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HIP JOINT INSTABILITY AFTER THE NEONATAL PERIOD

Diagnosis and Treatment of 20 Consecutive Cases

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A consecutive series of 20 children (21 hips) with idiopathic hip joint instability, diagnosed after the neonatal period, is presented. The diagnosis was confirmed by hip joint arthrography. In all the children, 1.5–21 months old at the time of diagnosis, closed reduction could be achieved. They were treated in plaster directly or after treatment of contractures in the adductor muscles of the hip joint.

Stability was rapidly attained during plaster treatment.

The results of the treatment in plaster were checked by a second arthrography in two thirds of the cases, and all cases have been clinically and radiologically evaluated 1–4.5 years after diagnosis. All of the children developed clinically stable hips and they walk normally. In two hips signs of avascular necrosis of the femoral head were found and in three hips (two children) the skeletal development was markedly delayed. In 81 per cent (17/21 hips) the prognosis was considered good; it is uncertain in the remaining four hips.

The appropriate period of fixation in plaster related to the age of the child is discussed.

Key words: arthrography; hip instability; late diagnosis; plaster treatment

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During the 1950's, the diagnosis of and abduction treatment for hip joint instability in newborns was introduced into Sweden. In 1963, 99 per cent of all newborns were included in the hip joint examination at the maternity clinics (Palmén 1970). The excellent results of diagnosis and treatment in an urban area (Malmö) have been presented by von Rosen (1970) and Fredensborg (1975). Practically all cases were diagnosed during the neonatal period. On the other hand, materials from Sweden as a whole (Palmén 1975), and from Uppsala University Hospital (Almby & Rehnberg 1977) have shown an unexpectedly high rate of cases diagnosed after the neonatal period.

The value of arthrography in the diagnosis of hip joint instability discovered after the neonatal period has been demonstrated by Severin (1941) among others. Severin's material consisted mainly of children over 1 year of age. As a result of the numerous and efficient Child Care Centres most cases not diagnosed during the neonatal period are now detected much earlier than before. According to Palmén (personal communication 1977), most cases are now diagnosed before the age of 6 months.

Because the diagnosis and treatment of this group has been somewhat neglected in favour of the newborns the following study has been undertaken in order to elucidate the diagnosis

and treatment of hip joint instability after the neonatal period. Arthrography has been used to analyse the changes in the joint. Treatment has been guided by this examination.

Definitions

Unstable hip joint. Hip joint in which the femoral head is or can be moved out of the acetabulum partially or completely.

Neonatal period. The child's first month.

PATIENTS

The series consists of 20 children, all girls. They were born in the county of Uppsala and constitute all of the cases diagnosed after the neonatal period within the county from January 1972 to December 1975. The age at diagnosis was 1.5 to 21 months (Table 1).

All pregnancies followed a normal course, and delivery was normal in 17 cases. In two cases Caesarian section was undertaken and one case required vacuum extraction because of a drawnout delivery. No breech deliveries were found. All the children were born within the normal time, except for two, who were overdue by about 1 week. Weight at birth varied from 2648 g to 4690 g (average 3606 g). One Rh-immunized child showed a mild neonatal icterus. The others were all healthy.

METHODS

Clincial diagnosis

Maternity Clinic. All children were examined by a consulting paediatrician with regard to hip joint instability (positive Ortolani, laxity) at least once during the first week of life.

Child Care Centres. The children were examined by a paediatrician or a general practitioner at the existing check-ups, the first of which takes place at about 6 weeks of age and there are three to four further examinations during the first year of life.

Orthopaedic Clinic. Consultation was requested by the physician at the Maternity Clinic or at the Child Care Centre, or by another physician. The children were examined with regard to positive Ortolani, provoked instability, laxity, limited abduction, asymmetrical thigh creases, a short leg and gait disturbances. After a radiological survey of the hip joints, the children were admitted to the clinic for further treatment.

The series has been divided into two age groups for this analysis:

(1) Less than 12 months at diagnosis (16 girls, before walking)
(2) More than 12 months at diagnosis (4 girls walking)

Radiological diagnosis

Radiological survey of the hip joints. In all cases, three examinations are referred to:

(1) Before any treatment

Table 1. Reason for orthopaedic examination, age at diagnosis, and the most important clinical sign leading to referral

Reason for examination	No.	Age at diagnosis (months)	Clinical signs
1. Check-up after examination at maternity clinic	3	1.5, 4, 4	Positive Ortolani (3)
2. Hip abnormality found at Child Care Centre	15		
(a) routine examination (9)		2, 3, 3, 4, 4, 4, 5, 6, 13	Limited abduction (5) Positive Ortolani (2) Stiff joint (1) Leg rotated outward (1)
(b) parents findings (6)		2, 3, 8, 17, 19, 21	Asymmetrical leg position (3) Limp (3)
3. Hip abnormality when examined for other illness	2	3, 5	Pain (coxitis?) (1) Limited abduction (1)
	Total 20		

(2) Within 5 weeks of completion of plaster treatment
(3) The most recent survey 1–4.5 years after diagnosis.

At least two films were exposed on each of these occasions:

(1) One a.p. view of the hip joints with the legs extended and rotated slightly inward.
(2) One a.p. view with the legs extended, abducted at least 45° and rotated maximally outward (Lauenstein's position).

At the first examination, a test of stability was also introduced, in which the legs were extended, rotated inward, and pressed axially.

Arthrography. Arthrography was done at an early stage in all the children. In the first three children only the unstable hip was examined. Thereafter a bilateral hip joint examination was always undertaken, even in unilateral instability, as was done by Severin (1941) and others.

Thirteen children were examined with a repeated arthrography after the completion of the plaster treatment, thereof 12 bilaterally. Nine were examined within 2 weeks, the other four within 8 months of the completion of the plaster treatment.

Standardized projections were used with the children always supine, with the legs symmetrically in different positions. One film was always taken with the legs extended, rotated slightly inward and pressed in an axial direction. This examination technique will be described in detail in a subsequent paper.

A total of 62 arthrographies have been done, all of acceptable quality. The children were examined under general anaesthesia without complications. The criteria suggested by Severin (1941) for a normal arthrogram have been used in assessing our material.

Treatment

In cases where there was little or no limitation in abduction, arthrography was done soon after admission. In 11 hips with a limitation of abduction of more than 20°, traction treatment for 5–25 days was given before arthrography was done. Radiological and clinical findings at arthrography, which was performed under general anaesthesia, decided further treatment. In 19 out of 21 unstable hips reduction was successful and the legs were fixed in a symmetrical hip cast, mostly while under the same anaesthesia. In the oldest bilateral case, repeated attempts at reduction were required before an acceptable position could be attained. If the limitation of abduction remained after reduction, adductor tenotomy was carried out (Table 2).

Table 2. Treatment before plaster in 21 unstable hips (20 cases)

Age at diagnosis (months)	<12	>12
Traction/tenotomy	9	4
No treatment	7	1

In 17 out of 20 cases the position of treatment was 90° flexion and 70–80° abduction (so-called frog position). In the three remaining cases, maximal congruency in the joint was attained by 45° abduction and 20–30° inward rotation. This position was used for the initial fixation. Later during the treatment, two of these cases could be fixed in the frog position, when the limitation in abduction had disappeared.

Plaster casts were changed every 4 weeks. The length of treatment in plaster was, in the younger age group, 13–27 weeks, in the older group 25–29 weeks.

After the period in plaster, treatment was continued with an abduction brace and the children have been followed for at least 1 year after diagnosis.

RESULTS

Clinical findings at diagnosis

At the maternity clinic. The paediatrician noted a positive Ortolani or laxity in four of the children during the first examination. Three of these were immediately referred for orthopaedic examination, and were at that time considered to have stable hip joints. No treatment was started, but continued check-ups at the orthopaedic clinic were considered necessary (Table 1:1). The fourth case was examined again by a paediatrician 2 and 5 days later, and was then considered to have stable hip joints. (This girl was later referred at the age of 4 months by the Child Care Centre with an abduction limitation, at which time a diagnosis of instability was made.)

At the Child Care Centres. Abnormality in the hip was found in 15 cases, including the child mentioned above. In general it was the limitation in abduction (sometimes combined with leg shortening) which led to a

Table 3. Clinical findings at diagnosis in 21 unstable hips (20 cases)

Age at diagnosis (months)	<12	>12	
	No.	No.	Total
Unstable hips	16	5	21
Findings			
Limited abduction	14	5	19
Leg shortening	10	4	14
Asymmetrical thigh crease	5	2	7
Positive Ortolani	5	0	5
Limp or other abnormal walk	—	5	5

referral, but other reasons were also given (Table 1:2).

In six of these cases the parents suspected an abnormal condition of the leg (Table 1:2). The four oldest of these children (8, 17, 19, 21 months respectively) had been seen earlier at the Child Care Centre without abnormal findings.

In two children hip abnormality was accidentally found during examination for another illness (Table 1:3).

At the orthopaedic clinic. There was a family history of hip joint instability in three cases. In 14 cases the left hip joint was affected, in 5 cases the right. One girl had a bilateral instability. (For other clinical findings, see Table 3.)

The five hips with positive Ortolani in the younger age group could be reduced without prior treatment. Two of these had no restriction in abduction, which, however, was found in the other three and remained even after reduction. All the other cases also had restricted abduction and could not be reduced.

Radiological findings at diagnosis

Survey films of the hip joint showed a cranial displacement of the femur in all cases. In all cases but one there was a retarded ossification laterally in the iliac bone, which gave the acetabular roof a steeper appearance (Figure 1a). In the younger age group (16 cases), the epiphyseal nuclei were not visible bilaterally in seven, they were of the same size in four, and smaller on the unstable side in five.

In the older age group the epiphyseal nuclei were always smaller on the unstable side. In the bilateral case, both epiphyses were smaller than normal at that age.

Arthrography. In all cases, the femoral head either spontaneously or by force was displaced cranially and laterally. Maximal cranial displacement appeared either with the leg abducted about 45° and rotated outward, or rotated inward under axial pressure (Figures 2a, 3a and 4). It was generally less than 5 mm in the younger age group, and more than 5 mm in the older group.

The shape of the femoral head differed from normal in 16 of the 21 unstable hips. There was a variable degree of deformation, from a slight flattening in the younger children (Figure 2a) to an obviously oval shape in the older children (Figures 3a and 4).

The cranial part of the labrum acetabulare was always deformed (Figure 2) and sometimes difficult to define (Figures 3a and 4).

The joint capsule was widened in all cases (Figures 2, 3a and 4).

In general a good reduction could be achieved (Figure 2b). In the oldest case with bilateral displacement, no reduction could be attained in connection with the arthrography. The reason for this was considered to be a residual limitation of abduction, and not an intracapsular obstruction.

Clinical findings after plaster treatment

At the completion of plaster treatment, all the hips were clinically stable. No restriction in abduction remained.

In Figure 5 the length of plaster treatment in this series is shown. The length of the treatment has differed greatly in the children aged under 6 months. One girl diagnosed at 5 months of age was treated in plaster for 13 weeks, the shortest period of treatment in the series. Two months later, a slight instability

Figure 1a. 5-month-old girl. Before treatment. Arrows (↑) indicate axial pressure on the legs. Left hip joint unstable with retarded skeletal development of the acetabulum laterally in the iliac bone. Femoral head bone nuclei missing bilaterally.

Figure 1b. Same girl 9 months old. After 14 weeks treatment in plaster for left hip instability. No displacement. The bone nucleus in the femoral head is small. An irregular ossification margin is visible in the iliac bone.

Figure 1c. Same girl 22 months old. No displacement. Bone nucleus in the left femoral head still smaller than the right. Skeletal development of the acetabulum normal.

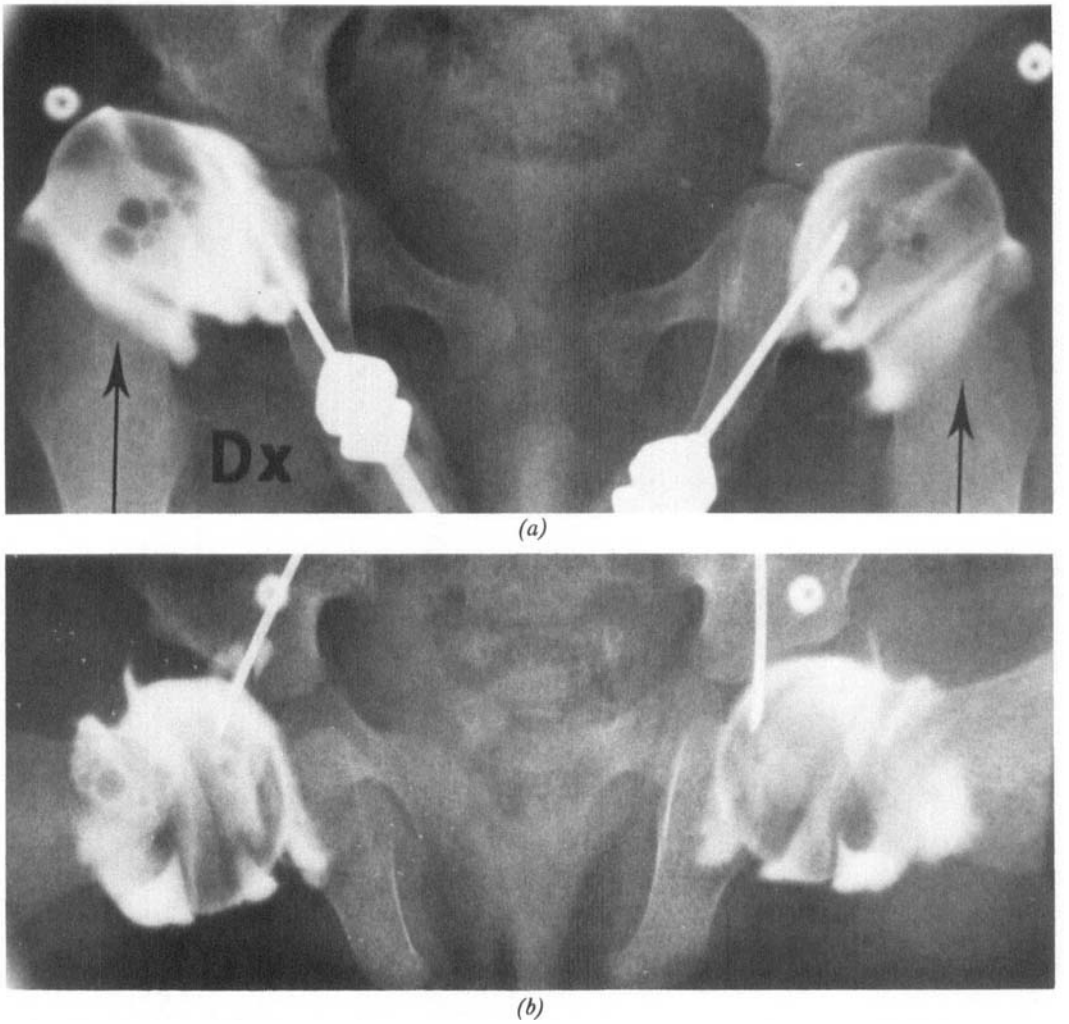

Figure 2. Bilateral arthrography. 4-month-old girl after 2 weeks traction. Right hip instability.
(a) Arrows (↑) indicate axial pressure on the legs. Max. displacement. Right femoral head slightly deformed cranially and medially. Labrum acetabulare pushed cranially. Wide joint. (Air bubbles in the joints accidentally. Metal indicators for stereoradiographic assessment.)
(b) An excellent reduction in frog position.

during outward rotation could be demonstrated. Treatment in an abduction brace was therefore extended to 8 months, following which arthrography showed a normal joint. Continued observation over a period of 16 months has shown the hip to remain normal.

The children have been followed for 1–4.5 years, 11 of them for at least 3 years after diagnosis. All the hips were clinically stable at the most recent check-up with a normal range of movement. No subjective problems have been reported. No limp has been observed.

Radiological findings after plaster treatment

Arthrography showed no cranial displacement of the femoral head, even during axial pressure on the legs, in 10 out of 14 examined hips. In four hips (the three oldest cases) the femoral head could be displaced cranially a maximum of 5 mm.

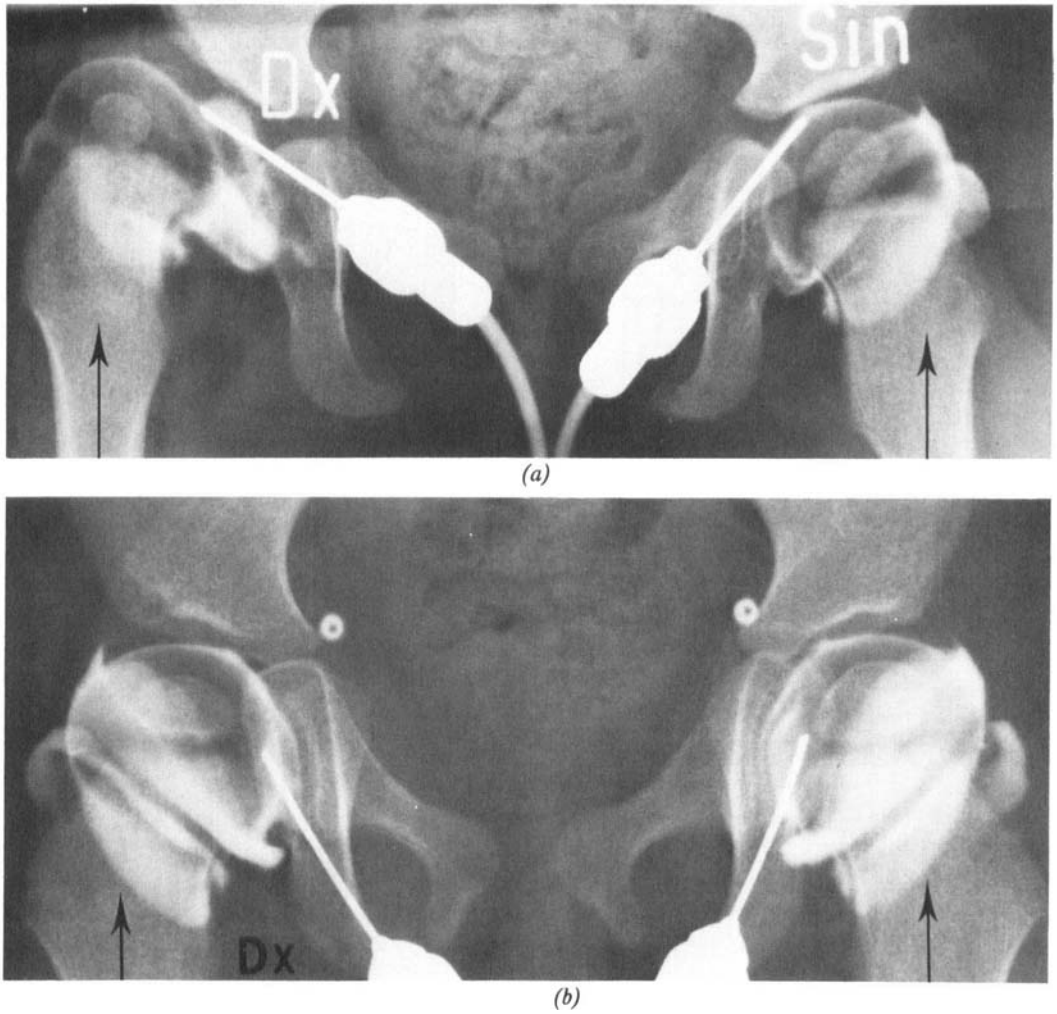

Figure 3. Bilateral arthrography. Instability of the right hip joint diagnosed at 13 months of age.
(a) Before treatment. Arrows (↑) indicate axial pressure on the legs. The femoral head is deformed in its cranial and medial aspects. The cranial part of the labrum acetabulare is not visible.
(b) Same girl 2 years old. After treatment in plaster for 26 weeks. Arrows (↑) as in Figure 3a. Stable. No femoral head deformity. Labrum acetabulare in normal position. (Metal indicators as in Figure 2.)

Widening of the capsule remained in 10 hips, but was less extensive than at the first arthrography. In these hips, the femoral head could be displaced laterally 1–5 mm, but only in abduction and outward rotation.

In four hips, the femoral head was normal in shape at this examination, as at the arthrography before treatment. In the other 10, the deformation of the femoral head was less pronounced (Figure 3b), but it could still be seen in eight hips.

The labrum acetabulare had a normal position in 10 hips. In the three oldest cases, it was still deformed.

On survey films at the end of plaster treatment, retarded skeletal development was still seen in the previously unstable hip joint. This was most marked in the cases which were diagnosed late. In one case, no femoral head nuclei could be found bilaterally at the age of 8 months. In all the other cases, the

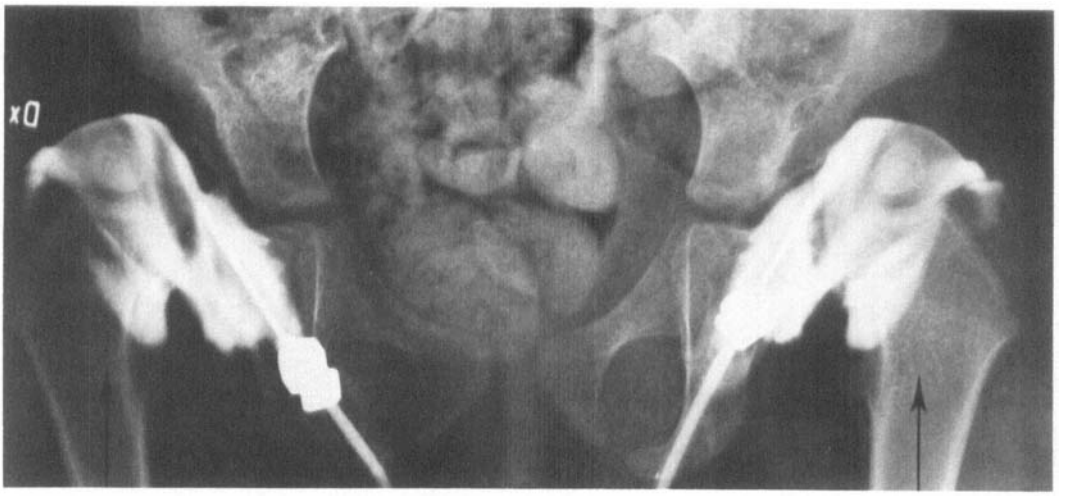

Figure 4. Bilateral arthrography. The oldest girl, 21 months, after 10 days traction. Bilateral hip instability. Arrows (↑) indicate axial pressure on the legs. Pronounced displacement bilaterally. Femoral head clearly deformed bilaterally. Labrum acetabulare cannot be distinguished on either side. Wide joints.

epiphyseal nucleus was clearly smaller on the previously unstable side (Figure 1b). In one case this was combined with an irregular and flattened epiphyseal nucleus as well as an irregularity in the metaphyseal bone. Only in one case had the acetabulum become completely normal. In the others, the previously demonstrated lateral defect was completely or partially filled; instead, the ossification margin in the iliac bone was more or less irregular (Figure 1b).

During the first year after plaster treatment skeletal changes of the avascular necrosis type appeared in one more case, about 12 months after the plaster treatment.

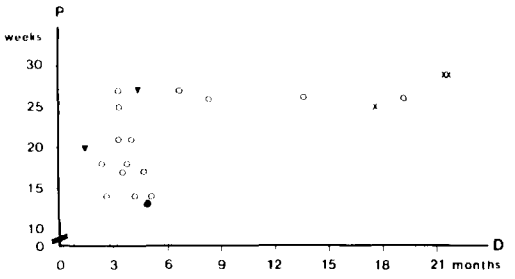

Figure 5. Age at diagnosis (D) in relation to the length of treatment in plaster (P)
Symbols: ○—satisfactory result of treatment
●—relapse of instability
▼—avascular necrosis of the femoral head
×—highly retarded ossification in the iliac bone.

Radiological findings at the most recent examination. One to 4.5 years after diagnosis, a situation of continuing favourable skeletal development was noted in 17 out of the 21 previously unstable hip joints, but only two of the girls had completely normal radiographs. The other 14 hips still showed a slightly irregular ossification margin in the iliac bone and/or a smaller head nucleus than on the other side (Figure 1c).

One of the girls with avascular necrosis has only insignificant skeletal changes after 4 years of observation. Four hips were marked by a less favourable skeletal development (Table 4); they are the other hip with avascular necrosis and three hips in which the mineralization of the acetabulum has been severely retarded (Figure 6).

DISCUSSION

As was noted in the introduction von Rosen and colleagues in Malmö (southern Sweden) have made great progress in neonatal

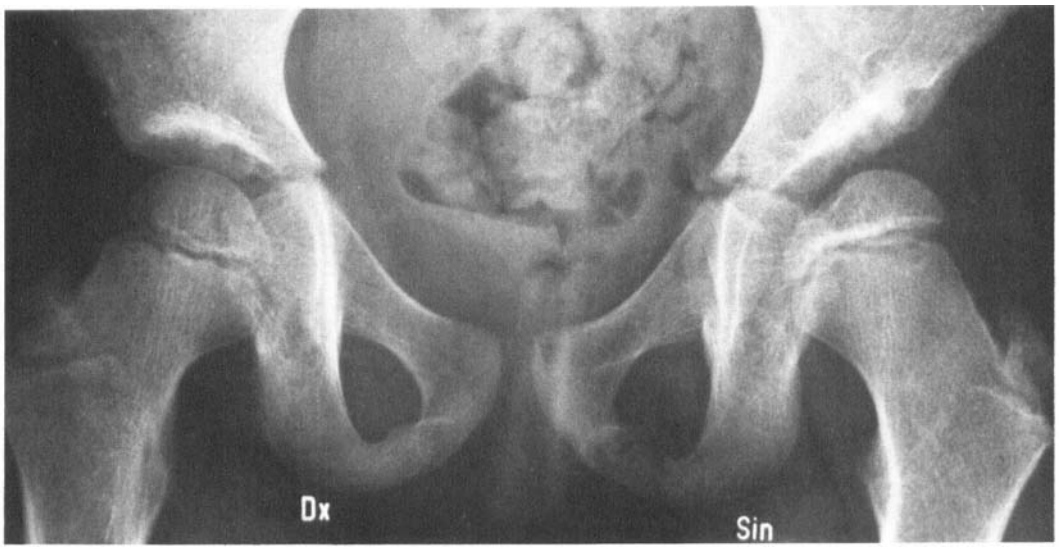

Figure 6. Girl, now 5 years and 2 months old. At diagnosis, 17 months old, left hip joint instability. After 3 weeks traction, tenotomy and 26 weeks in plaster, stable hip joint. Highly retarded ossification in the left iliac bone. The left bone nucleus of the femoral head is smaller and lies a few millimetres further cranially than the right one.

diagnostics. Practically all cases are diagnosed during the neonatal period. This goal has, however, not been achieved in the rest of Sweden. Reports from other countries also show difficulties in connection with neonatal diagnostics (Williamson 1972, MacKenzie 1972, Bjerkreim 1974, Nielsen 1975). At the neonatal examination, a variety of clinical instability tests are made (e.g., Ortolani, Barlow or Palmén). The problem with these tests is that they sometimes show variable results. This is demonstrated by four cases in this material, which were found to have unstable hips at the maternity clinic. This could only be verified by the orthopaedic surgeon after several examinations. Clinically and radiologically, these cases did not, however, differ from the others in the series once the diagnosis was made. Thus it is probable that the other hips also were unstable at birth, but that they were not discovered at this time.

After the neonatal period, the instability is often masked by contractures of the adductor muscle group of the hip. Because of this, the simple instability tests are either difficult or impossible to carry out. Limitation of abduction thus becomes the most common clinical sign (Table 3). This can, however, appear without concurrent instability. Radiographs of the hips are then necessary. Delayed mineralization of the acetabulum can be seen quite early in the lateral part of the iliac bone,

Table 4. Four hips (3 patients) with obvious skeletal changes at the final radiological examination

Age at diagnosis (months)	Obs. time after diagnosis (years)	Slight incorr. femoral head nucleus position	Structural changes			Cause
			Caput	Metaphysis	Acetabulum	
4	3.5	+	+	+	–	Avascular necrosis
17	3.5	+	–	–	+	Late diagnosis
21 (bilat.)	1.5	+	+	–	+	Late diagnosis
		+	+	–	+	Late diagnosis

whereas the skeletal development of the femoral head can be difficult to judge before the age of 6 months. Cranial displacement of the shaft of the femur is also evidence of an unstable joint, but for definite proof, one generally needs an examination under general anaesthesia and an arthrography.

The most extensive information on the radiological anatomy of the hip joint is obtained through arthrography. Both the normal and the unstable hips of children were described in detail by Faber (1938) and Severin (1941). Because of late diagnosis, the children were usually more than 1 year old when the arthrography was done. In recent times arthrography has been used on younger children, and has been found to be a valuable examination, which does not entail any great risks (among others Mitchell 1963, Motta 1965, Astley 1967, Nakamura 1968, Felländer et al. 1970 and Grech 1972).

In the arthrographies which we did after measures were taken against the more extreme contractures, instability could be verified in all cases. Since the arthrography was almost always done bilaterally, the stable hip served as a control. Some of the arthrographies also showed that even slight remaining adductor contractures prevented good congruency in the joint. This further emphasizes the importance of taking care of this problem by appropriate means (traction, tenotomy and choice of position) before starting immobilization treatment. When arthrographies were done after plaster treatment, it was sometimes found that slight instability remained despite the fact that the hips felt stable at the clinical examination. Most of the hips did in fact already feel stable when the plaster was changed after the first 4 weeks. The deformation of the femoral head which was found in a surprisingly large number of cases (16 out of 21) at the first arthrography had definitely decreased after treatment. This indicates that these changes are reversible and that the deformation of the femoral head is a secondary development in an unstable joint.

For newborns, the length of the abduction treatment is generally 3 months (von Rosen 1968). Information in the literature concerning fixation time for children diagnosed after the neonatal period, but before the age of 1 year, is scarce.

In our series, the length of treatment has differed greatly in children aged up to 6 months (Figure 5). Initially we treated all patients for about 6 months in plaster, but with more experience there was a tendency to shorten the periods of treatment in the younger patients to about 4 months (14–18 weeks). As can be seen in Figure 5 satisfactory results have been obtained even in these cases.

For children 1 to 2 years at diagnosis, Severin (1941) and Laurent (1953), among others, have recommended a fixation time of 4 to 6 months. According to Salter (1966) the ability of the acetabulum to develop normally decreases after the age of 18 months. His view is supported in our series by findings in three of the four hips that were diagnosed at about that age. After about 6 months treatment in plaster they were clinically stable, but arthrography showed a slight residual instability. A longer period of treatment was considered but judged unwarranted for other reasons (hip stiffness, muscular atrophy). They are still stable but have an obvious defect in mineralization in the acetabulum which may be permanent. This may necessitate operative procedures in the future.

CONCLUSIONS

From a consecutive series of 20 cases with idiopathic hip instability diagnosed after the neonatal period and verified by arthrography the following conclusions have been drawn:

1. The majority of the hip joints did not show instability at the examination(s) at the Maternity Clinic.
2. Through examinations at the Child Care Centres most cases could be detected before the age of 1 year.

3. Restriction of abduction was the most important clinical sign between the neonatal period and the walking age.
4. When a fixed abduction was found, clinical instability could at times only be demonstrated under general anaesthesia after a short period of traction.
5. Even in the youngest cases retarded skeletal development of the acetabulum could be demonstrated.
6. Arthrography is a valuable tool for the verification of hip joint instability, and for finding the optimal position after reduction.
7. The contractures of the hip adductors had to be treated before a good congruency of the joint could be attained.
8. Treatment in plaster for up to 29 weeks with a change of cast every 4 weeks has been used without great difficulty, and has led to clinically stable hips and a normal gait in all the children.
9. With a diagnosis made before walking age, most cases showed good skeletal development of the hip, but avascular necrosis of the femoral head was found in two cases.
10. In cases diagnosed after the walking age, radiographs after treatment showed a delayed skeletal development of the acetabulum in certain cases. Arthrography indicated a slight residual instability in these hips although they were clinically stable. This may necessitate operative procedures in the future.

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