvement.

The roentgenological results were studied when a definite normalization of the bone structure in the epiphysis had occurred. Classification of the results was made both from a "general assessment of the radiographs" according to Catterall (1972) (Figure 4) and by calculation of the epiphyseal and joint surface quotients (Figure 5) (Heyman & Herndon 1950, Eyre-Brook 1936, Meyer 1966). The mean period of time between diagnosis and the radiological assessment was 3.2 years (1.6–5.2).

RESULTS

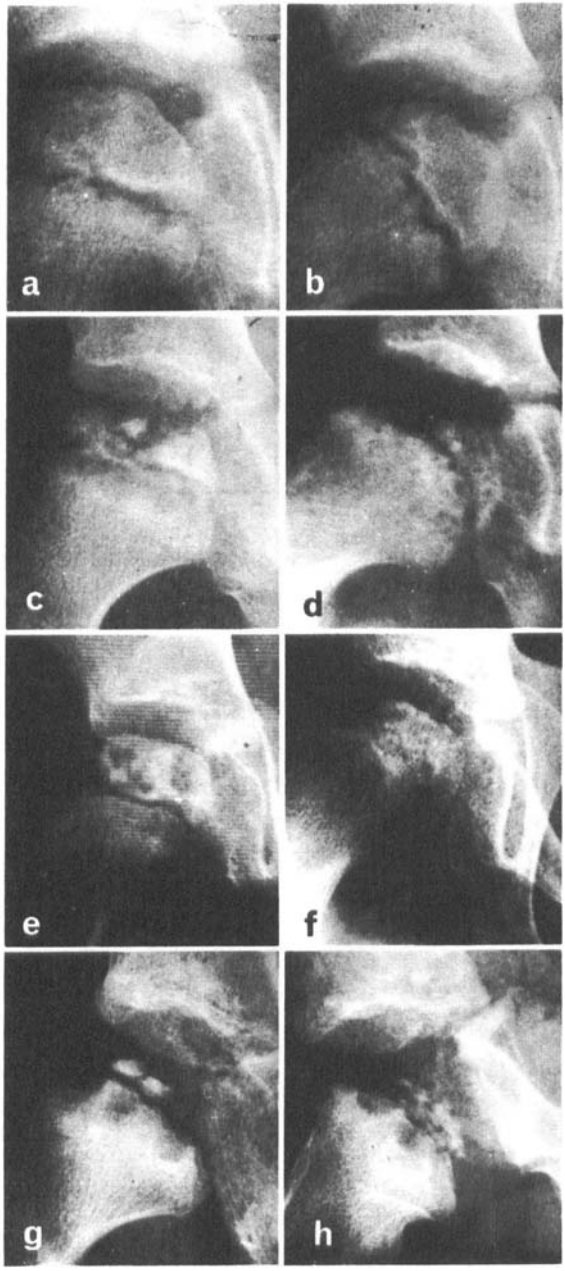
Total material

The "general assessment of the radiographs" gave good results in 33 per cent, fair in 45 per cent and poor in 22 per cent of the cases. No major differences in the results were found when using the three different methods (general assessment, epiphyseal quotient and joint surface quotient) for the evaluation (Table 2).

Groups with varying involvement of the epiphysis (1–4)

A definite classification according to the epiphyseal involvement was possible in all cases in the fragmentation stage of the disease. Subsequent radiographic examinations did not lead to a change of classification. The relationship between the degree of involvement of the

Antero-posterior (a–p) view. *Lateral view.*



Group 1 (Slight involvement). The changes are confined to the antero-superior part of the epiphysis. In the a-p view only a slight cystic appearance is visible. The lateral view shows the changes in the antero-superior part of the epiphysis.

Group 2 (Moderate involvement). Complete involvement of the anterior part of the epiphysis. The a-p view shows that the lateral and medial part of the epiphysis have escaped involvement. In the lateral view the complete involvement of the anterior part is illustrated.

Group 3 (Severe involvement). The major part of the epiphysis is involved. Only the postero-medial part of the epiphysis shows normal bone structure.

Group 4 (Total involvement). No normal bone structure is visible in the entire epiphysis.

Figure 2. Radiological features for classification of cases into the various groups according to epiphyseal involvement. (All cases shown are in the fragmentation stage of the disease).

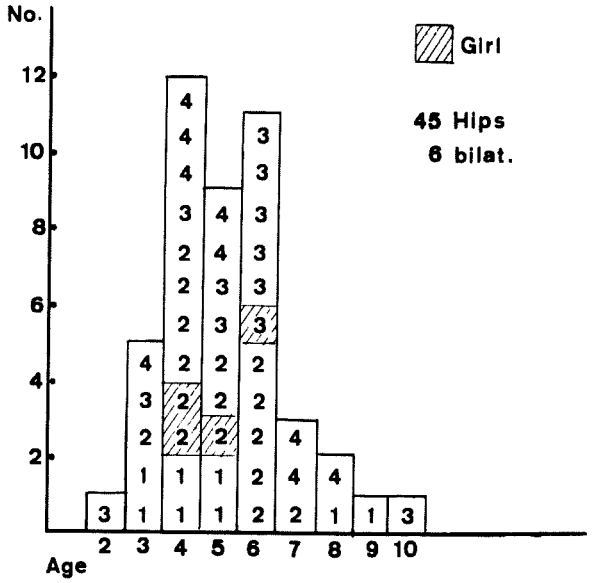
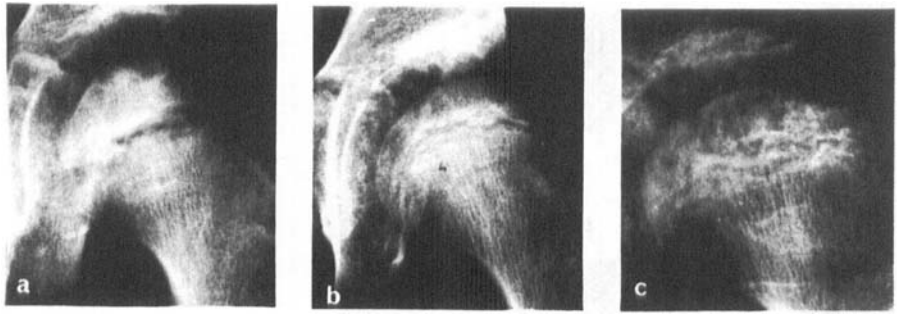


Figure 3. Age and sex distribution. (The degree of epiphyseal involvement is indicated by Arabian numerals).



Good result.

An almost normal head—round with minimal or no compression of the epiphysis.

Fair result.

A round head with moderate loss of epiphyseal height and not completely contained in the acetabulum; up to one-fifth being uncovered.

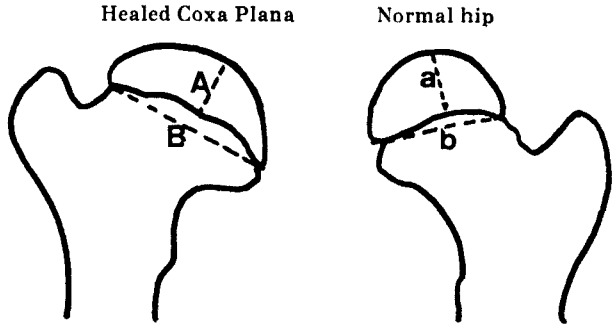
Poor result.

A flattened and irregular head with more than one-fifth uncovered by the acetabulum.

Figure 4. Criteria for the "general assessment of the radiographs".

EPIPHYSEAL QUOTIENT

$$\frac{A \cdot b}{B \cdot a} \times 100$$



JOINT SURFACE QUOTIENT

$$\frac{H \cdot r}{R \cdot h} \times 100$$

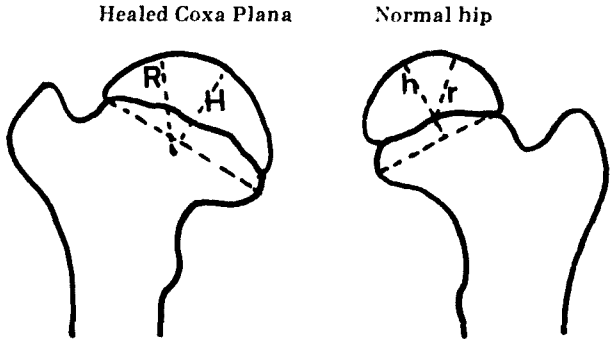


Figure 5. Methods for assessment of epiphyseal and joint surface quotients.

Table 2. Results—Total material.

	General assessment of radiographs	Epiphyseal quotient	Joint surface quotient
No. of hips	45	33	33
Good	33 %	(> 85) 27 %	(> 85) 36 %
Fair	45 %	(85–60) 39 %	(85–70) 34 %
Poor	22 %	(< 60) 35 %	(< 70) 30 %

epiphysis (group 1–4) and the result expressed in terms of "general assessment of the radiographs" is illustrated in Table 3. It was found that the good results were confined to groups 1 and 2 and the poor results to groups 3 and 4. The relationship between epiphyseal involvement and epiphyseal quotient and joint surface quotient is shown in Figures 6 and 7. The statistical analysis of the values found for the

Table 3. Results of "general assessment of radiographs" in groups 1–4. (Results expressed in no. of hips).

	Group 1 (slight)	Group 2 (moderate)	Group 3 (severe)	Group 4 (total)
Good	8	7	0	0
Fair	0	9	8	3
Poor	0	0	4	6

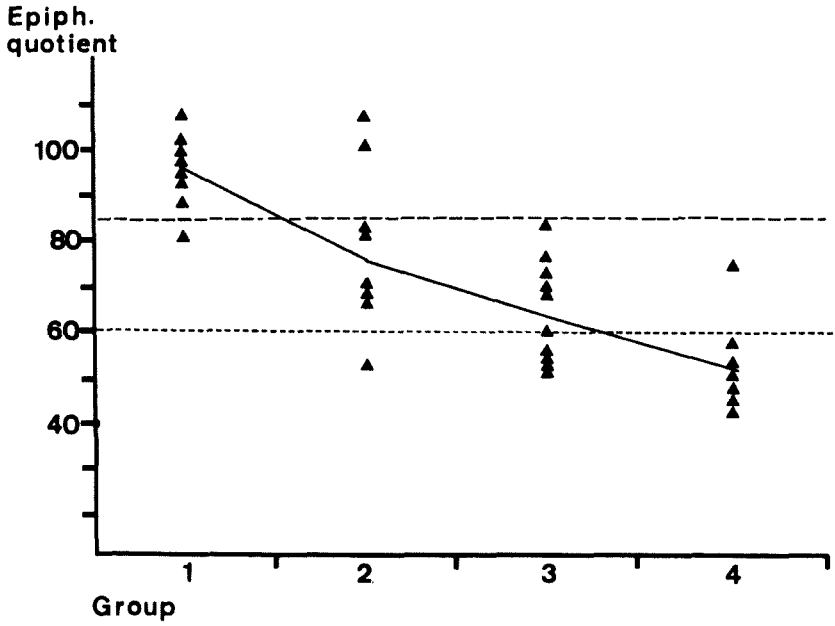


Figure 6. Results expressed as epiphyseal quotient in groups 1–4. The correlation between groups and epiphyseal quotient was 0.74, $P < 0.01$.

epiphyseal and joint surface quotients show a strong positive correlation ($P < 0.01$) between the groups with more complete necrosis of the epiphysis and a higher degree of final deformity of the head.

Results in groups 1–4 — Age

No differences* existed in the age distribution between the cases classified as belonging to the groups 1 and 2, and those in groups 3 and 4. The results in groups 1 and 2 and in groups 3 and 4 were

* χ^2-analysis.

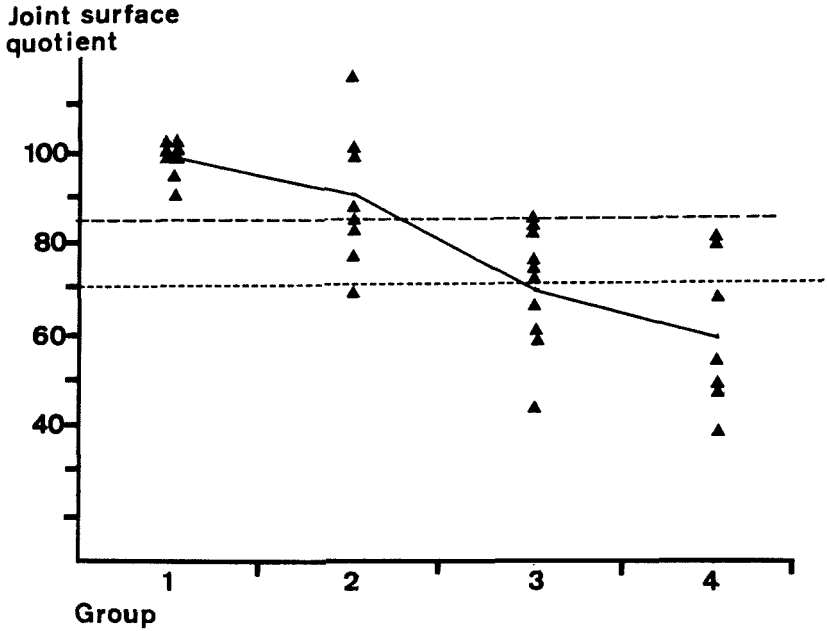


Figure 7. Results expressed as joint surface quotient in groups 1–4. The correlation between groups and epiphyseal quotient was 0.74, $P < 0.01$.

Table 4. Results—Age. (Results expressed in no. of hips).

Groups 1 and 2	Good	Fair	Groups 3 and 4	Fair	Poor
≦ 4 years	9	2	≦ 4 years	4	3
> 4 years	6	7	> 4 years	7	7

analysed in patients over and under 4 years of age. No significant differences* could be found (Table 4).

DISCUSSION

The radiological end results after caliper treatment (Thomas' splint) of 45 hips with Coxa Plana have been investigated. When the total material is considered the results (33 per cent good, 45 per cent fair and 22 per cent poor) are similar to those reported in earlier studies

* χ^2-analysis.

(Mindell & Sherman 1951, Evans & Loyd-Roberts 1958, Wansbrough et al. 1959, Mose 1964).

When the material was analysed with regard to the degree of primary involvement of the epiphysis according to Catterall (1972) it was found that the final deformation of the epiphysis was significantly more severe in the groups with primarily more complete necrosis of the epiphysis. The contrary was found in the hips which initially showed slight alterations. This is in agreement with the observations made by Catterall (1972) from an investigation of the results in the different groups of epiphyseal involvement after various forms of treatment (supervised neglect i.e. symptomatic treatment and periodic x-ray checks, caliper, bed rest and abduction splint). The observations made by Catterall and the results of the present investigation lead to the conclusion that if different materials are to be compared it is necessary to consider the degree of epiphyseal necrosis when assessing the radiological result after treatment.

In the groups with slight to moderate (groups 1 and 2) involvement of the epiphysis the results from the present investigation were satisfactory (good or fair) with no poor end results. However, in the groups with severe to total necrosis of the epiphysis (groups 3 and 4) the proportion of poor end results was high in spite of the caliper treatment. A direct comparison can be made between the present material and the results found by Catterall (1971, 1972) after "supervised neglect", as the materials were grouped and the results assessed (general assessment of radiographs) according to the same principles. When comparing the groups with different involvement of the epiphysis in these two studies no major difference could be found regarding the results. This confirms the observation made by Catterall (1972) that caliper treatment does not show any convincing advantages over "supervised neglect".

In the present material an even distribution of the primary groups with respect to age was found. In addition the results in the groups showed no difference between patients over and under 4 years of age. This contrasts with earlier reports where better end results have been claimed in the age group under 4–5 years of age (Edgren 1965, Catterall 1972).

The long-term results after Coxa Plana show that late osteoarthritis is confined to and will develop in at least fifty per cent of the cases with a poor end result (Helbo 1953, Danielsson & Hernborg 1965, Eaton 1967, Ratliff 1967, Gower & Johnston 1971). Effective treatment to

reduce the incidence of deformation must then be considered to be indicated in cases where a definite risk for a poor end result exists. The satisfactory (good or fair) end results reported by Catterall (1972) after "supervised neglect" in the groups with slight to moderate involvement of the epiphysis suggest that only symptomatic treatment would be necessary in the majority of these cases. In the groups with severe to total involvement of the epiphysis neither symptomatic nor caliper treatment can prevent a poor end result. In these two groups a definite need for more effective treatment exists.

The problem as to which treatment is the most effective in preventing deformation in Coxa Plana is still unsolved. The existing reports, with few exceptions, are hardly comparable since no account has been made of the primary degree of necrosis of the epiphysis. The results reported by Catterall (1972) after caliper treatment, bed rest and abduction treatment gave no definite evidence that these have any advantages over "supervised neglect". The satisfactory results (75 per cent good, 25 per cent fair) found by Haraldsson (1973) after subtrochanteric rotation and varisation osteotomies in 12 cases with severe to total involvement of the epiphysis suggested that osteotomy might be a possible method for the future. However, when Marklund & Tillberg (1974) compared the results after caliper treatment and osteotomy in groups with varying degrees of epiphyseal involvement they were not able to confirm Haraldsson's observations and found no difference in the results between these two forms of treatment.

SUMMARY

The radiological results after caliper treatment of 45 hips with Coxa Plana are presented. The material was grouped and analysed according to the degree of primary involvement of the epiphysis by the necrotic process. It was found that the risk for deformation of the femoral head became significantly higher in the groups with more extensive involvement of the epiphysis. This observation shows that the primary involvement of the epiphysis has a determining influence on the results. It further indicates that if the radiographic results from different materials of Coxa Plana are to be compared consideration must be given to the primary extent of necrosis of the epiphysis.

REFERENCES

Axer, A., Schiller, M. G., Segal, D., Rzetelny, V. & Gershuni-Gordon, D. H. (1973) Subtrochanteric osteotomy in the treatment of Legg-Calvé-Perthes syndrome. *Acta orthop. scand.* **44**, 31–54.

Canale, S. T., Di Anca, A. F., Cotler, J. M. & Snedden, H. E. (1972) Innominate osteotomie in Legg-Calvé-Perthes disease. *J. Bone Jt Surg.* **54**-A, 25–40.

Catterall, A. (1971) The natural history of Perthes disease. *J. Bone Jt. Surg.* **53**-B, 37–53.

Catterall, A. (1972) *Coxa Plana. Modern trends in orthopaedics*, Butterworths, London, 122–147.

Craig, W. A. & Pinder, R. C. (1969) A review of one hundred hips operated on for Legg-Calvé-Perthes disease. *J. Bone Jt Surg.* **51**-A, 814.

Danielsson, L. G. & Hernborg, J. (1965) Late results of Perthes disease. *Acta orthop. scand.* **36**, 70–81.

Eaton, G. O. (1967) Long term results in Coxa Plana. *J. Bone Jt Surg.* **48**-A, 1031–1042.

Edgren, W. (1965) Coxa Plana. *Acta orthop. scand.*, Suppl. 84.

Evans, D. L. & Loyd-Roberts, G. C. (1958) Treatment in Legg-Calvé-Perthes disease. A comparison of in-patient and out-patient methods. *J. Bone Jt Surg.* **40**-B, 182–185.

Eyre-Brook, A. L. (1936) Deformans coxa juvenilis or Perthes disease. *Brit. J. Surg.* **24**, 166–184.

Gower, W. E. & Johnston, R. C. (1971) Legg-Perthes disease. *J. Bone Jt Surg.* **53**-A, 759–768.

Haraldsson, S. (1973) Derotation-varization osteotomy in the treatment of Perthes disease. *Acta orthop. scand.* **44**, 105–108.

Harrison, M. H. M., Turner, M. H. & Nicholsson, F. J. (1969) Coxa Plana. Results of a new form of splinting. *J. Bone Jt Surg.* **51**-A, 1057–1069.

Hauge, M. F. (1957) The treatment of Coxa Plana. *Acta orthop. scand.* **26**, 53–65.

Helbo, S. (1953) *Morbus Calvé-Perthes*. Odense.

Herndon, C. H. & Heyman, C. H. (1952) Legg-Perthes disease, an evaluation of treatment by traction and ischial weight-bearing brace. *J. Bone Jt Surg.* **34**-A, 25–46.

Heyman, C. H. & Herndon, C. H. (1950) Legg-Perthes disease, a method for the measurement of the roentgenographic results. *J. Bone Jt Surg.* **32**-A, 767–778.

Katz, J. (1967) Conservative treatment of Legg-Calvé-Perthes disease. *J. Bone Jt Surg.* **49**-A, 1043–1051.

Marklund, T. & Tillberg, B. (1974) En klinisk och röntgenologisk jämförelse mellan konservativ och operativ behandling av Morbus Perthes. *Proceedings of the Scandinavian Orthopaedic Society 37th Assembly Uppsala Sweden. Acta orthop. scand.* In press.

Mindell, E. R. & Sherman, M. S. (1951) Late results in Legg-Perthes disease. *J. Bone Jt Surg.* **33**-A, 1–23.

Meyer, J. (1966) Treatment of Legg-Calvé-Perthes disease. *Acta orthop. scand.*, Suppl. 86.

Mose, K. (1964) *Legg-Calvé-Perthes disease*. Universitetsforlaget, Aarhus.

O'Garra, J. A. (1959) The radiographic changes in Perthes disease. *J. Bone Jt Surg.* **41**-B, 465–476.

Petrie, J. G. & Bitenic, J. (1971) The abduction weight-bearing treatment in Legg-Perthes disease, *J. Bone Jt Surg.* **53**-B, 54–62.

Ratliff, A. H. C. (1967) Perthes disease. *J. Bone Jt Surg.* **49**-B, 102–107.

Wansbrough, R. M., Carrie, A. W., Walker, N. F. & Ruckerbaur, G. (1959) Coxa Plana. Its genetic aspects and results of treatment with the long Taylor Walking caliper. *J. Bone Jt Surg.* **41**-A, 135–146.

Key words: child; hip; osteochondritis; classification; radiography; therapy

Correspondence to:

Dr. Sven Friberg
Ortopediska kliniken
Lasarettet
901 85 Umeå
Sweden