

NEONATAL HIP INSTABILITY

Reason for Failure of Early Abduction Treatment

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A series of nine children with hip joint instability in 17 hips, diagnosed neonatally, is presented. Seven had bilateral idiopathic instability and two instability secondary to arthrogryposis, one of them bilateral. After reduction seven of the children (14 hips) were treated with abduction devices, which in all cases did not lead to stability in one or both hips. In these cases arthrography revealed that closed reduction was impossible due to narrowing of the joint capsule (hour-glass shape) and the interposition of a capsular fold including the acetabular labrum. The same types of changes were seen within 1 or 2 months after birth in three hips which had had no abduction treatment before arthrography. At open reduction of 11 hips it was found that the narrowing of the capsule was caused by the tendons of the iliopsoas and rectus femoris muscles. Excision of the capsular fold (labrum) was not necessary. The femoral head was deformed and anteverted.

Failure of conservative treatment can be due either to incomplete reduction or to inadequate immobilization. Our analysis has shown that the most probable reason is incomplete reduction due to interposition.

An obstacle to reduction should be suspected if abduction is restricted at birth, if primary reduction is difficult and the position difficult to maintain or if instability persists after 8 weeks of treatment.

On the basis of our material the incidence of such an impediment to reduction was 0.08 per thousand births in the region studied during a 5-year period.

Key words: neonatal hip instability; failure of abduction treatment; open reduction; arthrography; CDH

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Over the last 25 years in Scandinavia, neonatally diagnosed hip joint instability has been treated with a von Rosen splint or an abduction pillow, or other similar methods. This treatment has been so successful (Palmén 1961, Emnéus 1966, Hierton & James 1968, von Rosen 1970, Hirsch & Scheller 1970, Bjerkreim 1974, Nielsen 1975, Fredensborg 1975, Almby & Rehnberg 1977) that open reduction of congenital dislocation

of the hip has been necessary only in exceptional cases.

Even if those cases requiring surgical treatment are few in number, they are nevertheless of great interest both in principle and from a practical point of view. The principal question to be answered is whether failure of abduction treatment is due to:

(a) interposition making primary closed reduction impossible; or to

Table 1. Nine children with neonatal hip instability. Heredity and observations during pregnancy and delivery

No.	Initials and year of birth	Sex	Hip disorder in family	Mother's age	Pregnancy		Delivery	
					Order of pregnancy	Comments	Position/Presentation	Comments
1	KJ-73	M	Twin (girl) unstable left hip	34	4	Oedema of pregnancy	Vertex	Duplex
2	VL-73	F	—	26	1	Normal	Breech	—
3	JN-74	F	—	26	3	Bleeding during 1st trimester Progesterone-treatment	Vertex	Rupture of uterine cervix
4	LL-74	F	—	23	1	Normal	Breech/Caesarean section	—
5	VR-74	F	Older sister with unstable hips	39	4	Normal	Breech	—
6	SR-75	F	—	20	1	Normal	Vertex	—
7	AO-76	M	—	23	1	Normal	Vertex	—
8	VV-72	F	—	33	1	Goitre Levaxin 0.1 g/di	Breech/Caesarean section	—
9	ÅH-74	F	—	29	2	Normal	Breech	Intrauterine asphyxia

(b) redislocation occurring during or after treatment due to inadequate immobilization or too short an immobilization time.

The aim of this study was to shed light on these questions on the basis of clinical and arthrographic findings, and also with the aid of patho-anatomical observations made at open reduction. Furthermore, a comparison is made between preoperative arthrograms and anatomical findings at operation. The findings in idiopathic and arthrogryptic hip dislocations are also compared.

Definitions

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

Acetabular dysplasia. Abnormal ossification of the iliac bone (roof of the acetabulum) observed on plain radiographs of the hip. The chondral part of the acetabulum may show a normal or abnormal shape at arthrography.

Neonatal period. The first month of life.

PATIENTS AND METHODS

The material consisted of seven children with bilateral idiopathic instability of the hip joint and two children with hip dislocation associated with arthrogryposis, one of them bilateral. The children were born in the period 1972–1976 within a region with a population of about 1.5 million. During this time about 90,000 children were born within the region.

Data concerning the heredity, pregnancies and deliveries are given in Table 1.

Of the seven children with idiopathic instability, two were breech deliveries and one was delivered by Caesarean section because of breech position. In two of these cases radiographs, taken 24 and 16 days, respectively, before birth, were available. On these it was seen that the fetuses lay with greatly flexed hips with the legs pointing upwards and the knees almost fully extended (Figure 1).

All patients were examined clinically and many of them also radiographically with respect to hip instability within the first week of life. The



Figure 1. A fetus (case 2) in breech position, with the back to the right. Plain radiograph 24 days before delivery. The hip joints are hyperflexed but there is only slight flexion of the knee joints. No evaluation of a possible deformity of the hip joints can be made from this film.

The child was born with a breech presentation. On clinical examination on the second day of life bilateral hip instability was observed.

findings at these examinations are presented in Table 2.

Since 1972 arthrography has been performed routinely in our hospital in all cases of hip instability persisting after the neonatal period.

The treatment of the children after diagnosis at their respective hospitals and before referral to this hospital is given in Table 3. In only one of the seven cases with idiopathic instability (No. 4) was interposition suspected primarily, and this was confirmed by arthrography at an early stage (Figure 2 a and b). In two other cases (Nos. 6 and 7) interposition was suspected, as the hip instability persisted after 1 to 2 months of abduction. In the other four cases hip instability still persisted after 1.5 to 3 months of treatment with an abduction pillow or splint, but an obstacle to reduction was not suspected and therefore closed reduction was again performed and the hip was immobilized in plaster.

One of the two children (case 8) with arthrogryposis was treated with a von Rosen splint and hip spica for a total of 4 months,

Table 2. Nine children with neonatal hip instability. Clinical and radiological findings during first week of life

No.	Initials and year of birth	Sex	Findings at clinical examination		Retrospective evaluation of the radiograms
			General	Hips	
1	KJ-73	M	—	Bilat. instability	No examination
2	VL-73	F	—	Bilat. instability	No examination
3	JN-74	F	—	Bilat. instability	Bilat. displacement
4	LL-74	F	Overstretched knees	Bilat. restricted abd.	Bilat. displacement
5	VR-74	F	—	Left instability	No examination
6	SR-75	F	—	Bilat. instability	Bilat. displacement
7	AO-76	M	VOC (ASD). Aplasia 4th dig. left hand	Bilat. instability	No examination
8	VV-72	F	Arthrogryposis. Pes equinovarus. Fract. of left femur	Bilat. instability	Bilat. displacement Fract. of left femur
9	ÅH-74	F	Arthrogryposis	Bilat. fixed flexion	Right: Displacement Left: Normal

followed by another reduction with immobilization in plaster for a long period (Table 3). In the other child, with unilateral dislocation, no treatment was given until open reduction was performed at the age of 2 months.

Results of the primary treatment. The child with a primarily suspected reduction impediment (case 4)

was referred for investigation and operation after an unsuccessful attempt at reduction.

In five cases (Nos. 1, 2, 3, 6 and 7) the abduction treatment resulted in stability in one hip but not in the other. In one case (No. 5) the treatment failed in both hips (Table 3).

Thus in seven children with idiopathic instability (out of about 90,000 births) the primary treatment failed. This number corresponds to 0.08 per thousand of all children born in this region in the period in question.



Figure 2. (a) Radiograph of a 3-day-old girl (case 4) delivered by Caesarian section because of breech position, which had been confirmed at plain X-ray 16 days before delivery. Marked cranial and lateral displacement of the femur are seen bilaterally indicating hip dislocation. On clinical examination at the same time bilateral restriction of hip abduction and extension contracture in the knee joints were noted.

(b) Bilateral hip joint arthrography on the same girl at 1 month of age. No treatment had been given before the arthrography, apart from an unsuccessful attempt at closed reduction after bilateral adductor tenotomy. The arthrogram shows bilateral dislocation with marked narrowing of the joint capsule. A capsular fold is clearly seen, especially on the right side. These findings were apparent in all projections.

Table 3. Nine children with neonatal hip instability. Treatment, clinical and radiological findings up to the time of referral

No.	Initials and year of birth	Sex	Treatment until first X-ray check-up	Retrospective evaluation of first X-ray check-up	Continued treatment before referral	Findings at time of referral
1	KJ -73	M	Pillow 1.5 months	Displacement right	Reduction + plaster 2.5 months	Unstable right
2	YL -73	F	Pillow 3 months	Displacement bilat.	Reduction + plaster (left open reduction) 27 months	Unstable right
3	JN -74	F	Pillow + splint 1.5 months	Displacement right	Reduction + plaster 7.5 months	Unstable right
4	LL -74	F	Failure of reduction after adductor tenotomy 3 months	Displacement bilat.	Referred	Unstable bilat.
5	VR -74	F	Pillow 3 months	Displacement bilat.	Reduction + plaster 6 months	Unstable bilat.
6	SR -75	F	Splint 1 month	Displacement right	Reduction + plaster 1 month	Unstable right
7	AO -76	M	Splint 1.5 months	Displacement right	Referred	Unstable right
8	VV -72	F	Plaster 1 month	Displacement left (not diagnosed primarily)	Splint Reduction + plaster 3 months 23 months	Unstable left
9	AH -74	F	No treatment 1.5 months	Displacement right	Referred	Unstable right

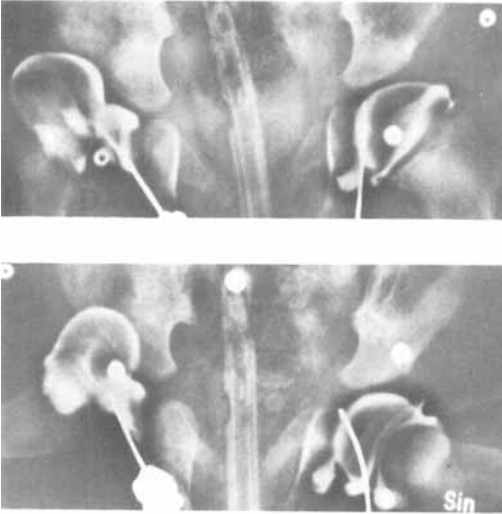


Figure 3. Arthrograms of a 2-month-old boy (case 7). Bilateral hip instability was noted at delivery. After abduction treatment for 1.5 months, the right hip was still unstable.

(a) the legs in neutral position

(b) the hips flexed and abducted about 90°

(c) the right hip abducted 45° and rotated outwards.

In the right hip the femoral head is deformed and is constantly dislocated. The capsule is narrowed between the femoral head and the acetabulum (hour-glass shaped), which is apparent in all projections. On the right side the head and neck of the femur are clearly anteverted.

On the left side the arthrogram is normal.

(Plastic tube in the rectum for dosimetry. Metal indicators for stereoradiographic assessment).

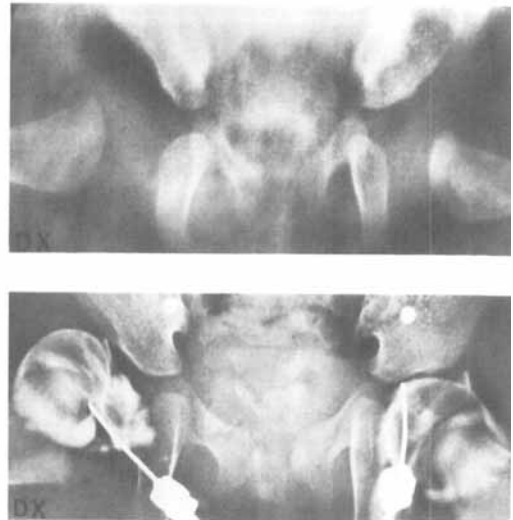


Figure 4. A girl (case 3).

(a) Tomogram during treatment with immobilization in the frog position at the age of 2.5 months. The right femoral shaft is displaced laterally and cranially, indicating dislocation with marked acetabular dysplasia. The left femur is correctly oriented.

(b) Arthrography at the age of 10 months after 7 months of conservative treatment. The same projection as in Figure 4a. The right femoral head is still dislocated and deformed. The capsule is narrowed, which will impede reduction. The size and shape of the chondral part of the acetabulum cannot be judged satisfactorily.

The left hip joint appears normal. (Metal indicators as in Figure 3).

In the child with arthrogryposis treated with abduction (case 8), this led to stability of one hip but not of the other (Figure 5).

Reasons for failure of abduction treatment. Of the six children with idiopathic instability in whom abduction treatment was initiated, it was noted in three cases that one hip was difficult to reduce or to retain in the reduced position (cases 3, 6 and 7 in Table 3). Two of these showed a reduction impediment in the hip in question at arthrography at the age of 2 months (cases 6 and 7) as shown in Figure 3, and the third at arthrography at 10 months (case 3). Retrospective evaluation of radiographs taken in the other three idiopathic cases showed that in two of these cases the femoral head was not in the correct position during the treatment. The femoral head was oriented towards

Table 4. Nine children with neonatal instability. Age at arthrography and open reduction, operated side and treatment after open reduction

No.	Initials of birth	Sex	Age in months at arthrography	Age in months at open reduction + operated side	Months in plaster after open reduction	Femoral rotational osteotomy	Pelvic osteotomy (Salter)	Results
1	KJ-73	M	4.5	5 right hip	7	yes	no	Stable
2	VL-73	F	31	37 right hip	7	no	yes	Stable
3	JN-74	F	10	11 right hip	4	yes	no	Stable
4	LL-74	F	1	1 bilat.	6	yes bilat.	no	Stable
5	VR-74	F	8	9 bilat.	12	yes bilat.	yes bilat.	Dislocated right Subluxated left
6	SR-75	F	2	2 right hip	6	yes	yes	Stable
7	AO-76	M	2	2 right hip	6	no	no	Stable
8	VV-72	F	26	27 left hip	3.5	yes	no	Dislocated
9	AH-74	F	—	2 right hip	2.5	no	no	Plaster treatment stopped because of pulmonary compl. Dislocated

the upper part of the acetabulum and located more laterally than normal (Figure 4a), indicating interposition. In the third case (No. 2) the femoral head might have been reduced successfully but redislocation occurred when the legs were extended.

Further investigation and treatment. The nine patients were referred to the University Hospital in Uppsala, for clinical and arthrographic examination, eight of them because treatment had failed and one (case 9) without previous treatment.

Arthrography

Bilateral arthrography was performed pre-operatively in all cases except one. Details of age at arthrography are given in Table 4. The examination was carried out under general anaesthesia and with a standardized technique (Lönnérholm, to be published). Films were taken in the frontal projection with the legs in a neutral position, in abduction, in flexion + abduction and during attempts at provocation and reduction. This examination in different positions showed whether any capsular narrowing was constant or not. The size and shape of the femoral head, the acetabulum and the ligamentum capitis femoris were evaluated. Pairs of stereo films were always included in order to see whether the femoral head was displaced anteriorly or posteriorly. The arthrographic criteria for a reduction impediment were:

- (a) constant capsular narrowing with a diameter clearly smaller than that of the femoral head; and
- (b) a capsular fold or labrum which became interposed during an attempt at reduction.

Results of arthrography

The case with primarily diagnosed irreducible dislocation was confirmed at arthrography (Figure 2b). In the other six idiopathic cases with bilateral hip instability, seven hips showed persistent dislocation and constant narrowing of the joint capsule which impeded reduction (Figures 3 and 4b). In addition the femoral head was deformed. The other five hips were stable and the shape of their femoral heads normal.

One of the children with arthrogryposis underwent arthrography. This revealed unilateral dislocation, narrowing of the capsule and femoral head deformation of the same kind as in the idiopathic cases (Figure 5).



Figure 5. Arthrogram of a 26-month-old girl with arthrogryposis (case 8). Delivered by Caesarean section because of breech position. Bilateral hip instability was noted at delivery and treated conservatively. At the time of arthrography the left hip was dislocated and the right hip stable.

Left: The small, deformed femoral head is dislocated cranially. The capsule between the femoral head and acetabulum is narrowed. The acetabulum is only partly contrast-filled.

Right: The femoral head is deformed but lies centrally in the joint. The acetabular labrum is clearly visible. (Metal indicators as in Figure 3).

Operative treatment

Open reduction was considered indicated when arthrography showed that closed reduction was impossible according to the above criteria.

Open reduction was performed on 11 hips with irreducible dislocation (9 patients). An incision was made from the middle of the iliac crest to the antero-superior iliac spine and then in a curve down towards the anterior aspect of the thigh. The attachments of the gluteus medius and the tensor fascia lata were freed and retracted. The rectus femoris tendon was divided at its acetabular origin, and then at the site of departure of the portion of the anterior inferior iliac spine. The psoas tendon was divided in a Z-shaped fashion; the capsule was then opened laterally over the femoral head and was divided in the medial direction down to the distal rim of the acetabulum (Figure 6). The loose soft tissue contained in the acetabulum was removed. The ligamentum capitis femoris was excised in cases where this comprised an obstacle to reduction. Reduction was performed. On account of the marked anteversion of the femoral head, reduction could only be achieved by strong inward rotation of the femur. The joint capsule was sutured. The psoas and rectus femoris tendons were sutured with elongation and thus without stretching. After insertion of a tube for vacuum drainage and closure of the wound, a hip spica was applied with

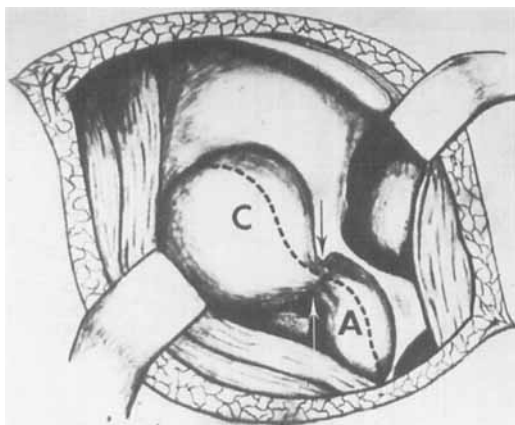


Figure 6. Schematic drawing of the capsule with its isthmus. The dotted line indicates the line of incision.

The black arrow shows the capsular indentation caused by the acetabular part of the rectus femoris. The white arrow shows the indentation caused by the tendon of the iliopsoas muscle.

A = Acetabulum

C = Femoral head

the legs in 25° flexion and 30° abduction, and with inward rotation of the treated hip.

Rotation osteotomy. In eight hips an intertrochanteric rotation osteotomy of the femur was performed about 6 weeks after the open reduction. Fixation was achieved either by Schantz's screws and external fixation or by internal fixation with a small angled plate.

Salter pelvic osteotomy. This was done in one case in connection with the open reduction (case 2). In two cases (3 hips; Nos. 5 and 6) the pelvic osteotomy was performed 16–18 months after open reduction because of persistent dysplasia and subluxation.

The total duration of immobilization in plaster after the open reduction is given in Table 4. The mean duration was 6 months.

Results of operative treatment

The present observation time of 6 months–3 years after completion of treatment is too short to allow any definite conclusions to be drawn.

In the seven patients with idiopathic hip dislocation open reduction was performed in nine hips with, in some cases, further surgical treat-

ment. Of these, seven are clinically stable (Table 4).

In the two patients with arthrogyposis open reduction was performed on the two dislocated hips. In both cases re-dislocation occurred later.

Operation findings in relation to arthrographic findings

All arthrographies in cases with clinical instability revealed narrowing of the joint capsule between the femoral head and acetabulum. The diameter of the isthmus was clearly smaller than that of the femoral head (Figure 3a–c), according to the criteria given above. This was confirmed at operation, and reduction was not possible until the capsule had been divided along its entire length (Figure 6). The narrowing was mainly due to compression of the capsule from the outside by the psoas tendon and by the acetabular part of the rectus femoris tendon (Figure 6). The components of the interposed tissue, i.e. the capsular fold and the labrum, could not be differentiated at arthrography (Figures 2b, 3, 4b, 5). This was also impossible at operation (Figure 7).

The ligamentum capitis femoris was always found at operation to be lengthened but sometimes it was very thin, and sometimes rather thick. A long, thick ligament may become interposed on reduction of the joint and therefore has to be excised. At arthrography it was often difficult to decide whether the ligament was thin or thick. As the capsular narrowing in itself constituted an impediment to reduction, it was also impossible to determine arthrographically how much of the ligament might be interposed at reduction. This evaluation could only be made at operation.

The femoral head was invariably deformed and was often egg-shaped with a larger diameter proximo-distally than ventro-dorsally. The arthrographic and surgical findings corresponded entirely.

The size and shape of the acetabulum could not be determined satisfactorily at arthrography. This was due to the fact that the aceta-

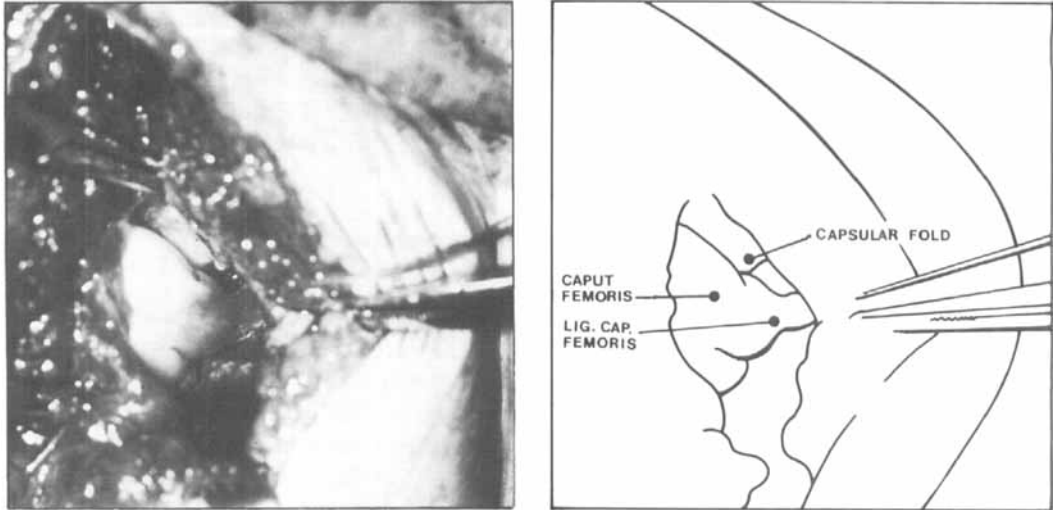


Figure 7. Photo and schematic drawing from case 3. The capsule has been opened and is held by clamps. Note the capsular fold including the labrum which is interposed between the femoral head and the acetabulum.

bulum was filled to a varying degree with loose, fatty tissue. Not until this had been carefully dissected away at operation could the acetabulum be examined more closely.

The observations at arthrography and at operation concerning the femoral head, the joint capsule and the acetabulum were the same in the arthrogryposis cases as in those with idiopathic instability.

DISCUSSION

Failure of abduction treatment despite an early diagnosis and prompt initiation of therapy can be due to:

- (a) interposition preventing complete reduction of the femoral head; or
- (b) redislocation of the femoral head because the immobilization time has been too short or the fixation inadequate during the treatment period.

In one case of idiopathic hip instability interposition was diagnosed primarily and both arthrography and the findings at operation showed that closed reduction was not possible (Figure 2b). Thus all cases of

neonatal hip instability cannot be treated by closed reduction.

In the other six cases of bilateral idiopathic hip instability the abduction treatment was successful in five of the twelve hips. Concerning three of the seven dislocated hips it was stated primarily that they were difficult to reduce and dislocated easily. At arthrography and open reduction it was found that closed reduction would not have been possible. It is probable that a reduction impediment was present primarily in these cases also.

As regards the remaining four hips, several attempts at reduction had been made, the immobilization time had been between 4 and 30 months, and at retrospective evaluation of the radiographs it was found that the femoral head had never been completely reduced, except perhaps in one case (No. 2), where on one film it seemed that the reduction position had been attained. A primary obstacle to reduction in the form of interposition may also be suspected in these four cases, with the possible exception of the latter patient.

Our investigations have shown that an impediment to reduction must be strongly suspected in neonatal hip instability if:

- (1) abduction is already restricted at birth;
- (2) reduction of an unstable hip joint in a newborn infant is difficult and the reduced position is hard to maintain;
- (3) stability of the hip has not been achieved after 6 to 8 weeks of abduction treatment.

In all these cases, arthrography should be performed as soon as an obstacle to reduction is suspected, i.e. within 2 months at the latest. A delayed diagnosis means increased difficulty in attaining a good therapeutic result and unnecessary radiographic examinations during the early part of the treatment period. The agreement between arthrographic and operative findings was excellent. This was due largely to the fact that films were taken with the legs in various positions and during attempts at provocation and reduction.

Severin (1956) gives the incidence of hip joint dislocations in Sweden before the time of early diagnosis as 0.9 per thousand. This implies an expected figure of 12 cases of manifest dislocation out of 13,000 births, if the diagnosis is not made at an early stage and treatment initiated immediately. According to our results abduction treatment will fail and open reduction will be necessary in one case out of about 13,000 births, which may seem a high figure. According to Fredensborg (1975) no such cases were encountered among about 60,000 children born in the county of Malmöhus in Sweden. Jones (1977), however, mentions two cases out of 29,000 births who were operated on because of persistent dislocation after conservative treatment. Smail (1968) reports one case out of 6000 births with a history and operation findings similar to those in our patients.

In all dislocated hips both arthrography and operation showed narrowing of the joint capsule, giving it an hour-glass shape, which has been described earlier by Leveuf (1948), among others. The narrowing was caused by compression of the capsule by the psoas tendon and the acetabular portion of the rectus femoris tendon, which together exerted

a pincer effect around the capsule. Similar observations have been made by other authors, including Scaglietti & Calandriello (1962), Lloyd-Roberts & Swann (1966), Hirsch (1970), Ferguson (1973) and Eyre-Brook et al. (1978). Even when the tendons had been divided at operation, however, some narrowing of the capsule still remained. In most untreated hip dislocations discovered at a late stage some capsular narrowing is in fact observed, but this is generally less pronounced than in the cases reported here and seldom impedes closed reduction up to the age of about 2 years (Almby & Lönnerholm 1978). The extreme capsular narrowing in our cases seemed to be due to shortening of the two hip flexors, the rectus femoris and iliopsoas. A probable reason for this is that the foetus has lain with the hips hyperflexed for a long time before delivery. In two of our cases with breech presentation we know that this was the case (Figure 1). Dunn (1969) described post-mortem observations in perinatal deaths that corresponded well with our findings at operation (CDH grade III according to Dunn), demonstrating that severe changes in the hip joint can be present even at delivery.

After incision of the capsule, the interposed capsular fold (labrum) was no longer an impediment to reduction. The excision of an entrapped labrum recommended by Somerville (1953) was therefore not considered necessary in our cases.

In all of our patients there was distinct deformation of the femoral head, consisting of both flattening medio-laterally (egg-shaped) and marked anteversion. The head appeared to be rotated anteriorly on the neck. Moreover, the head was small. Similar observations have been reported, among others, by Laurent (1953) and Dunn (1969), who stated that these changes occurred with so-called posterior dislocation. Our stereo films showed that such posterior dislocation was present in all cases of our series. When the femoral head had left the acetabulum, it was moved postero-superiorly by the shortening of the

iliopsoas tendon and forced against the wing of the ilium.

In the arthrogryposis cases the same type of capsular narrowing was found as in the cases of idiopathic instability.

Conclusions

1. In occasional cases of neonatal hip instability interposed capsular tissue may impede reduction.
2. It is important that this is diagnosed early – preferably within 2 months – so that open reduction can be performed without delay.
3. An impediment to reduction can be suspected if
 - (a) abduction is already restricted at birth
 - (b) if the primary reduction is difficult and the reduced position is not easily maintained
 - (c) if the instability persists after 6 to 8 weeks of treatment.
4. If an impediment to reduction is suspected, arthrography should be performed.
5. The findings at arthrography and at operation corresponded well.
6. The findings at open reduction were
 - (a) a greatly narrowed joint capsule compressed by the rectus femoris and iliopsoas tendons
 - (b) a capsular fold including the acetabular labrum was interposed, but was not an impediment to reduction when the capsule was incised.
 - (c) the femoral head was markedly anteverted, with varying degrees of deformation
 - (d) the ligamentum capitis femoris was lengthened and was sometimes thin and sometimes broad and thick.
7. The changes mentioned were essentially the same in the patients with arthrogryposis as in those with idiopathic instability of the hip.
8. On the basis of our investigation a primary impediment to reduction is

probably present in one case out of about 13,000 births (= 0.08 per thousand).

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