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Abduction treatment in late diagnosed congenital dislocation of the hip

Follow-up of 1,010 hips treated with the Frejka pillow 1967–76

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Contents

Abstract

There are many countries such as Poland where treatment of congenital hip dislocation is started late. The purpose of this work was to report our results in this group of children.

1010 hips in 780 children with congenital dislocation of the hip were treated with the Frejka pillow. The early results were evaluated in 830 hips at 15–36 months of age and the late results in 527 hips at a mean age of 14 (10–21) years. 90 percent of the children were treated by the same physician.

The age at the onset of the treatment varied from 2 weeks to 24 months, with 12 percent younger than 3 months and 28 percent older than 6 months. The initial degree of dislocation was determined with our own index. Radiographic results were evaluated with a scoring based on four or six parameters.

There were 6 percent failures, including lack of reduction or redislocation at the time when the child started to walk. Ischemic necrosis was observed in 14 percent of the hips, with significant permanent sequelae in 5 percent. Indications for surgical treatment of residual dysplasia were found in 4 percent of the hips evaluated early; and in the group evaluated late, still 5 percent of the hips required operation.

There was good ability for spontaneous remodeling between the age of 3 and 7 years, whereas around the age of 10, the radiographic appearence of the hip became stabilized.

At the end of treatment and at the time when the children started to walk, 59 percent of the early evaluated hips were still insufficiently remodeled; but in cases evaluated late, 95 percent of them had a normal or almost normal radiographic appearance. At that time, the clinical state of the children was satisfactory.

The results of treatment depended on the initial degree of displacement. Only when treatment was begun after 5 months of age did the patient's age affect the treatment results.

The Frejka pillow successfully reduced and stabilized these hips.

Acknowledgements

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Introduction

The treatment of congenital dislocation of the hip is still a problem in many countries, expecially in countries such as Poland where its incidence is high (Dezyna and Ratomski 1959). There are still questions raised and discussions concerning the basic aspects of the disease (Catterall 1984, Tönnis 1984). This fact has been, and still is, a challenge and a fascination for orthopedic surgeons. This is well illustrated by the 60 years' committment of Professor Wiktor Dega, whose work "On the etiology and pathogenesis of congenital dislocation of the hip" was published in 1929 (Dega 1929, 1933) and who is now, at the age of 93, working on the fourth edition of his handbook *Orthopedics and Rehabilitation.*

It is to him that we would like to dedicate this study.

The purpose of this investigation is to report some aspects of conservative treatment of CDH. We feel justified to do so for the following reasons:

1. We have studied a large number of consecutive children.
2. The children were consistently treated with the same method.
3. 90 percent of the children were treated by the same physician
4. Objective criteria were used in the diagnosis and in the follow-up of the children.
5. The children were followed almost until the end of the growth period.

Nevertheless, taking into consideration the present state of early diagnosis and prophylaxis, our series might be considered out of date. We are dealing with children in whom treatment started late, up to 24 months of age; only in 12 percent of the children was the treatment started before 3 months of age. Our study might, from this point of view, be considered historic, but as such, interesting and hopefully instructive—in many countries screening of the newborn for CDH is still ineffective or even nonexistent.

We report the results in outpatients treated with the Frejka pillow, and with the following prerequisites:

1. The diagnosis was congenital dysplasia with dislocation.
2. Treatment was not started later than at 24 months of age.
3. The children had not previously been treated.
4. The treatment was continuous and carried out according to instructions.
5. The cases were sufficiently documented radiographically.

Thus, we do not include dislocations due to teratologic or neurologic disorders. Nor do we discuss congenital dysplasia without dislocation.

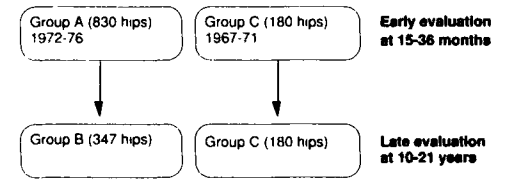
Patients and methods

Patients

In 1952, Wiktor Dega initiated the clinical examination of the hips of newborn in the hospitals of Poznan. Among the first 36,000 infants examined, 4.4 percent were found to require further examination or treatment (Dega 1960). A clinic for congenital deformations of the hip was opened in 1955, with increasing numbers of children attending. During 1955–1989 a total of 119,749 children were examined. Of these children, 4.7 percent had CDH. Thus, the total number of children treated for CDH has todate surpassed 5,000.

The children were managed by a small team of physicians and since 1970, 90 percent of the children have been treated by the same physician. We had no influence on the selection of the children seen at the clinic and thus on the age at which the condition was discovered and the treatment started. Older children (> 12 months) were referred to the hospital for skin traction (overhead extension) or surgical treatment. Because these children often had to wait several months to be admitted to the hospital we used the Frejka pillow in some cases. Hence, our study includes children treated at such an advanced age.

Table 1. Selection of cases



Selection of cases (Table 1).

The treatment of 1,010 hips in 780 children was analyzed. The material comprised three groups:

Group A. Treatment started between 1972 and 1976. In this group we analyzed failures, femoral head necrosis, early results at the age from 15 to 36 months, and surgery due to residual dysplasia. There were 830 hips in 641 children in this uniform, nonrandomly selected group.

Group B included those children in group A who were reexamined at the age of > 10 years. Surgically treated hips or hips with serious femoral head necrosis possibly affecting hip remodeling were excluded. Group B comprised 347 hips in 268 children.

Group C. Treatment started between 1967 and 1971, and early evaluation was also made at the age of 15 to 36 months (with a result similar to that of group A). A late follow-up examination was performed at the age of > 15 years. Surgically treated hips or hips with necrosis were excluded. Group C comprised 180 hips in 139 children, and was added to the study to increase the number of hips accessible for late evaluation.

The children in groups B and group C were used to compare early and late follow-up results.

In all three groups the sex ratio, the age at the time of treatment, initial degree of displacement, and the ratio unilateral/bilateral, as well as left/right affections, were similar.

General characteristics of the children

The ratio of boys to girls was 1/6.6. The ratio of bilateral/unilateral affections was 1/2.4. In unilateral affections the ratio of right/left hip affections was 1/1.5. In all, 6.8 percent of the children had a family history of hip dislocation. Other congenital malformations in the extremities or in the spine (torticollis, clubfoot, vertical talus, extremity aplasia, scoliosis) were present in 1.8 percent of the children. Totally, 83 percent of the children were delivered in the normal position, 10 percent in the breech position and 7 percent by cesarean section.

The age of the children at onset of treatment varied from 2 weeks to 24 months (Table 2).

Ortolani's sign or easy reduction at first examination in older children was observed in 50 percent of

Table 2. Age at the onset of treatment

Months	<3	3–4	5–6	7–12	13–24	Total
Hips (n)	99	356	144	148	83	830
Hips (percent)	12	43	17	18	10	100

Table 3. Acetabular angle at the onset of treatment

Acetabular angle	< 30	30–34	35–39	40–44	> 44
Hips (percent)	10	34	29	20	7

Table 4. Degree of dislocation at the onset of treatment. (In 12 percent of the hips treatment started before 3 months of age and thus the degree of diclocation was not determined)

Degree of dislocation	1	2	3	4	5
Hips (percent)	24	31	25	13	7

Table 5. Time at stable reduction

Weeks	0	2–4	5–6	7–8	9–10	11–12	>12
Hips (percent)	26	50	11	7	3	3	1

Table 6. Duration of continuous Frejka pillow treatment and total treatment

Months	"0"	2–3	4–6	7–9	10–12	13–15	>15
Percent of hips with:							
Cont. Frejka pillow	12	9	53	21	4	0,6	–
Total treatment	–	–	17	53	21	9	1

"0" only "soft" Frejka pillow.

the hips. Limited abduction (< 80° in girls and < 70° in boys) was observed in 62 percent of the hips. In 7 percent of the children, there were no clinical findings in spite of a manifest radiographic displacement.

The radiographic structure of the hips is presented in Tables 3 and 4.

The Frejka pillow treatment

Initially, almost all known conservative methods of treatment were used, but in the 1960s a uniform treatment program using the Frejka (1941, 1959) pillow was introduced. Only in a few instances requiring prolonged treatment, was the Ortolani splint used after an initial period of treatment with the Frejka pillow. The Frejka pillow was chosen because of its simplicity of use and because it could also be used for treating children above 12 months of age.

The treatment was initiated with a "soft" Frejka pillow, i.e., soft-felt or folded diapers in the pillow case. After 2–4 weeks, the normal, i.e., the hard-felt Frejka pillow was introduced. Only in the older children, with substantially limited abduction, was the hard pillow introduced from the start. In those cases the pillow was either narrower or we applied it intermittently for rather short periods with several hours pauses. As the range of abduction increased, we recommended gradual tightening of the pillow's braces to make it fit tightly in the perineum. In some younger children the treatment was limited only to the soft Frejka pillow. We always made sure to use a pillow of appropriate width, increasing with the child's growth.

In 50 percent of the children, full abduction was obtained after 2–4 weeks, Ortolani's sign disappeared, and there was a stable reduction of the hip. In 26 percent of the children, the displacement was too small to allow for the reduction to be noticed during physical examination. In the remaining children the period from the onset of treatment to stable reduction of the hip was longer (Table 5).

In some cases the normal position of the leg in the Frejka pillow was not sufficient to achieve reduction. In those cases increased flexion of the hip was induced by placing a rolled diaper between the pillow and the femur or by placing one or both feet into the pillow (Bernardczyk and Sobon 1975). Four to six weeks later, after reduction, the child was placed in the normal position in the pillow. This method was also used in those children in whom, after removing the pillow, even a slight movement of the leg caused redislocation. The pillow was used continously day and night for 2–9 months, and in exceptional cases longer. During this period the pillow was only removed for hygienic purposes. Thereafter we recommended intermittent application of the pillow, i.e., only daytime or nighttime or continuous or intermittent application of Ortolani's splint for another 1–6 months.

The duration of treatment, including soft pillow, hard pillow, and intermittent application of the pillow or splint, totaled 4–9 months in 70 percent of the children, in the remaining children it was longer (Table 6).

In cases where reduction failed in spite of a long period in full abduction and flexion or when the hip was permanently unstable, i.e., redislocation occurred immediately after removing the pillow, we performed closed reduction under general anesthesia. In those cases, as a rule, hip reduction was easily obtained. A hip spica cast was applied in 80°–100°

flexion, 50°–80° abduction and about 20° medial rotation for 6–8 weeks followed by the Frejka pillow. Reduction was performed in 35 hips (4.2 percent), in 20 due to failed reduction and in 15 due to permanent instability.

After the treatment the child was allowed to walk, although the parents were advised not to encourage it. Some of the children were allowed to start walking with the Frejka pillow or the Ortolani splint. From this moment on, the hip was left to itself. The only intervention took place in unilateral cases, in which we occasionally recommended an 1–2 cm elevation of the opposite, nonsymptomatic leg. This intervention was in children who started walking after 24 months of age and in whom the joint was very poorly remodeled. The idea was to increase abduction during walking. Hips with avascular necrosis did not receive any special treatment.

All the children were advised to avoid jumping, running, and long strenous walking. They were recommended to swim and to ride their bicycles. Moreover, they were advised to avoid becoming overweight. The children were periodically examined, and if the joint remodeling was not satisfactory surgery was recommended.

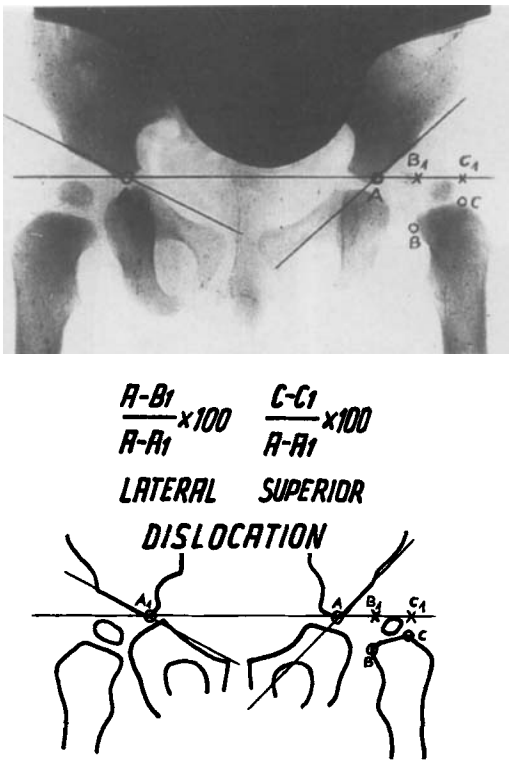


Figure 1. Calculation of the dislocation index.
A_1A intersection of the Y-line with acetabular lines.
B medial end of spina colli.
C the top of the proximal femoral metaphysis.
B_1,C_1 the projection of B and C on the Y-line.

Methods

Clinical diagnosis

We considered Ortolani's (1937, 1976) sign as the only reliable clinical sign of hip dislocation. In children below the age of 3 months, we considered this sign sufficient for the diagnosis. If Ortolani's sign was not observed in children under 3 months of age, but if there was limited abduction (< 80 ° in girls and < 70° in boys), a family history of hip dislocation, or if the child was delivered in the breech position, we recommended a wide pad of diapers and delayed the final diagnosis until the first radiograph was obtained. We paid due attention to differences in leg length, but we tended to disregard asymmetric medial thigh folds. In children with a considerable limitation of abduction, a follow-up examination was performed 2–3 weeks later to establish whether or not wide diapers had corrected the abduction limitation.

In older children the hip dislocation was diagnosed by means of all the well-known symptoms such as a change in the hip contour, an elevation of the greater trochanter, a limited range of motion of the hip, and (after the child had started to walk) a positive Trendelenburg or Duchenne test. In some of the older children, it was possible to reduce the hip at the first examination. This was also classified as a positive Ortolani sign.

Radiographic diagnosis

The first radiograph was usually performed after the age of 3 months. In prematurely born children or children with very low birth weight, it was postponed another 1 or 2 months. The radiographs were obtained in the neutral position with the gonads protected against radiation (Bruszewski 1971).

The following measurements were performed on the radiographs: acetabular angle and the ratio of the proximal end of the femur to the acetabulum based on our own index of displacement. Usually the displacement was assessed visually, and the case was classified as subluxation, marginal, supraacetabular or iliac dislocation. This classification is not sufficiently precise, especially in young children lacking an ossified femoral head. We needed a method that

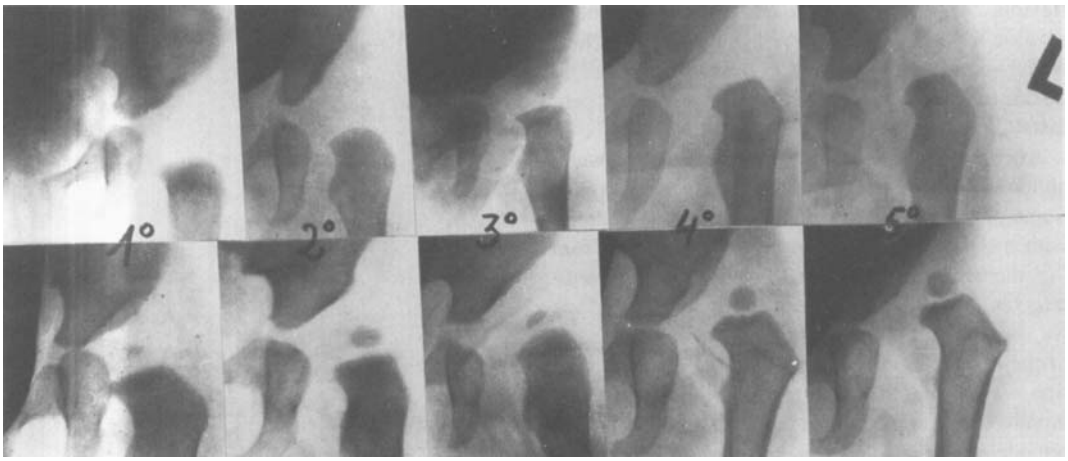


Figure 2. The 5 degrees of dislocation before (upper row) and after (lower row) the ossification of the femoral head.

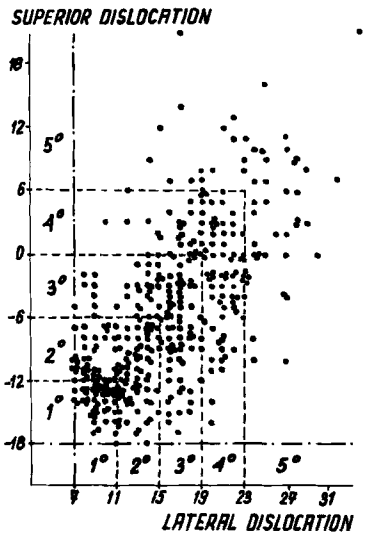


Figure 3. Superior and lateral dislocation in 400 hips in children aged 3–24 months. According to the severity of the dislocation the cases were classified into 5 groups (degrees).

made it possible to determine the degree of dislocation objectively and to compare children at different ages with different pelvic size on radiographs exposed under different conditions. For these reasons, we developed our own index of dislocation (Lempicki 1989; Figure 1) This index was calculated in 400 randomly selected hips of our children aged 3–24 months. The values were introduced into a diagram. The area of the diagram was divided into five parts, thus distinguishing 5° of displacement (Figures 2 and 3).

Evaluation of the early results

The aim of the treatment was to reduce the hip to obtain conditions for the remodeling that will continue after the child has started to walk. We recorded an early success if 3–6 months after the child started to walk the femoral head was at least partially covered by the acetabular roof. The remaining cases were classified as failures; they included redislocation after the child started to walk, marginal dislocation, or nonreduced hips.

Early results were evaluated in the 830 hips of group A between 15 and 36 months of age, 3–6 months after the child started to walk. The time of evaluation was also determined by the presence of satisfactory radiographs and could be longer in isolated cases.

The hips with early success were evaluated radiographically by scoring four radiographic parameters: the shape of Shenton's line, the acetabular angle, Wiberg's CE angle and the lateral distance angle (Labaziewicz 1979; Figure 4). The tested parameters was assigned a score from 0–3. The total score, i.e., the sum of the score of the four parameters, classified the result as excellent, good, or fair (Table 7).

We did not perform a physical examination of the hip, because we did not consider it decisive at that age.

Evaluation of late results

Late results were evaluated in 527 hips of groups B and C. We assumed that the late results of treatment and hip remodeling can be evaluated as early as after

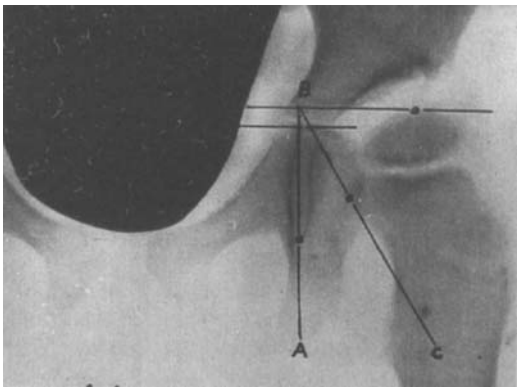


Figure 4. Calculation of the lateral distance angle (A-B-C).

A-B vertical line through the distal part of Köhler's pelvic teardrop (U-figure).

B point of intersection of line A-B with a horizontal line through the top of the femoral head.

B-C line through the medial end of spina colli.

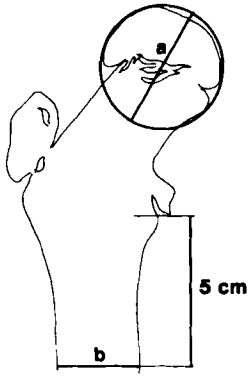


Figure 5. Calculation of the head-shaft index (a/b x 100)
W 185.7 *SD 12.4 SE 1.0*

Table 7. Scores of radiographic evaluation. Angles in degrees

Score	3	2	1	0
Acetabular angle				
< 5 years	< 20°	20°–30°	> 30°	–
≥ 5 years	< 15°	15°–20°	> 20°	–
Shenton line interrupted	no	no	considerably	extremely
Lateral distance angle				
< 5 years	< 30°	30°–35°	> 35°	–
≥ 5 years	< 25°	25°–30°	> 30°	–
Wibergs CE-angle	> 24°	24°–15°	< 15°	–
Neck-shaft angle	120°–140°	141°–155°	> 155°	–
		119°–110°	< 110°	–
Anteversion angle	10°–40°	41°–50°	> 50°	–
		9°–0°	–	–

Result	Fair	Good	Excellent
Score (4 parameters)	<8	8–10	11–12
Score (6 parameters)	<14	14–16	17–18

10 years of age. This cannot, of course, be considered a final evaluation, because this cannot be performed before the age of 30, when possible degenerative changes as a result of poor function in a dysplastic joint have developed or as a result of our treatment may be observed. Nevertheless, at 10 years of age, as we shall show in our results, the state of the hip is sufficiently stable to justify the evaluation of the results of treatment. Moreover, the average age of our patients at the time of late evaluation was about 14 years. Taking into account that 87 percent of them were girls, we might say that the late evaluation was performed almost at the end of the growthperiod.

In the radiographic examination, besides the four parameters of early evaluation, we also measured the neck-shaft angle and the anteversion angle calculated according to Rippstein (1955). In this way an extra 2-6 points were added to the total score, changing the range of the scores (Table 7). Thus, the late evaluation was more strict than the early evaluation.

At the age of our late evaluation, the shadow of the Y-cartilage disappears. For this reason, in order to draw a line corresponding to the Y-line needed to measure the acetabular angle, we established the landmarks at which the acetabular curve turns up from the horizontal into the verical plane. We assumed these points to correspond to the previous location of Y-cartilage shadows.

In the evaluation of sequelae of ischemic necrosis (coxa magna), we used a femoral head-shaft index (Kruczynski 1987; Figure 5) which is defined as follows: A circle surrounding the femoral head is drawn up and the width of the femoral shaft is measured 5 cm below the lesser trochanter. The index was calculated dividing the diameter of the circle and the width of the shaft and expressed as a percentage. In addition, we performed a clinical examination of the hip, recorded the pattern of walking, pain and the general activity of the child. We also recorded any leg length discrepancy.

Statistical methods

A total of 90 to 140 data in each child concerning the initial state, the treatment and the radiographic state at every stage of observation were analyzed by Kruscall's test. A significance level of 0.05 was assumed. The differences between fractions were calculated using Gauss' test at a significance level of 0.05.

Results

Early results

830 hips in 641 children were evaluated. The radiographic examination of 783 (94 percent) with "early success" showed an excellent result in 8 percent, a good result in 33 percent, and a fair result in 59 percent (Table 8; Figure 6).

Lasting reduction failed in 47 hips (6 percent). In 8 hips no reduction had been obtained. In those cases an open reduction was performed, and in all of them we found intraarticular soft-tissue interposition preventing reduction including interposition of the labrum, a very thick ligamentum teres, or a fibrous membrane and other soft tissues. In 25 hips, there was permanent lateralization, and thus a marginal dislocation. In 13 hips, there was redislocation after the child started to walk (Figure 7).

Surgery for residual dysplasia

Surgery was performed in 51 hips (6 percent) with insufficient joint remodeling. The surgical procedures performed were as follows (Figure 8):

1. In 14 hips, arthrotomy with removal of interposed soft tissue from the acetabulum, pelvic transiliac osteotomy (Dega 1974), and subtrochanteric osteotomy.

Table 8. Scores of early radiological evaluation

Results (percent)	Excellent (8)		Good (33)			Fair (59)				
Score	12	11	10	9	8	7	6	5	4	3
Hips (percent)	3	5	8	12	13	18	17	14	10	1

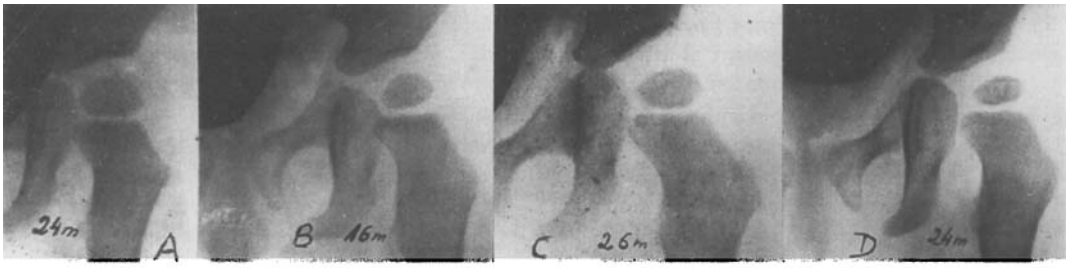


Figure 6. Classification of early results. A excellent, B good, C and D fair.

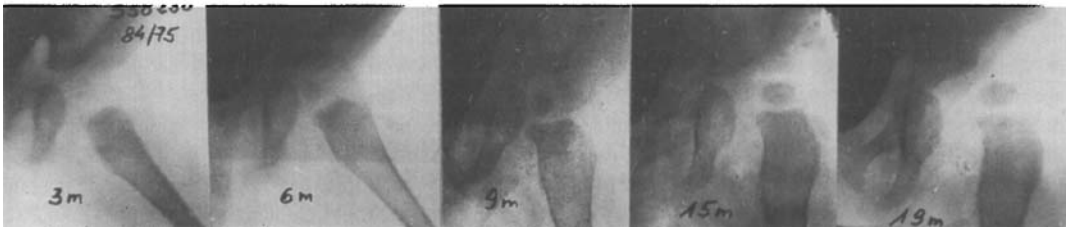


Figure 7. An example of failure. Treatment started at 3 weeks of age (positive Ortolani sign). Good initial acetabular remodeling. The child started to walk at 13 months of age. Follow-up radiographs at 15 and 19 months of age showed a redislocation.

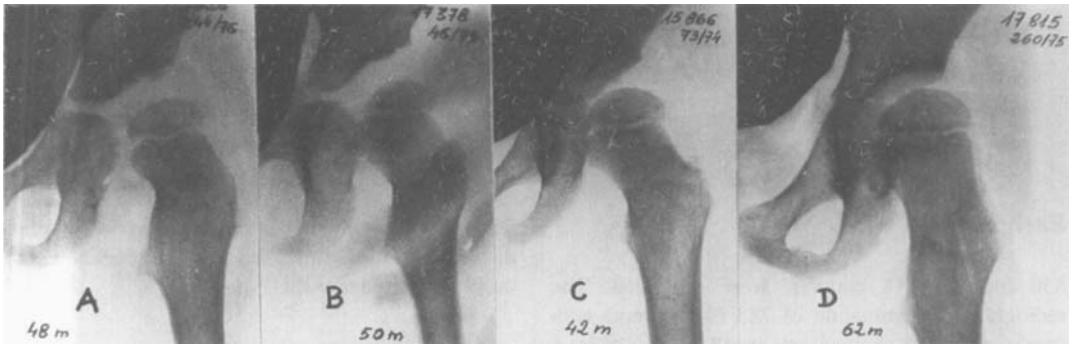


Figure 8. Preoperative radiographic appearances and subsequent surgical procedures in residual dysplasia. A arthrotomy, transiliac and subtrochanteric osteotomy. B transiliac and subtrochanteric osteotomy. C transiliac osteotomy only. D subtrochanteric osteotomy only.

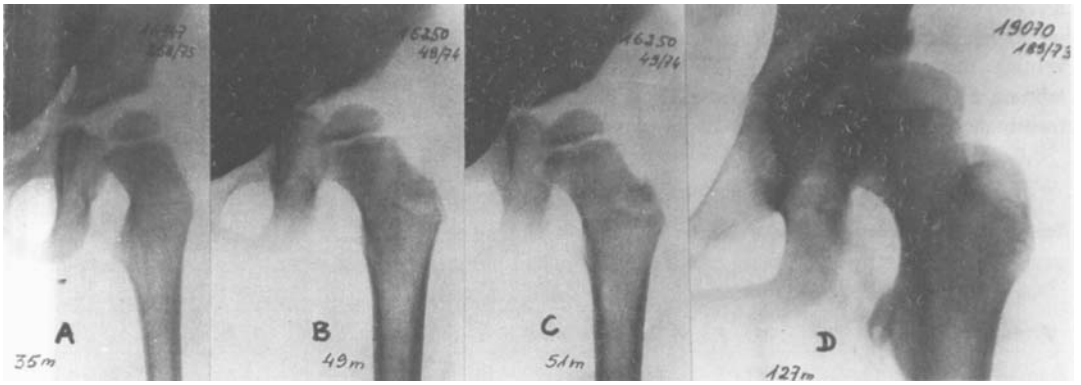


Figure 9. Surgically treated residual dysplasia. Preoperative radiographs. A age 35 months, score 10. B age 49 months, score 14. C age 51 months, score 16. D age 127 months, score 7. Cases A, B and C are doubtful surgical indications. In case D surgery was performed too late.

2. In 24 hips, the same as (1) but without arthrotomy.
3. In 9 hips, pelvic transiliac osteotomy only.
4. In 4 hips, subtrochanteric osteotomy with reduction of the anteversion angle by 10–30°; in some of the cases the neck-shaft angle was reduced to about 120°.

The degree of residual dysplasia prior to surgery expressed as a score of the radiographic parameters varied greatly. In 95 percent of the hips, there was an increased anteversion; in 85 percent, an interruption of the Shenton's line; in 66 percent, an increased acetabular angle; in 57 percent, an increased lateral distance angle and a decreased Wiberg CE angle; and in only 29 percent, the neck shaft angle was greater than 140° (maximum 153°). The radiographic score varied from 6 to 16, with a score 9–11 in 50 percent of the children who had surgery.

Eighty percent of the children had surgery between 3 or 4 years of age. The youngest child was 35 months old at the time of surgery, and the oldest was 10 years old (Figure 9).

Five hips had surgery with scores of 14–16, three of them at 3–4 years of age. These hips were already well remodeled at the time of surgery. On the other hand, 4 hips were operated after the age of 6 with scores of 6–13 (Figure 10). Surgery was also performed on 6 hips with scores from 11 to 13 below 4 years of age. As will be demonstrated on page 14, these hips would have had a fair enough chance of further spontaneous remodeling.

In retrospect, the indication for surgery was sometimes questionable; in 11 cases the acetabular angle and the femoral head covering were corrected in spite of the fact that the acetabular angle was less than 20°; in 9 cases in spite of a Wiberg CE angle > 20°. In 3 cases an anteversion angle < 40° was reduced.

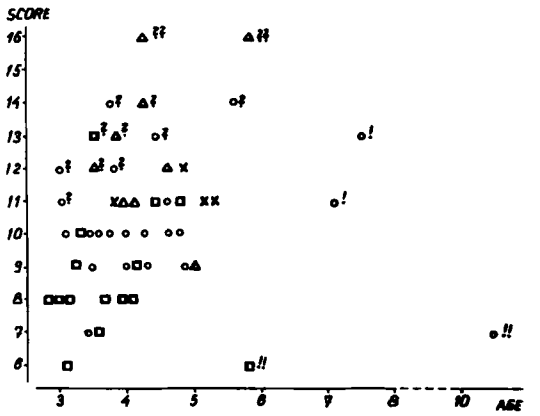


Figure 10. Radiographic score, age, and surgical procedure:
- arthrotomy, transiliac and subtrochanteric osteotomy,
- transiliac and subtrochanteric osteotomy,
- transiliac osteotomy only,
X subtrochanteric osteotomy only,
? doubtful surgical indications,
! surgery too late.

Table 9. Age of patients and number of hips at late evaluation

Age (years)	10	11	12	13	14	15	16	17	18	>18	Total
Number of hips	81	56	92	63	41	19	67	41	34	33	527

Table 10. Arc of rotation movements at late evaluation

Arc of rotation	Number of hips (percent)
Normal	68
Medial 40°–60° and lateral 20°–40°	18
Medial > 60° and lateral < 20°	14

Table 11. Length of legs and dislocation (number of hips)

Length	Unilateral	Bilateral
Equal (93 percent)	259	231
Shortening < 1cm	15	9
Lenghtening < 1 cm	7	
Shortening 1–2 cm	3	0
Lenghtening 1–2 cm	3	

Late evaluation

A clinical and radiographic examination of the 527 hips (groups B and C) was performed in 407 children 10–21 years of age. The mean age at the time of the late evaluation was 14 years (Table 9). These hips represented 52 percent of the hips first evaluated at the age from 15 to 36 months.

Clinical examination

All the children went to school or were employed at the time of the late evaluation. All the patients walked normally. None of them had a positive Trendelenburg or Duchenne test. There was no medial rotation of the leg when walking, not even in children with an increased anteversion angle.

Extension, abduction, and adduction were all normal. There were characteristic changes in rotation. The total arcs of rotation were not changed, except in 2 cases, and varied from 60° to 90°. In some hips, however, the internal rotation arc was increased while that of the external rotation was reduced (Table 10). Eight hips had limited flexion varying from 90° to 110°. There were equal leg lengths in 93 percent of the children; in 7 percent, there were leg-length discrepancies of 0.5–2 cm (Table 11).

Radiographic examination

According to the radiographic score, 60 percent of the hips were excellent, 35 percent good, and 5 percent fair (Table 12).

Those hips classified as excellent had a radiographically normal or nearly normal structure, i.e., with an increased anteversion of maximally 50°. All the other parameters included in the radiologic evaluation were normal (Figure 11A).

Hips classified as good had an anteversion angle > 50° (62 percent), or anterversion 41-50° and a lower score for another parameter (33 percent), or a lower score in other parameters with an anterversion angle < 40° (5 percent; Figure 11B, C).

The 25 hips (5 percent) classified as fair (Table 12)

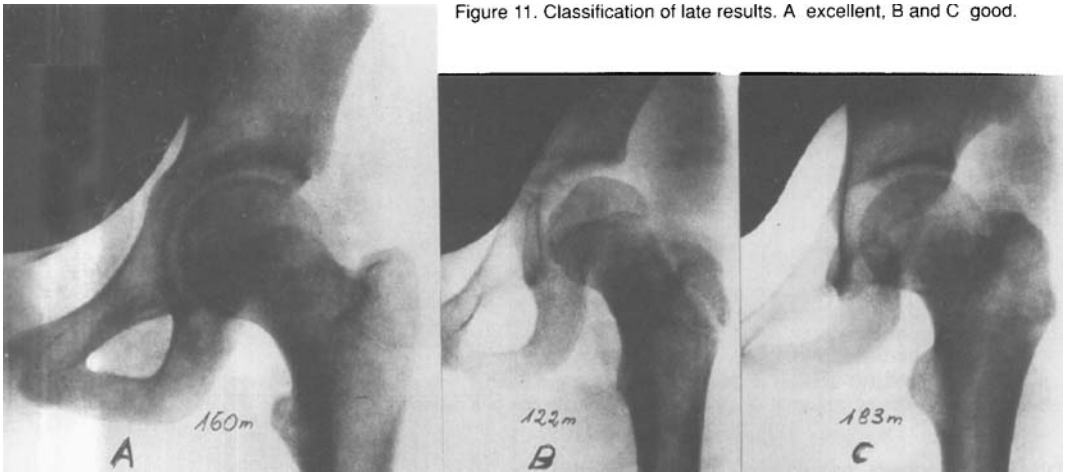


Figure 11. Classification of late results. A excellent, B and C good.

Table 12 Scores of late radiological evaluation

Results (percent)	Excellent (60)		Good (35)			Fair (5)				
Score	18	17	16	15	14	13	12	11	10	9–5
Hips (percent)	31	28	26	5	4	3	1	0.4	0.2	0

Table 13 Scores of hips classified as fair

Score	13	12	11	10	9–5
Number of hips	17	5	2	1	0

Table 14. Causes for the classification of the late results as only fair

Cause	Percent
Shenton line considerably or extremely interrupted	33
Anteversion angle > 40°	28
Wiberg's CE angle < 24°	18
Neck-shaft angle > 140°	10
Acetabular angle > 15°	7
Lateral distance angle > 25°	4

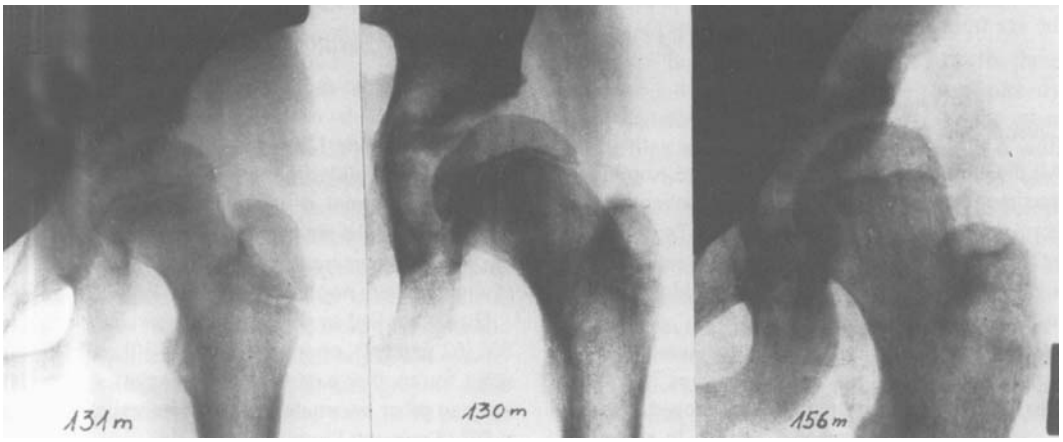


Figure 12. Late classification. Examples of "fair" cases.

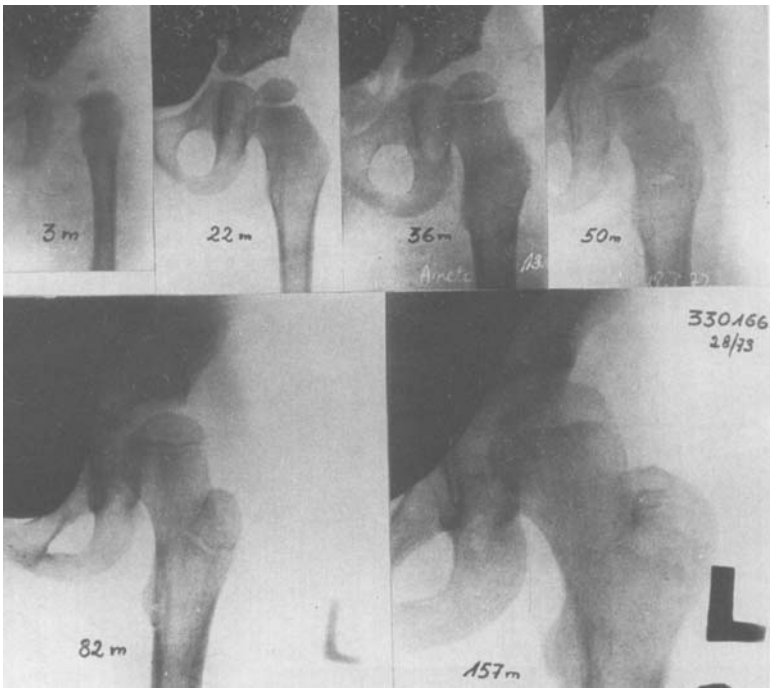


Figure 13. This child had been walking for many years with a 1.5 cm lengthened leg.

Table 15. Number of examinations in different ages

Age	< 2	2	2.5	3	4	5	6	7–8	9–10	11–12	13–14	15–16	17–18	> 18	Total
Examinations	383	487	323	498	256	154	137	168	142	159	104	86	75	33	3005

require a more detailed analysis. In two thirds of those hips the score was 13 (Table 13). Radiographically observed disqualifying findings appeared in different combinations (Table 14; Figure 12).

Nine out of the 25 children with a fair result failed to attend a follow-up examination after the age of 3. In 7 children, an operation had been recommended between the ages of 3 and 6 years, but for various reasons the operation had not been performed. Three children had been walking for several years with a leg-length discrepancy (the affected leg was longer; Figure 13).

In some cases, it was impossible to determine why the child had not been operated on in time or why the hip was not properly remodeled.

Hip remodeling

3005 hip radiographs obtained between the age of 15 months and 21 years in 916 hips in 708 children in all the groups were analyzed. A varying number of radiographic examinations were performed at different ages (Table 15). The percentage of excellent, good, and fair results were calculated (Figure 14).

After the end of the treatment when the child started to walk, the fraction of fair cases increased at the expense of excellent and good cases (Figure 15).

Between the ages of 2 and 7 years, the fair category decreased rapidly. Around 7 years of age, it equaled the findings of the late follow-up. The number of excellent results increased from about 10 percent at 3 years to 60 percent during puberty (Figure 16).

After the age of 10, the proportions of excellent and good results also equaled the findings at the time of the late evaluation.

In a similar way the behavior of each parameter in the radiographic evaluation during the growth period can be analyzed. Such an analysis, however, goes beyond the scope of the present study. It is clear, though, that there is a correlation between the tendency of correct containment of the femoral head and the improvement of the acetabular angle, and that

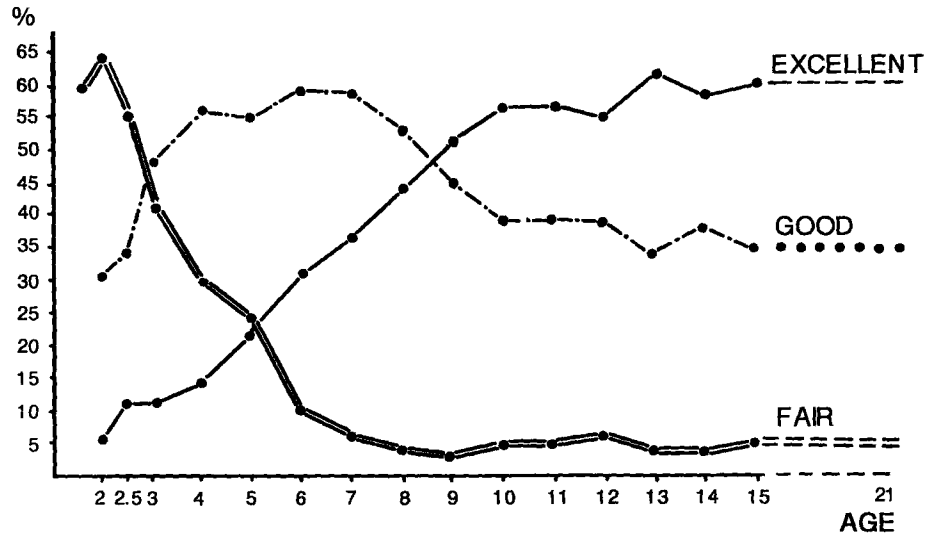


Figure 14 Growth remodeling. Percentage of excellent, good and fair results.

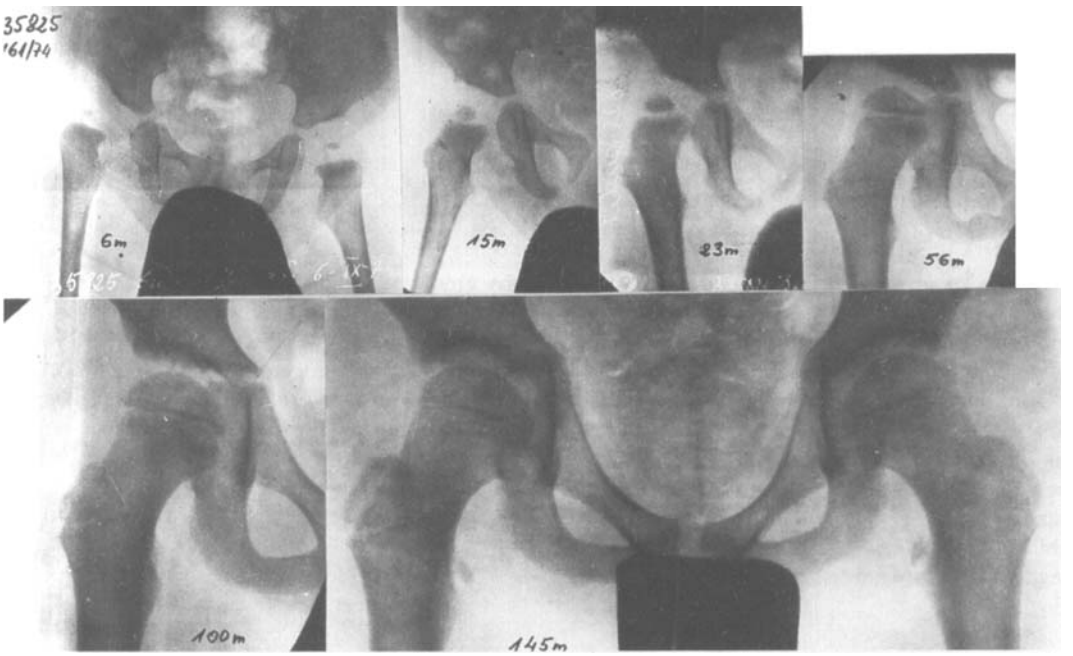


Figure 15. In this case there was a deterioration after the child started to walk at 17 months of age. Later on there was a good remodelling.

Shenton's line and Wiberg's CE angle take the longest time to reach normal values. Delayed improvement of the acetabular angle indicates little hope for a final good result at a later age.

Femoral head necrosis

Avascular necrosis was observed in 113 out of 830 hips (14 percent). In diagnosing necrosis, we took

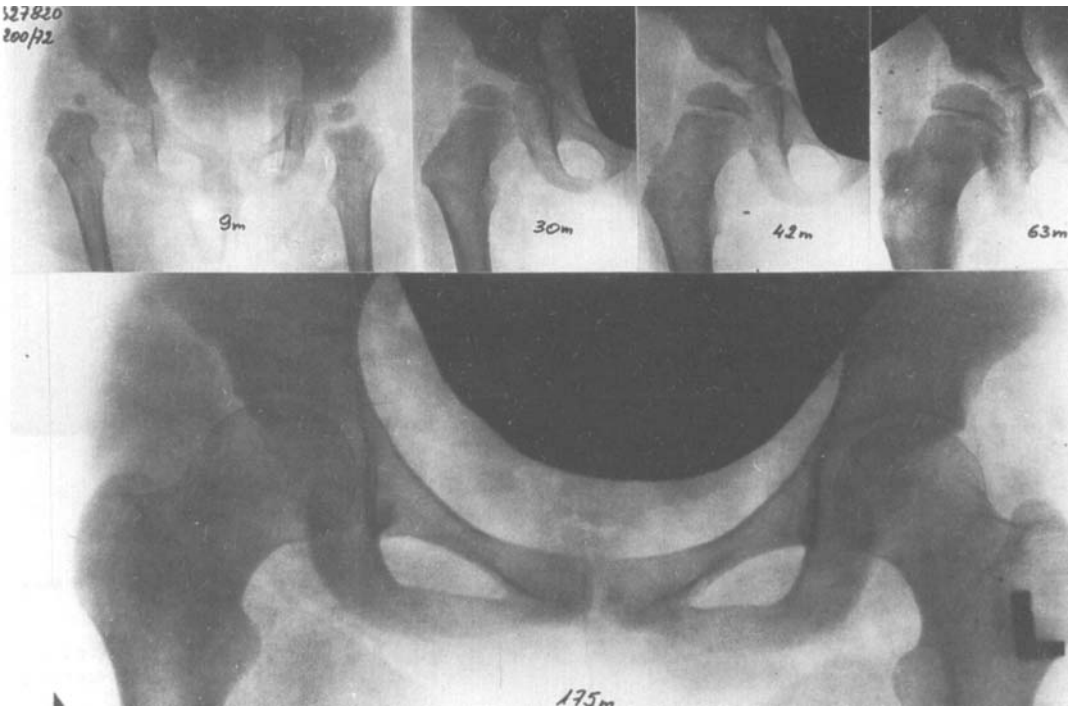


Figure 16. Late remodeling, not before 63 months.

into account the criteria of Salter et al. (1969), Gage and Winter (1972), and Tönnis and Kuhlmann (1968). Thus, changes considered by some authors as transient disorders of vascularization have been included. Hips where no necrotic characteristics could be identified during the treatment but with deformation at follow-up > 10 years of age, indicating a previous epiphyseal cartilage lesion, were also included, because there was no other plausible explanation for their appearance (Kalamchi and McEwen 1980). These late diagnosed cases constituted 5 percent of the necrotic cases.

The necrotic cases were classified according to their severity. A critical analysis of the classifications of Tönnis and Kulhmann (1968) and Buchholz and Ogden (1978) was carried out to study their prognostic values. On this basis, our own classification was established (Kruczynski 1987; Table 16).

Changes involving only the femoral head without fragmentation were observed in 55 hips (49 percent). The late follow-up in these cases did not reveal any hip deformation except a slight increase in the size of the femoral head (Figure 17, Table 17), classified as mild. In 16 hips (14 percent), there was femoral-head fragmentation without a physeal lesion. This resulted in increased femoral head size with shortening of the femoral neck (Figure 18), classified as moderate.

Table 16. Percentage of ischaemic necrosis: type and severity according to Kruczynski

Type	Percent	Severity	Percent
I	49	Mild	49
II	14	Moderate	14
III	19	Severe	37
IV	3		
V	16		

Table 17. Head-shaft index in hips examined after the age of 10 years

Type of ischaemic necrosis	I	II	III	IV	V
Head-shaft index	201	205	212	210	219

Radiographic symptoms of growth-plate arrest (lateral, medial, or total) were found in 42 hips (37 percent). This arrest resulted in considerable and permanent deformation of the proximal end of the femur, classified as severe in 5 percent of all the cases (Figure 19).

In five hips, deformations caused by necrosis indicated surgery (4.4 percent of the necrotic cases, 0.6 percent in group A). The older the child was at the

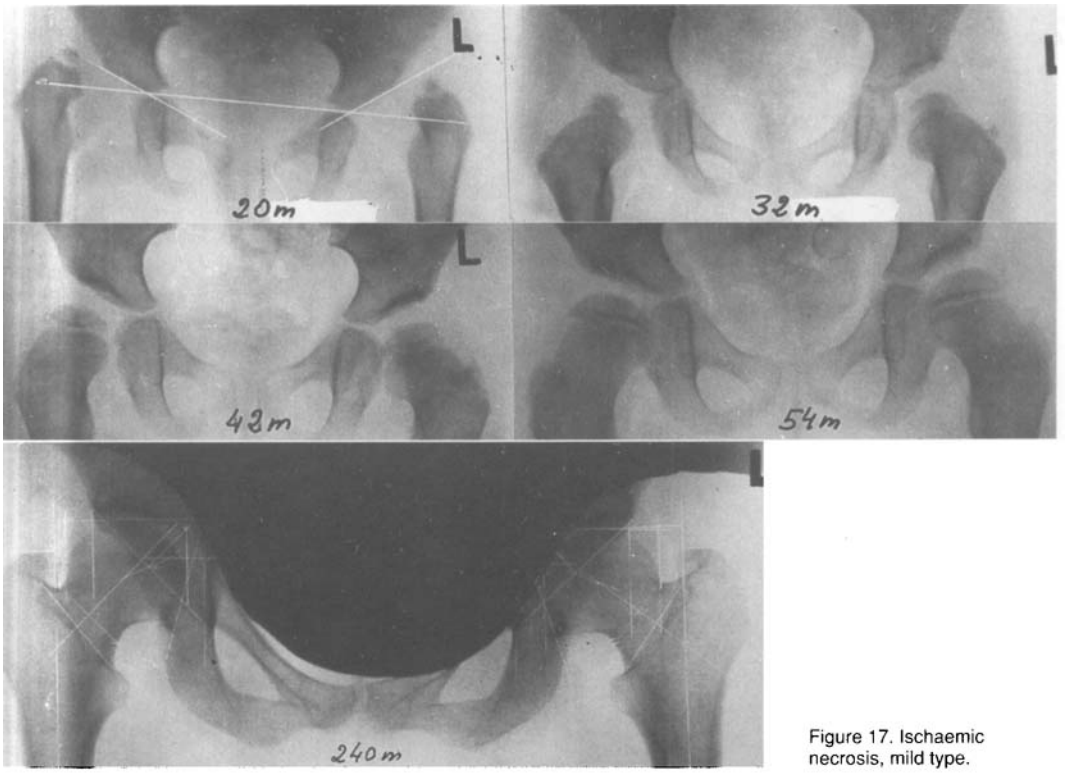


Figure 17. Ischaemic necrosis, mild type.

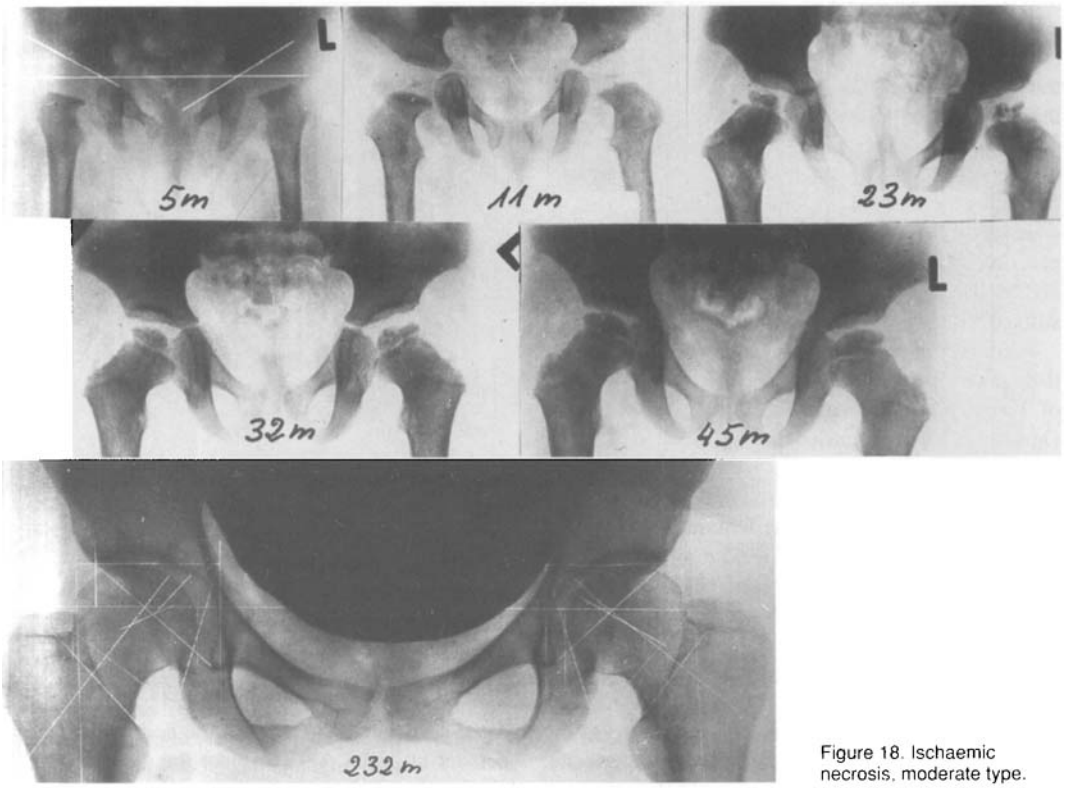


Figure 18. Ischaemic necrosis, moderate type.

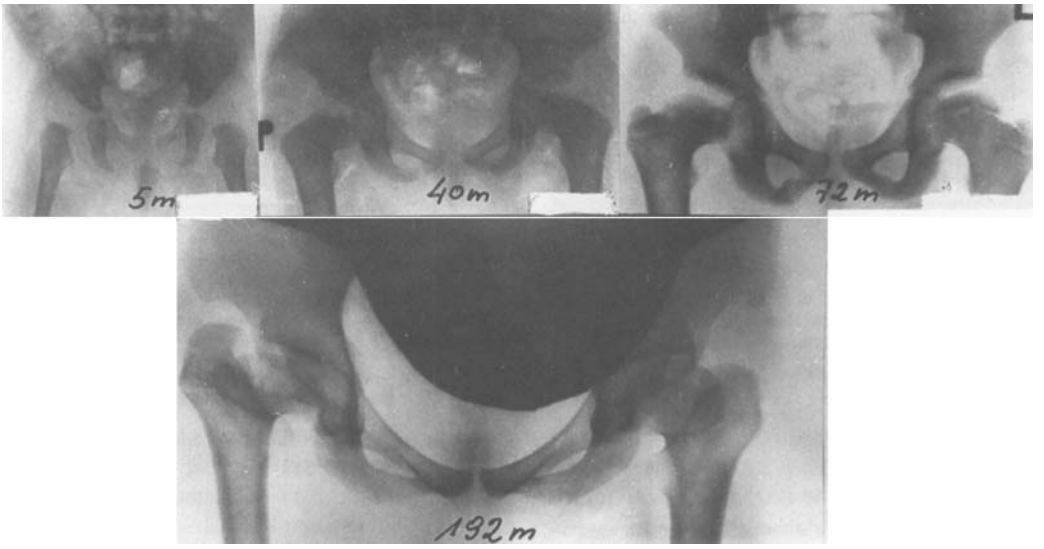


Figure 19. Ischaemic necrosis, severe type.

Table 18. Age at the onset of treatment for CDH and the percentage of femoral head necrosis in each age group

Months	<3	3–4	5–6	7–12	13–24
Mild	1.7	4.0	4.4	13.5	14.5
Moderate	2.7	0.5	2.9	2.5	4.8
Severe	3.7	7.0	4.5	4.3	1.2
Total	8.1	11.5	11.8	20.3	20.5

Table 19. Initial dislocation and the percentage of femoral head necrosis in each age group

Degree of dislocation	1	2	3	4	5
Mild	2.6	5.1	5.9	17.8	16.3
Moderate	0	1.3	1.6	6.9	2.3
Severe	1.7	5.0	8.6	4.0	7.0
Total	4.3	11.4	16.1	28.7	25.6

onset of treatment, the greater the risk of necrosis, notably if treatment was begun after 6 months of age. However, the incidence of the more severe cases was higher in the younger children (Table 18).

Necrotic changes were more likely to occur and the proportion of severe changes was increased in cases with a higher degree of initial displacement (Table 19). Such factors as whether the treatment affected the right or the left hip, or both, sex, or family history did not increase the risk of necrosis.

Factors influencing the results of treatment

Failures and residual dysplasias taken as an element of the results of treatment were subjected to a statistical analysis. One group of the hips with incomplete remodeling was eventually operated on, another was found during the late evaluation—this group comprised our late fair results. These two groups of dysplasia arose from different subsets and thus had to be analyzed separately (Table 20).

Table 20. Analysis of treatment and remodeling of 1,010 hips

Early evaluation 15–36 months (n 830)	Remodeling during growth	Late evaluation 10–21 years (n 527)
Stable reduction, 94%	Good	Excellent and good results, 95%
Failures, 6%[a]	Insufficient (residual dysplasi, operated, 4%)[a]	Fair results, 5% (residual dysplasi, nonoperated)[a]
Femoral head necrosis, 14%		Sequele of femoral head necrosis, 1%[a]

[a] Indication for surgery

Various factors characteristic of a given child were investigated with respect to their effect on the results of the treatment.

The results were not affected by sex, whether the right or the left hip was affected or whether the

Table 21. Results of treatment in 830 hips in relation to the age at the onset of treatment (percent)

Age (months)	< 3	3–4	5–6	7–12	13–24
Failures	5	3	6	10	12
Residual dysplasia, operated	2	2	7	6	8
Residual dysplasia, nonop.[a]	0	5	9	11	7

[a] Late evaluation fair.

Table 22. Results of treatment in relation to the initial displacement (percent)

Degree of displacement	1	2	3	4	5
Failures	0	0	5	22	19
Residual dysplasia, operated	0	1	5	16	16
Residual dysplasia, nonop.[a]	7	8	4	9	6

[a] Late evaluation fair.

Table 23. Age at the onset of treatment and the median degree of initial displacement. Hips with onset of treatment before 3 months were not examined

Onset of treatment (months)	3–4	5–6	7–12	13–24
Degree of displacement	2	2	3	4

Table 24. Initial displacement and the median age at the onset of treatment

Degree of displacement	1	2	3	4	5
Onset of treatment (months)	4	4	6	8	12

Table 25. Results of treatment in relation to the initial acetabular angle (percent)

Initial acetabular angle	< 30°	–35°	–40°	–45°	> 45°
Failures	3	6	5	5	7
Residual dysplasia, operated	5	4	4	8	7
Residual dysplasia, nonop.[a]	9	4	10	5	10

[a] Late evaluation fair.

changes were unilateral or bilateral, nor was there any correlation to family history.

The age of 5 to 6 months at the onset of treatment was the borderline above which the number of failures and residual dysplasias increased markedly. Generally, in children whose treatment started at 5 to 6 months of age or later, the chance for a succesful course of treatment decreased twice (Table 21). Better results were observed at the late follow-up in the group of children above 12 months of age at the start of treatment as compared with those whose treatment began at the age of 7–12 months.

The possibility of succesful treatment was much lower in hips with a higher degree of displacement (Table 22). No differences were observed between hips with a first or second degree of displacement nor between those with a fourth or fifth degree of displacement. We also observed a relatively high number of late fair cases in the first and second degree of displacement.

The degree of displacement and the age at the onset of treatment was correlated (Tables 23 and 24).

The initial acetabular angle had no clear effect on the result of treatment (Table 25).

Discussion

Patients

Our material differs from other published materials in that we used a uniform treatment program and studied a large number of cases over a long period. By comparison, Shamotov et al. (1982) described 2,032 cases, but their cases were treated with different methods. Heikkilä and Ryöppy (1984) presented the results from 920 children treated by a single method, but their conclusions were based only on short-term results and were not confirmed by radiographic examination. Smith's (1968) long-term observations were limited to 53 cases.

On the other hand, the general characteristics of our patients are similar to those presented by Palmén (1984) and Heikkila (1984).

Treatment

The Frejka pillow has been criticized for inducing maximum abduction (Tönnis 1984). It should, however, be noted that our treatment, starting with a soft Frejka pillow, did not force the hip into maximum abduction. Even while using the hard felt pillow, the child can move its legs, as well as obtain greater flexion, which is often desirable. It is also important that, unlike the Pavlik harness, the pillow can be used even after 6 months of age. All rigid braces that force the legs into a predetermined, fixed position were excluded from the start of this project.

We believe that the Frejka pillow is optimal for treating CDH: it achieves and retains reduction of the hip. We disagree with the view of Hanson et al. (1983) that the Frejka pillow does not provide reliable retention of fhe femoral head in a reduced position in newborn infants with neonatal hip instability and that the von Rosen splint, i.e., a rigid brace, should be used instead.

Undoubtedly, in some cases our attempts to obtain reduction in the Frejka pillow were unnecessarily prolonged. This period should not be longer than 6-8 weeks. We believe that shortening this period to 3 or 4 weeks, as recommended by those using the Pavlik harness (Iwasaki 1987, Kohler 1987), is due to a lack of patience, indispensable in the treatment of CDH.

We seldom recommended immobilization in a plaster cast, except for a few weeks after closed reduction, and we cannot see any other indication for its use.

Methods

Our selection of the radiographic parameters was determined on the one hand by the need to describe the hip joint architecture as objectively as possible, and on the other by practical considerations as to the time necessary to analyze each radiograph. The general configuration of the hip is well described by the acetabular angle and Wiberg's CE angle. Shenton's line remains the best indicator of superior dislocation. The angle of the lateral distance (Labaziewicz 1979) is an good index of the head-to-acetabulum relation. All the selected parameters except Shenton's line are based on objective measurements.

It is not unusual that authors evaluate their results using subjective interpretations, such as better or worse "joint congruency" or "normal appearance" of the hip. Our method of evaluation is stricter than the most frequently used (Severin 1941). We classified a hip as excellent if the acetabular angle was $< 15°$ and Wiberg's CE angle $> 24°$. Ueno et al. (1975) considered hips with an acetabular angle $< 20°$ and Wiberg's CE angle $> 20°$ as anatomically cured.

In sum, our results are objective, but on the other hand more difficult to compare with other studies.

Results

Our 6 percent reduction failure seems to be the limit of conservative methods of treatment. In some cases intraarticular interposition (thick ligamentum teres, elongated capsule in high dislocations) prevents closed reduction, and surgery will then be required. This was also confirmed by Heikkilä and Ryöppy (1984), who reported 4 percent failures in spite of the fact that their treatment was started at the age of 5–8 days. Iwasaki (1987) reported 16 percent failures with the Pavlik harness: in his study a lack of reduction after 4 weeks in harness was classified as a

failure and traction was applied. Similarly, Viskelety (1981) reported 9 percent failures with the Pavlik harness and abduction splint, whereas Kohler and Seringe (1987) reported 15 percent failures.

In our failed cases, attempts to obtain reduction by conservative treatment were unnecessarily prolonged. Perhaps sonography could be helpful in predicting the results of treatment, or we should apply arthrography more often as suggested by Hughes (1982) and Tönnis (1984).

Our study supports the opinion that when the period of treatment is over and the child starts to walk the hips are not yet sufficiently remodeled. In the early evaluation, almost two thirds of the hips were classified as fair, i.e., almost subluxated. Nevertheless, they remodeled spontaneously during the process of growth and were classified as normal or nearly normal in the late evaluation (Figure 14).

In the late follow-up analysis, the only remaining pathologic element is an increased medial and a decreased lateral rotation and, visible in the radiographs, an increased anteversion. Thus, an increased anteversion may be considered a permanent sequel of past dysplasia. These findings disagree with Medbö (1965), who found a normal anteversion angle at the age of 5–7 years in 49 children treated with the Frejka pillow. Our study did not, however, show that an increased neck-shaft angle was an integral element of hip dysplasia, as it is often assumed to be. 85 percent of our hips had a normal neck-shaft angle of 120°–140°. In 14 percent of the hips it was 141°–150° and in only 1 percent > 150°. Our late radiographic evaluation is, to a certain degree, comparable to that of other authors. Zionts and MacEwen (1986) reported 79 percent very good cases at a mean age of 12 years. Ueno et al. (1975) reported 71 percent of his cases as anatomically cured around 10 years of age, but their criteria were less strict than ours. The longest follow-up after conservative treatment, 31 years on the average, was reported by Smith et al. (1968). Their cases included, however, cases treated by the Lorenz method, and included surgically treated cases.

They concluded that 80–85 percent of the hips are cured after conservative treatment. The remaining cases are either bound to be failures in conservative treatment or require surgery due to insufficient remodeling during the growth process (Table 20).

Hip remodelling and residual dysplasia

Our method of analysis is based on the evaluation of hips at different ages. The hips from which mean values are calculated each year are not always the same hips! Still, our conclusions seem justified because of the large number of cases. We have not come across any analysis in the literature where a sufficiently large group of children have been examined periodically for long enough periods of time. Some authors have reported, however, changes in different elements of the radiographic structure of the hip at various ages. Visser (1984), for instance, claimed that the progressive improvement of the acetabular angle ceases around the age of 3 years. Lindström et al. (1979) claimed that it continues until 5 years of age. Sage (1980) showed that remodeling of the acetabulum continues until the age of 10 years. Szulc (1977) reported an improvement in Wiberg's CE angle above 10 years of age. Charnley and Westin (1982) observed remodelling of the acetabulum up to the age of 11 years. Thus, the remarkable ability of the hip joint to remodel spontaneously during the process of growth is confirmed.

It is usually assumed that the age limit for successful remodeling is 5 years (Salter 1961, Dega 1973, Tönnis 1984). We consider this limit to be 7 years, and believe that there is no further remodeling after 10 years of age.

Differences in remodeling rate have practical implications. We are convinced that before 3 years of age surgery due to residual dysplasia should only be recommended in extreme cases and that advantage should be taken of the spontaneous remodeling capacity between 3 and 5 years.

We are still responsible for the 5 percent of the children with a fair result in the group with the late evaluation; these children should have had surgery. Hence our study confirms that there are hips where spontaneous remodeling is insufficient; these hips should be treated surgically at the right time. On the other hand, about one third of our surgically treated residual dysplasias had, retrospectively, a chance to undergo spontaneous remodeling. There is, nevertheless, the dilemma of each individual case: will there be sufficient remodeling or should we operate now? This question is open for further research on the dynamics of hip during growth. Recent studies by Suhik and Sadofieva (1983) and Brougham et al. (1988) are inconclusive. Serial radiographic observations of various elements of the hip architecture may give an accurate prediction of remodeling in a given joint and subsequently define the indications for surgery.

The behavior of the hip when the child begins to walk remains to be investigated. Our study shows that in this period, before and during the child's second year, the state of the hip deteriorates (Figures

14 and 15). Important conclusions concerning the pathogenesis of CDH may be drawn from this fact: the interdependence between the dislocation and the dysplastic structure of the joint.

Femoral head necrosis

Necrosis is still the most severe and in some series the most frequent complication in the treatment of congenital dislocation of the hip. We diagnosed necrosis in 14 percent; 1 percent of the total material required surgical treatment for this reason.

The incidence of necrosis in various series presented in the literature is wide: from 0 (Kalamchi and Mac Farlane 1982, Ramsey et al. 1976) to 98 percent (Polakowski 1953). Our criteria may be considered very strict. In the present situation, it would be difficult to compare the incidence of ischemic necrosis after different methods of treatment or to compare the incidence in different materials with our results. A similar opinion is expressed by Krol (1963) and Kohler and Seringe (1987). Because we consider our method of treatment as gentle, the only way to reduce the incidence of femoral head necrosis would be to apply any treatment, even a wide diaper pad, intermittently from the start for carefully planned periods of time. There is, of course, the question of starting the treatment at an earlier age, since this has such a positive influence on the incidence of necrosis.

The final answer as to the long-term effects of ischemic necrosis, especially in less pronounced cases, cannot be evaluated earlier than at the age of 30.

Factors influencing the results of treatment

It is generally believed that the sooner treatment starts, the better the results. Our results indicate that this opinion should be revised. We found that the age when treatment begins has no effect on the results if treatment starts before 5–6 months of age. Not until the long-term results of treatment starting during the first days of life are published can our opinion be questioned. It would be interesting to compare our results with the results of using our treatment but starting it in the first days of life. Would those children have developed anatomically normal hips at the time they began to walk?

Fredensborg (1976) reported a series of 111 children treated within the first few days after births with a von Rosen splint. Except for 2 children, the remaining hips developed normally until the age of 10 years. It turned out, however, that the hips scored as normal, had a CE angle less than 25° (average 8 percent of the cases) and a spherical index of the femoral head of 25 percent of normal (average 12 percent of the cases).

Also Heikkilä and Ryöppy (1984) reported on treatment started between the age of 5 and 8 days with the proportion of failures very similar to ours, but the radiographic state of the hips at the end of treatment was not presented.

The lower number of failures in children where treatment started at the age of 3–4 months as compared with younger children can be explained by the fact that at this age there were radiographs taken, whereby the first and second degrees of dislocations, especially subluxations, were diagnosed. In these children no reduction failures occurred. On the other hand, below the age of 3 months, the diagnosis was based on a positive Ortolani sign. Thus, all these cases were dislocations.

Similarly, small differences, and even better results in the late follow-up in the group of children above 12 months of age at the beginning of treatment as compared with those where treatment started between the age of 7 and 12 months could be explained by the fact that dislocations diagnosed in the second year of life were usually treated by skin traction (overhead extension) or by surgery. Only those with a rather small degree of dislocation, and thus a better prognosis, were referred to us.

The correlation between the results of treatment and the degree of displacement is very obvious, especially in cases with a third-degree displacement or greater. Thus, the lack of contact between the femoral head and the acetabulum, as in the fourth- and fifth- degree displacements, considerably inhibits reduction and later remodeling of the hip. On the other hand, one should note the high number of late fair cases in the first- and second-degree displacements, i.e., mainly in subluxation cases. These were even more numerous than the average proportion of late fair cases in the total results of treatment. This was because children with a lower degree of displacement were treated surgically only in exceptional cases. Taking into account that the degree of displacement depends on the age at the start of treatment, the question arises, which of these two factors is more important? The conclusion from our material was that the degree of displacement was more important and the deterioration of results was closer correlated to the increasing degree of displacement than to the age. Age at onset of treatment

affects the results indirectly because the degree of displacement increases with age.

The correlation between the obtained results and initial acetabular angle proves, that this component has prognostic value only in severe dysplastic hip.

Surprisingly, dysplasia recorded in the family history did not influence treatment results.

Conclusions

1. The Frejka pillow provides a stable reduction of the hip.
2. The hip is not yet completely remodeled when the child starts to walk at the end of the treatment.
3. The hip has a substantial potential of spontaneous remodeling during the growth process. This potential decreases after the age of 7 and ceases radiographically after the age of 10 years.
4. In hips without evidence of severe femoral head necrosis, the radiographic appearance at the end of the growth period is normal or almost normal. A small proportion of insufficiently remodeled hips would probably have benefitted from surgery at an earlier stage.
5. The age of the child and potential spontaneous hip remodeling, as evaluated on serial radiographic examinations, should be taken into account when surgical intervention is considered.
6. The initial degree of displacement of the femoral head considerably influences the treatment result.
7. Age at the start of treatment influences the results indirectly because the degree of displacement increases with age. The results deteriorate markedly if treatment starts after the age of 5–6 months.
8. Femoral head necrosis is the most severe and unpredictable complication of the treatment. Its incidence increases with the age when treatment begins but its severity is more marked in younger children. An objective evaluation of necrosis is difficult because of differences in the criteria used for diagnosis and radiographic evaluation of the condition.

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Case reports

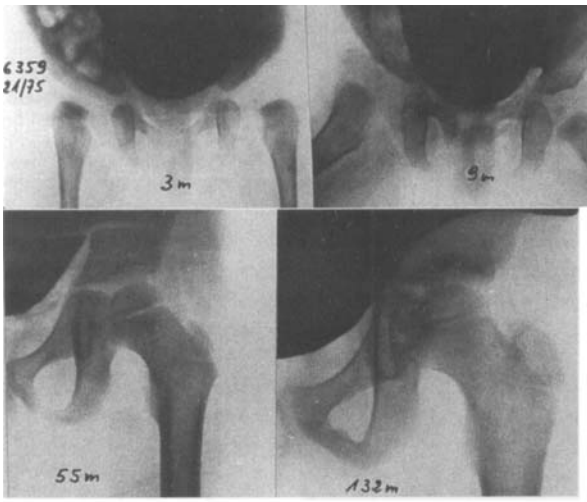

Figure 20. Failed reduction.

Treatment was started at 3 months of age. There was a symmetric initial fourth-degree displacement in both hips. The acetabular angle were 32° and 33°, respectively. The left hip was reduced after 2 weeks. Reduction of the right hip was never achieved in spite of Frejka-pillow treatment for 4 months. Arthrotomy revealed soft tissue and fat in the acetabulum. In the late evaluation the left hip was "good" (Shenton's line was slightly interrupted.)

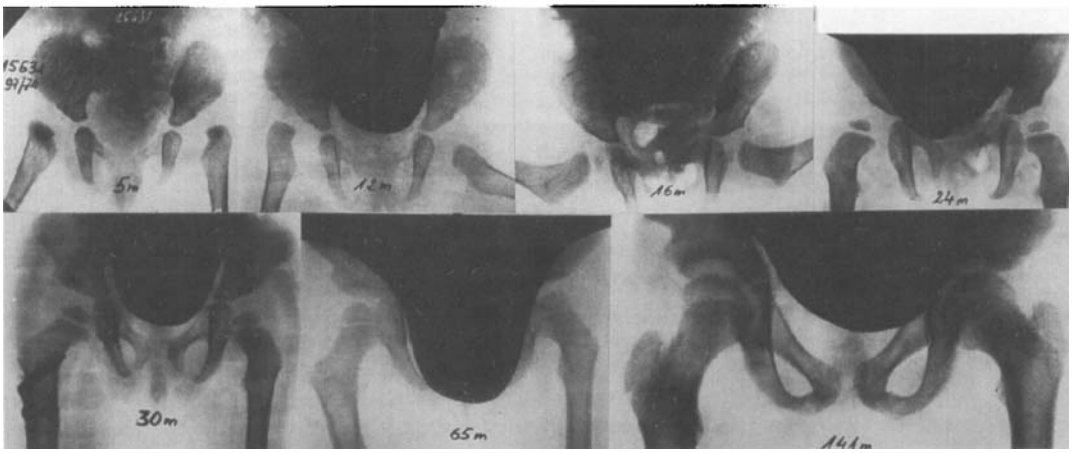

Figure 21. Redislocation.

Bilateral CDH was diagnosed at 5 months of age, and treatment was started at 8 months. There was a fourth-degree displacement in both hips. The left hip was reduced in a Frejka pillow after 10 weeks, the right hip was reduced under general anesthesia but redislocated after the child started to walk at 17 months of age. Surgery at 25 months included arthrotomy and transiliac and subtrochanteric osteotomy. The final result was "excellent."

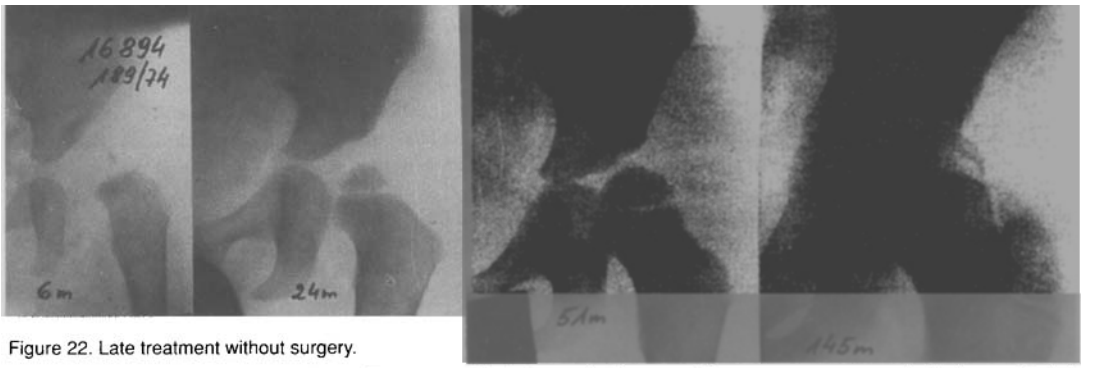

Figure 22. Late treatment without surgery.

Treatment was started at 6 months of age. There was a third-degree displacement. Surgery was recommended but was rejected by the parents at 51 months of age and a follow-up radiograph was obtained at 145 months of age. At this time, there was a 1.5-cm leg-length discrepancy. The final result was "poor" (interrupted Shenton's line, anteversion 65°).

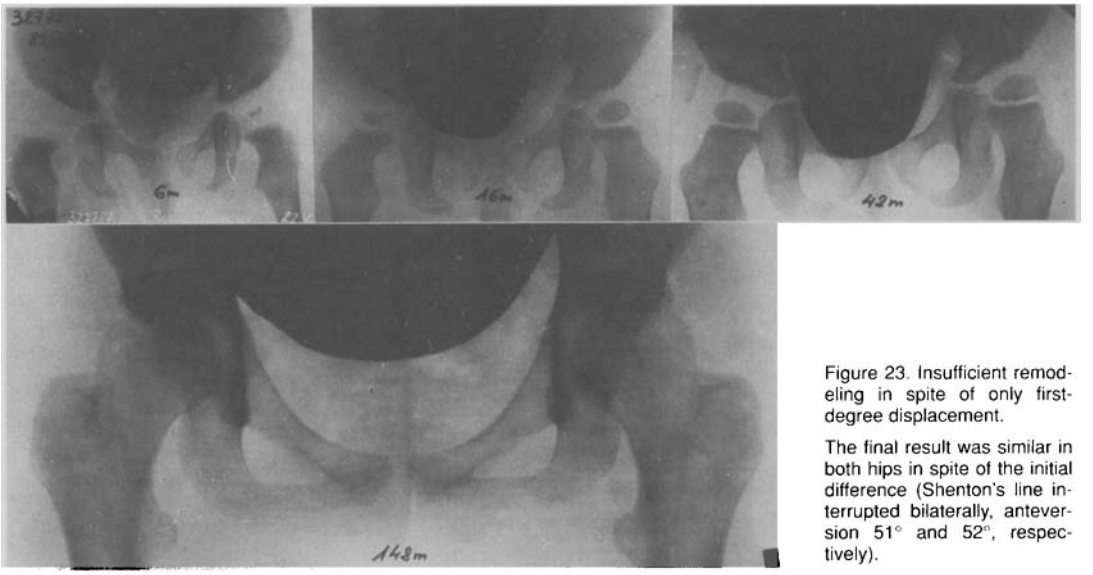

Figure 23. Insufficient remodeling in spite of only first-degree displacement.

The final result was similar in both hips in spite of the initial difference (Shenton's line interrupted bilaterally, anteversion 51° and 52°, respectively).

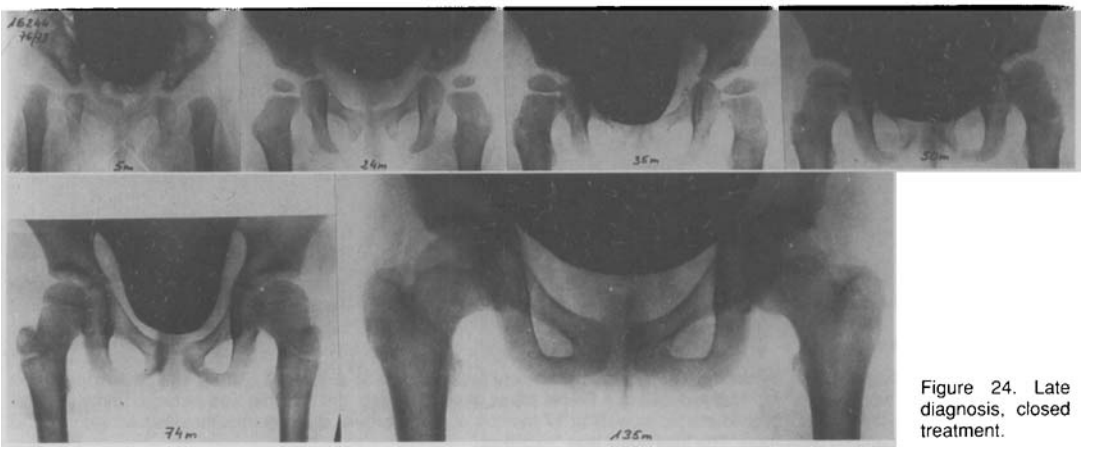

Figure 24. Late diagnosis, closed treatment.

Treatment was started at 5 months of age. There was a fourth-degree displacement in the left hip, a fifth-degree displacement in the right hip. The left hip was reduced after 2 weeks, the right after 4 weeks. The Frejka pillow was used for 8 months followed by an Ortolani splint for another 3 months. The child started to walk at 15 months of age. At 35 months of age surgery was considered but there was good remodeling and an "excellent" final result.

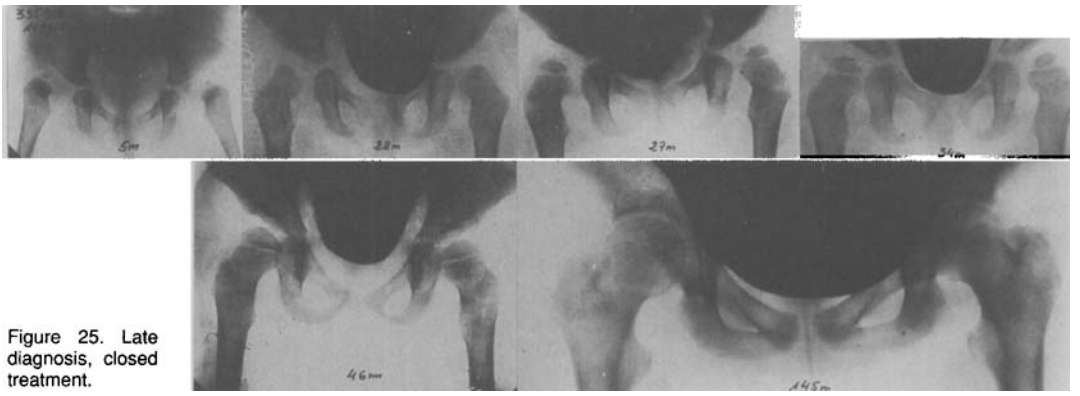

Figure 25. Late diagnosis, closed treatment.

Frejka-pillow treatment was used from 5 to 11 months of age. The child started to walk at 18 months of age. There was insufficient remodeling at 46 months of age but an "excellent" final result.

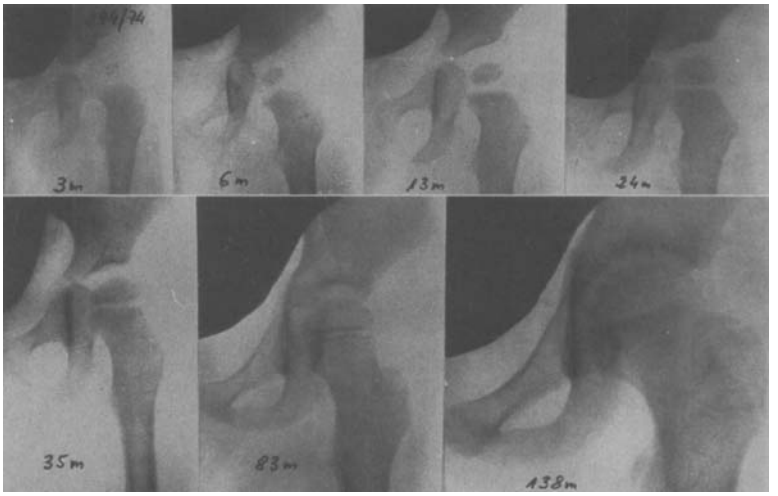

Figure 26. Closed treatment with early remodeling.

Treatment of a third-degree displacement was started at 3 months of age. The hip was reduced after 4 weeks. The Frejka pillow was used for 5 months, and the child started to walk at 12 months of age. This child illustrates a typical good, early remodeling. In the final evaluation, there was an increased anteversion angle (45°).

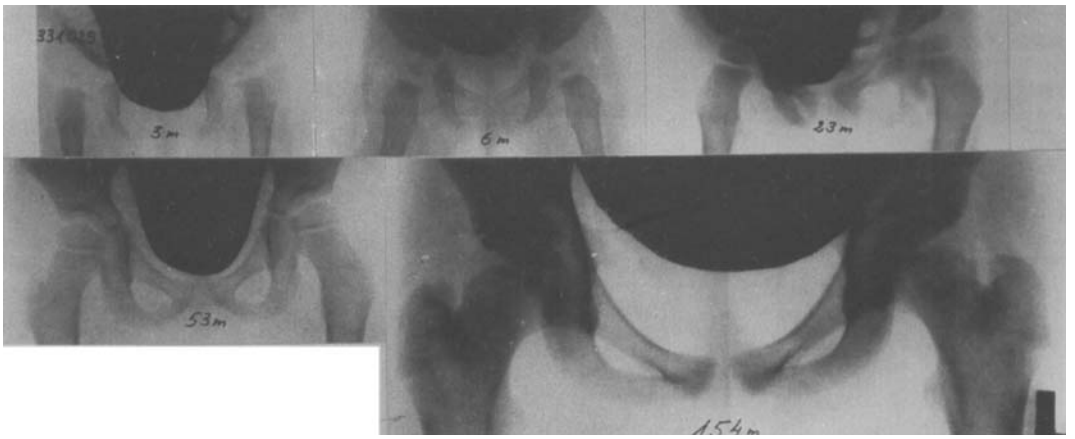

Figure 27. Closed treatment with early remodeling.

Treatment of a fourth-degree displacement bilaterally was started at 3 months of age. The right hip was reduced after 2 weeks, the left hip after 6 weeks. The Frejka pillow was used for 5 months continuously, then intermittently for another 3 months. There was a rapid and good remodeling and an "excellent" final result.

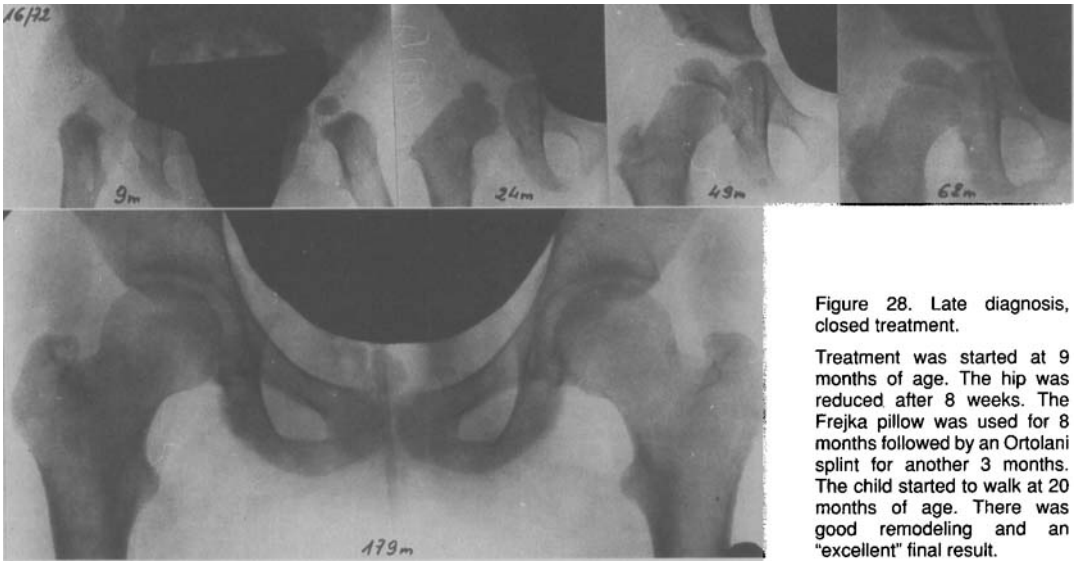

Figure 28. Late diagnosis, closed treatment.

Treatment was started at 9 months of age. The hip was reduced after 8 weeks. The Frejka pillow was used for 8 months followed by an Ortolani splint for another 3 months. The child started to walk at 20 months of age. There was good remodeling and an "excellent" final result.

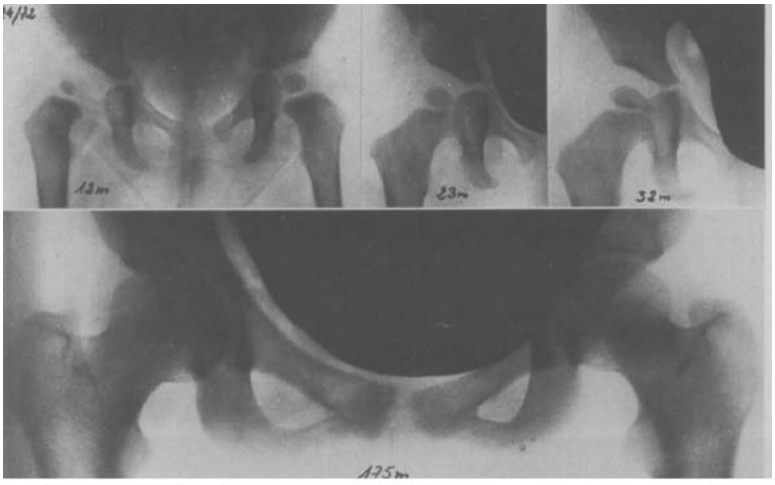

Figure 29. Late diagnosis, closed treatment.

Treatment of a fourth-degree displacement was started at 12 months of age. The hip was reduced after 2 weeks. The Frejka pillow was used for 6 months continuously and intermittently for another 3 months. The child started to walk at 22 months of age. There was an "excellent" final result.

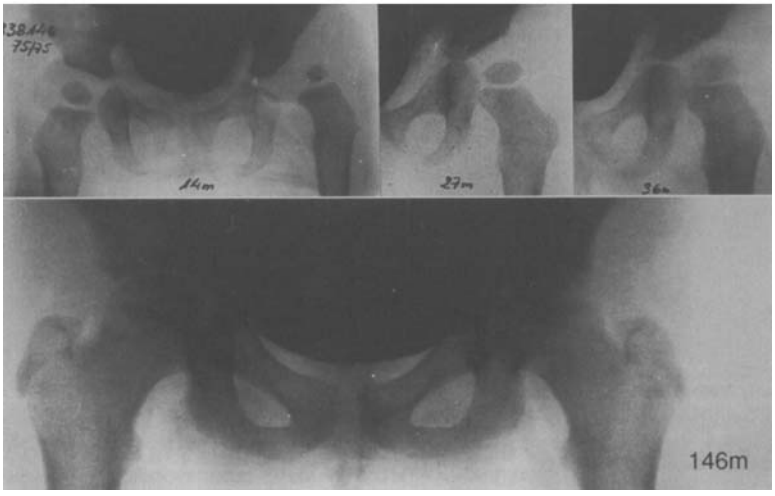

Figure 30. Late diagnosis, closed treatment.

Treatment of a third-degree displacement in the left hip was started at 14 months of age. The hip was reduced after 2 weeks and the Frejka pillow was used for 9 months. The child started to walk at 23 months of age. At 36 months of age the acetabular angle was 28° and Wiberg's angle was 11°. There was an "excellent" final result.

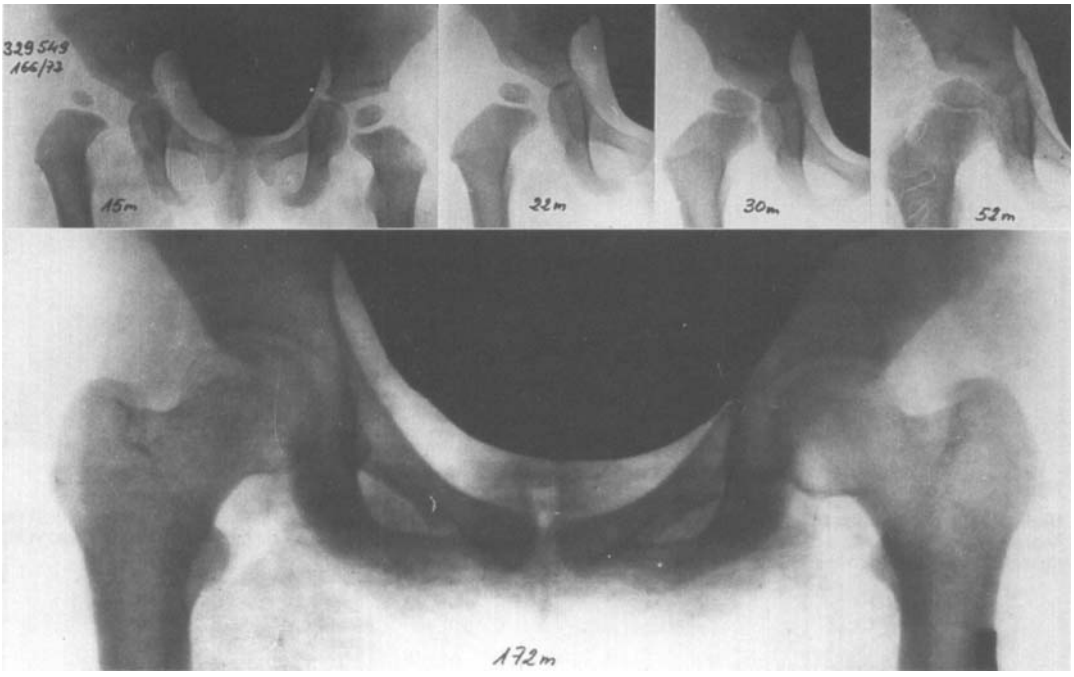

Figure 31. Late diagnosis, closed treatment.

Treatment of a third-degree displacement was started at 15 months of age. The hip was reduced after 3 weeks and the Frejka pillow was used for 5 months. There was a good rapid remodeling and an "excellent" final result.

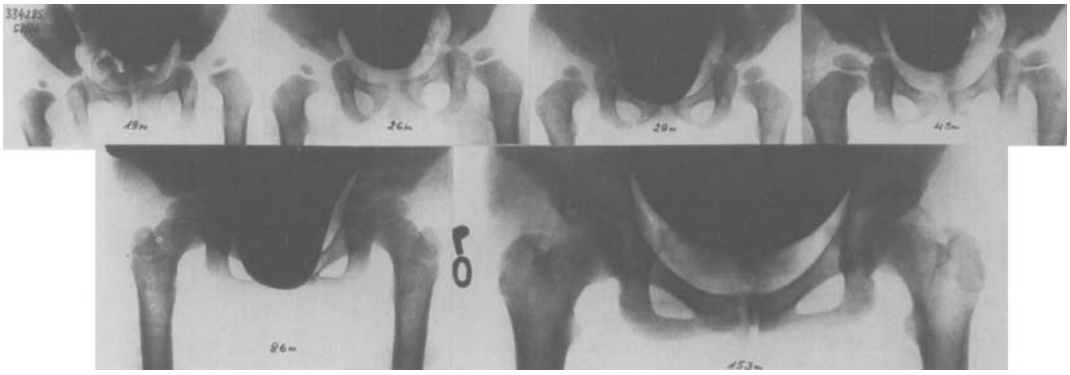

Figure 32. Late diagnosis, closed treatment.

Treatment of a third-degree displacement in the right hip started at 19 months of age. The acetabular angles were 43° and 41°, respectively. The hips were reduced after 5 weeks. The Frejka pillow was used for 9 months continuously and intermittently for another 3 months. The child started to walk at 32 months of age. There was good remodeling and the final result was "good" (anteversion angles were increased).

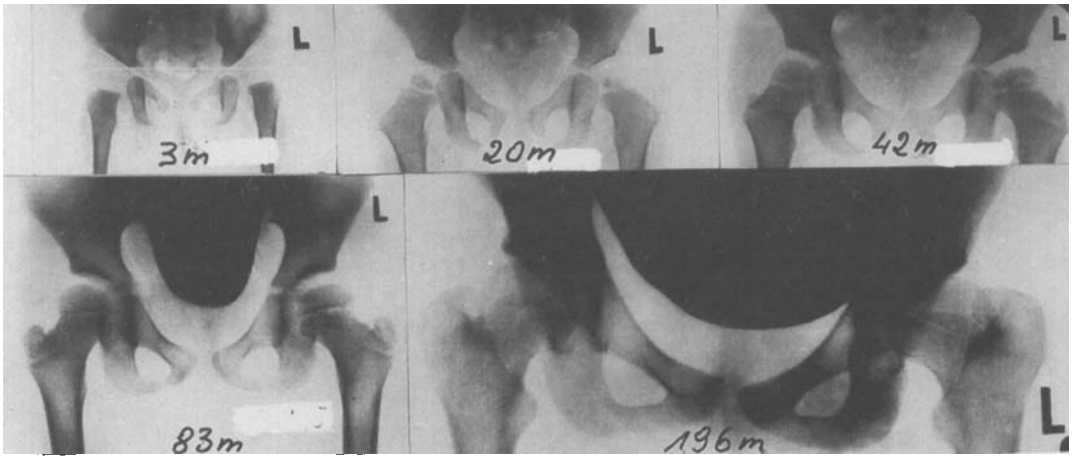

Figure 33. Femoral head necrosis.

Bilateral necrosis of similar severity (changes are observed in the epiphyses and in the lateral parts of the metaphyses). In the final evaluation, there was a deformity in the left hip indicating a premature closure of the lateral part of the growth plate. In the right hip there was only mild sequelae (coxa magna).