CONGENITAL DISLOCATION OF THE HIP

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In the campaign for better results in the treatment of congenital dislocation of the hip there are two possible lines of attack: earlier diagnosis, and a more rational employment of the methods of treatment at present open to us. After early diagnosis, the importance of which is paramount, our chief problem is still how to make the best use of a number of well known manoeuvres, and here there is not yet any agreed policy. This paper is a contribution to a debate that seems likely to continue for some years.

Since 1949 two of the authors (H. J. S. and D. T.) have worked together on the treatment of patients with congenital dislocation of the hip and have come to adopt the policy that will be described. This was based on our experience of seventy-five hips* treated before 1949. These patients did not form a consecutive series and were not looked after exclusively by the authors: for these reasons the results of their treatment are not presented in detail.

This paper is concerned with 137 patients treated between January 1949 and December 1953 and followed up for at least five years: brief reference will also be made to 197 patients treated by us between January 1954 and December 1958. Members of the staff of the Royal National Orthopaedic Hospital and other orthopaedic surgeons have been kind enough to refer their patients with congenital dislocation of the hip to one or other of the two senior authors. To all of these colleagues we are greatly indebted.

On one point we can speak with conviction: closed reduction can give reasonably satisfactory and durable results in a fair proportion of cases. This was shown by Muller and Seddon (1953), who reviewed the results of treatment of patients who attended the Royal National Orthopaedic Hospital during the half century between 1891 and 1941. The primary method of treatment in this series was therefore closed reduction. The two main problems are how to deal with a hip which becomes unsatisfactory after an apparently successful closed reduction, and what to do with the patient in whom closed reduction fails or who is too old for it. **The 1949-53 series**—In this series we have excluded only those few patients in whom the dislocation did not conform to the standard pattern, namely those with familial laxity of joints or with arthrogryposis multiplex congenita, who present special problems. There remained 137 patients; three of these could not be traced, leaving 134 available for study.

Fifty-three (39 per cent) of our patients presented special problems and had been referred by other orthopaedic surgeons because of difficulties during treatment.

METHOD OF ASSESSMENT

The results were assessed by the method used by Muller and Seddon (1953) in their review of the late results of treatment of congenital dislocation of the hip. Marks were given for the severity of pain in the joint, the amount of restriction of the patient's activities, the range of movement in the joint, and its radiographic appearance. The method of marking is as follows.

Pain (P)—1) Severe even at rest. 2) Severe on movement; little at rest. 3) Some on movement; none at rest. 4) Occasional discomfort. 5) None.

* Forty treated conservatively, sixteen open reductions, eighteen rotation osteotomies, twenty acetabular reconstructions, and four capsular arthroplasties.

Function (F)—1) Walks short distances only with difficulty. 2) Walks half a mile with a marked dip. 3) Walks two miles with a slight dip. 4) Slight limitation of activities. 5) Can do anything.

Movement (M)—1) Little or none. 2) Less than half normal range; or some fixed deformity. 3) More than half normal range; no fixed deformity. 4) Slight limitation with no fixed deformity. 5) Full range.

Radiographic appearance (X)—1) Dislocation, ankylosis, osteotomy, excision of head and neck. 2) Marked subluxation or gross deformity. 3) Slight subluxation with much deformity. 4) Slight subluxation with slight deformity. 5) Almost normal.

A joint that caused no pain, which did not restrict the patient's activities in any way, and which exhibited a full range of movement and nearly normal radiographic appearances, would thus score 20 points. A unilateral dislocation, eventually treated by arthrodesis, might be graded P5, F4, M0, X1=10=Poor.

The results were classified in four groups:

Excellent	= 17 points or more	} Satisfactory results.
Good	= 14–16 points	
Fair	= 11–13 points	} Clinical failures.
Poor	= 10 points or less	

Hips graded fair or poor are recorded as failures. This method of assessment is simpler than that of Massie and Howorth (1950) and gives a fair picture of the present condition of the hip.

FIG. 1
Arthrographs showing dislocation (*left*) and subluxation (*right*).

GENERAL FEATURES

It has been possible to trace and re-examine 134 of the 137 patients, a follow-up rate of 97.8 per cent. There were 114 girls and twenty boys, giving a sex ratio of 5.7:1. The condition was bilateral in thirty-three patients and unilateral in the remaining 101, making a total of 167 hips involved. In 136 of these hips there was a complete dislocation, and in the other thirty-one subluxation only. In a complete dislocation the head loses all contact with the acetabulum, and often soft tissue is interposed between the joint surfaces. In

subluxations the head is in contact with the acetabular rim, and there is seldom any barrier to reduction (Fig. 1).

Platt (1956) questioned the value of Leveuf's distinction between dislocation and subluxation. Although it is, in Platt's words, "no longer a safe guide to treatment" there seems little doubt that the difference in prognosis is sufficient to warrant continued use of the terms.

A family history was obtained in only ten patients (7.5 per cent). Other defects were associated with the dislocation in seven patients (5.2 per cent): treatment of the hip in these patients did not present any special difficulties.

FIG. 2
Age at first attendance.

FIG. 3
Percentage of failures at different ages.

Figure 2 shows the percentage of patients attending for treatment at various ages. Too often the diagnosis was made much too late. Figure 3 shows the percentage of failures in the series grouped according to the age of first attendance for treatment. If the child was over five years old when first seen, a third or more of the results were unsatisfactory: under the age of four years less than a fifth were failures.

The results are shown in Table I. The patients have been divided into those who came to us for treatment under the age of three years (ninety-one patients with 114 hips involved), and those who first presented after this age (forty-three patients with fifty-three hips involved).

The results in patients with subluxation were excellent in every patient under three years and in 80 per cent of patients over three. All patients with subluxations who were treated

FIG. 4

Figure 4—Method of treatment of subluxations in children under three years of age (seventeen hips).

FIG. 5

Figure 5—Method of treatment of subluxations in children over three years of age (fourteen hips).

FIG. 6

Method of treatment of dislocations in children under three years of age (ninety-seven hips).

FIG. 7

Method of treatment of dislocations in children over three years of age (thirty-nine hips). All of the ten hips in the "unreduced" category were over five when first seen and most had had several operations elsewhere.

TABLE I
RESULTS IN 134 PATIENTS (167 HIPS)

	Type	Number	Per cent	Excellent	Good	Fair	Poor	Percentage	
				Satisfactory	Unsatisfactory	Satisfactory	Unsatisfactory		
Under three years when treatment began									
UNILATERAL	Subluxation	11	6.6	11	—	—	—	100	—
	Dislocation	57	34.2	40	10	4	3	88	12
BILATERAL	Subluxation	6	3.6	6	—	—	—	100	—
	Dislocation	40	24.0	18	11	10	1	72.5	27.5
Over three years when treatment began									
UNILATERAL	Subluxation	10	6.0	3	6	—	1	90	10
	Dislocation	23	13.8	5	9	6	3	61	39
BILATERAL	Subluxation	4	2.4	1	1	2	—	50	50
	Dislocation	16	9.6	6	6	2	2	75	25

after the age of three needed some operation, whereas three-quarters of those under three years required none (Figs. 4 and 5).

Of those with dislocation, 83 per cent had satisfactory results if treatment was begun under the age of three, whereas only 67 per cent had satisfactory results if treatment was started over three: only 8 per cent of the hips in the older group were stable after reduction without further operation, compared with 29 per cent in those under three (Figs. 6 and 7).

INVESTIGATIONS

Arthrography—The enthusiasm that led us to carry out arthrography on 120 hips has waned. Although some elegant pictures (Fig. 1) gave an indication of possible hindrances to reduction we still felt bound to attempt closed reduction first, and in some cases with success in spite of an unpromising arthrograph.

Anteversion—A radiographic method of measuring anteversion (Dunn 1952) was devised by Shelswell in 1950 and was used for some years, but the estimates when checked at operation were sometimes found to be so wide of the mark that it has been abandoned. We now doubt whether estimates of anteversion made before or during the early stages of treatment are helpful in the management of the individual patient. If anteversion is of such a degree that it must be corrected, the need will become apparent during the course of treatment: this is discussed later.

The C.E. angle—This is the angle (Wiberg 1939) between a line drawn in the longitudinal axis of the body through the centre of the femoral head and another line joining this centre to the lateral edge of the acetabular roof. It is used as an index of the development of the acetabular roof and of the stability of the femoral head in its socket. In young children, in whom the acetabular roof is largely cartilaginous it is best measured on an arthrograph done after reduction. Its importance will be discussed later.

TREATMENT

Except in infants, reduction is attempted by gradual abduction on a frame (Scott 1953) with fixed skin traction applied to both legs. When the legs have been abducted so that the angle between them is over 90 degrees, a cross pull is applied through a band round the upper

part of the affected thigh (Fig. 8); the object of this is to coax the femoral head, which is then lying opposite the acetabulum, into the socket; the force used should not exceed three pounds. Clinical signs of reduction are a feeling of resistance deep to the femoral artery and a notable improvement in the happiness and comfort of the child. Antero-posterior and lateral radiographs are used to check reduction.

FIG. 8
The abduction frame.

FIG. 9
Batchelor plaster.

If reduction is successful, leg plasters are applied and joined by two crossbars holding the hips abducted and medially rotated (Fig. 9) (Batchelor 1951). These plasters are changed when necessary, usually every three months, and are retained for ten months. The child is then allowed to go free, but is examined frequently to ensure that development of the hip is proceeding normally.

If the radiograph taken when the child has been on the frame for a month shows the femoral head opposite the acetabulum but standing out (Fig. 10), Batchelor plasters are still applied and the position is reviewed after three months. Like Severin (1950) we are convinced that a barrier to reduction can sometimes be overcome if the head is held opposite the acetabulum. If the head has not sunk home after three months in a Batchelor plaster the child is allowed to go free, and open reduction is undertaken when the hips are fully mobile.

Not more than about four weeks should be spent in trying to obtain reduction on a frame. Longer immobilisation may lead to osteoporosis, and we have seen collapse of the femoral head in such a case at the time of open reduction. For this reason, if reduction has not been obtained within one month, the child is allowed free, and open reduction is carried out only after an interval and when the density of the bones has returned to normal.

Open reduction is used if closed reduction fails. After operation the hip is immobilised in a hip spica in the position of greatest stability, which is usually one of medial rotation and always one of abduction. If anteversion is excessive, as shown by the degree of medial rotation required, rotation osteotomy is carried out about a month later and fixation in plaster is

FIG. 10
Head standing out after closed reduction.

continued for a further two months. If the radiograph, in older children, shows very poor development of the acetabular roof, or if, at open reduction, the cartilaginous roof is seen to be sloping, acetabuloplasty is carried out at the time of open reduction.

Closed reduction—Subluxations present no problem in reduction (Figs. 4 and 5) and the following discussion is concerned with the treatment of complete dislocation (Table II).

Provided that reduction could be obtained by manipulation the result was eventually satisfactory in 80 per cent of cases. Manipulative reduction had been attempted by other surgeons in some of the cases later referred to us, but we ourselves used it only in infants under six months or in rather older children with subluxations: stability after manipulation was less common than after frame reduction (Table II) and the greatest age at which manipulation was followed by a satisfactory result was four years (Table III). Thus, except in a young infant, we consider that manipulation is inferior to reduction on a frame in a hospital where the use of this apparatus is well understood.

Reduction on a frame was successful in the dislocations of over half the children under three years, but of under half in the older children: Crego (1948) found that stable seating after

TABLE II
DISLOCATION ALONE: METHOD OF REDUCTION

		Frame	Manipulation	Open reduction	Not reduced
Under three	97 hips (<i>per cent</i>)	57·6	18·6	20·7	3·1
Stable without further operation	(<i>per cent total</i>)	29·9	10·4	3·2	—
Satisfactory result	(<i>per cent group</i>)	83·8	89	70	—
Over three	39 hips (<i>per cent</i>)	44	13	18	25
Stable without further operation	(<i>per cent total</i>)	7·7	5·1	0	—
Satisfactory result	(<i>per cent group</i>)	82·3	80	100	—
Greatest age for satisfactory result	(<i>years</i>)	5	4	6	7 Colonna

TABLE III
GREATEST AGE FOR SATISFACTORY RESULT

	Age (<i>years</i>)
Unilateral subluxation .	12
Unilateral dislocation .	6
Bilateral subluxation .	5
Bilateral dislocation .	4
Frame reduction . .	5
Manipulative reduction .	4
Open reduction . .	6
Avascular necrosis . .	4
Acetabuloplasty . .	8
Corrective shelf operation	6
Shelf operation for pain .	18
Colonna operation . .	7

TABLE IV
OBSTRUCTIONS TO CLOSED REDUCTION

	1949-1953 (30 hips)	1954-1958 (62 hips)	Total (92 hips)
Limbus	21	30	51
Acetabular tissue	15	20	35
Mis-shapen femoral head	15	12	27
High medial attachment of inferior capsule	4	19	23
Shortened psoas tendon	6	17	23
Enlarged and/or long ligamentum teres	8	13	21
Hour-glass constriction of capsule	10	7	17

closed reduction occurred in only 55 per cent. In our series the proportion was even smaller: less than one in three of those under three, and less than one in ten of those over three, obtained a satisfactory result without further operation (Table II). The greatest age at which frame reduction was followed by a satisfactory result was five years (Table III). This finding is the same as that of Hass (1951). Provided reduction could be obtained on a frame, the final result was satisfactory in over 80 per cent (Table II).

Open reduction—Open reduction was used only when closed reduction had failed. It was necessary in about one in five hips. Even in a child over four years old it is worth while going through the motions of closed reduction on a frame because the operation is thereby made easier: it might have been more effective if adductor tenotomy had been used. Stability after open reduction alone was rare (Table II): several redislocations occurred through failure to carry out an acetabuloplasty at the time of open reduction. It appears that the acetabulum is often seriously defective in the case requiring open reduction, and acetabuloplasty should always be considered. The greatest age at which open reduction led to a satisfactory result was six (Table III).

The reasons for the failure of closed reduction were noted at the time of open reduction, and the findings in ninety-two hips are shown in Table IV: this includes patients treated since 1953. The infolded limbus was the commonest single cause of difficulty, but of all the interposed tissues it is perhaps the one most likely to be squeezed out of existence by the femoral head. Other factors may be equally important, and more than one obstruction to reduction may be present. In a recent case the limbus had been removed by an experienced surgeon. After some months the hip redislocated. On exploration it was found that a ligamentum teres, which at its femoral attachment looked innocent enough, expanded medially into a tough sheet of tissue which filled about one-third of the acetabular cavity.

Failure to achieve stable concentric reduction, even after attempted open reduction (Figs. 6 and 7), is uncommon under the age of three,* but occurred in one in four of the older patients—a reminder of the penalties of late diagnosis.

Acetabular reconstruction—The most unpredictable feature in the treatment of a dislocated hip is the behaviour of the acetabulum. It is commonly believed that normal development depends on concentric reduction of the femoral head (Massie 1951). Smith (1958) showed that in animals the acetabulum failed to develop after experimental dislocation of the hip. In spina bifida acetabular dysplasia is probably secondary to paralytic dislocation of the hip although a primary defect of both hip and spine cannot be excluded (Carr 1956). On the other hand, Hart (1949) and Hass (1951) believed that acetabular dysplasia was the primary lesion, and this was why well reduced hips sometimes redislocated.

There is probably truth in both views. In the unreduced hip the acetabulum becomes progressively more inadequate. On the other hand good reduction is no guarantee that the acetabulum will develop normally. We have already mentioned that in a hip requiring open reduction the deformity of the acetabulum is often such that acetabuloplasty is called for immediately; even after closed reduction the acetabulum may deteriorate or at least remain inadequate. Massie (1951) thought that the acetabulum passed through a critical period of development between the ages of five and eight years, and we agree that constant vigilance is called for even after an apparently concentric reduction.

In this series, failure of acetabular development was dealt with in two ways. If the bone was likely to be pliable—and it always is under the age of five—an acetabuloplasty was carried out; the existing acetabular roof was levered downwards over the head, and the resulting gap packed with bone wedges from the ilium or pieces of rib from the bone bank. If the bone was expected, or found, to be rigid, a shelf operation was done; a full-thickness graft from the ilium was used to extend the acetabular roof laterally over the head.

* In a unilateral case redislocation occurred twice after two open reductions, and arthrodesis was later carried out. In a bilateral case redislocation occurred after open reduction and was treated by capsular arthroplasty of both hips.

Although it is usual to describe all these reconstructions as shelf operations the distinction we have made is not unprecedented or otiose. In the operation that we call acetabuloplasty the sloping roof is levered down to its proper level; in the other, that we call a shelf operation, the existing roof is merely prolonged laterally. Our French colleagues rightly distinguish between these operations, but whereas the simple lateral extension of the roof is neatly described as a "butée ostéoplastique" there are at least three terms, all clumsy and one inexact, for what we have here described as acetabuloplasty.

FIG. 11

Sclerosis of acetabular roof while still sloping.

These operations fell into two groups, corrective when subluxation had recurred, and preventive when it was thought likely that it would occur, as when a very sloping roof was found at open reduction.

At first we hesitated to employ preventive acetabuloplasty. It is an operation carried out on a child whose hip is clinically normal but shows a radiographic blemish. The operation is not a minor affair and we know of one death. We have also seen delayed healing of the wound and prolonged, though never permanent, limitation of movement of the joint. However, with improvements in anaesthesia and operative techniques our confidence has increased, and we now prefer to carry out acetabuloplasty before subluxation has started—preventive acetabuloplasty. This tendency towards earlier operation is shown in Table V.

There are three radiological features which may help in deciding whether acetabular reconstruction is required. Wiberg (1953) examined the C.E. angle in 200 hips and stated that an angle of under 20 degrees was abnormal. Laurent (1953) found the measurement particularly useful in children over three years. Yet, in fifteen of our forty-three hips successfully treated by closed reduction alone, the C.E. angle was under 20 degrees while the child was in plaster.

Hass (1951) stated that sclerosis of a steeply sloping acetabular roof indicated that regeneration had finished and that operation was indicated (Fig. 11). We have found this a more reliable sign than the C.E. angle, but the absence of sclerosis of a sloping roof is no contra-indication to operation.

Ossa acetabuli may appear in normal hips after the age of eleven years: similar centres may be seen in congenital dislocation as early as two years. Wiberg (1953) thought they indicated a good prognosis, and we confirm this.

The frequency with which we employed these operations for roof reconstruction is shown in Table V. They were required more often in the older children. The greatest age for a successful result after acetabuloplasty for subluxation was twelve. A shelf operation, as here defined, is not a true reconstruction of the acetabulum, and there were no successful cases above the age of six: it was used with decreasing frequency in children (Tables III and V). Like Wiberg (1939) and Merle d'Aubigné (unpublished work) we have found that, for the relief of pain in older patients, the operation has a different and more effective place.

TABLE V
ACETABULAR RECONSTRUCTION

1949-1953	Frequency of employment			
	Under 3 (114 hips)		Over 3 (53 hips)	
	Number	Per cent	Number	Per cent
Preventive acetabuloplasty	13	11.4	6	11.3
Corrective acetabuloplasty	19	16.7	12	22.7
Preventive shelf operation	4	3.4	8	15.1
Corrective shelf operation	8	7.0	8	15.1
Total	44	38.5	34	64.2
1954-1958	Under 3 (140 hips)		Over 3 (98 hips)	
	Number	Per cent	Number	Per cent
Preventive acetabuloplasty	43	30.5	12	12.4
Corrective acetabuloplasty	10	7.1	8	8.1
Preventive shelf operation	3	2.1	3	3.0
Corrective shelf operation	0	—	2	2.0
Total	56	39.7	25	25.5*
Satisfactory results (1949-1953 only)				
	Number	Per cent	Number	Per cent
Preventive acetabuloplasty	10	77.0	6	100
Corrective acetabuloplasty	17	89.5	10	83.3
Preventive shelf operation	3	75.0	8	100
Corrective shelf operation	5	72.5	7	87.5

* Follow-up in this group is too short to show the numbers of corrective acetabuloplasties and shelf operations that may be required.

The results of these operations are good (Table V). Acetabuloplasty is easier over the age of three, and, because the results of corrective acetabuloplasty are much the same as those of preventive acetabuloplasty, there is no need for haste when a young child has a defective acetabulum.

Rotation osteotomy—The importance of anteversion of the upper end of the femur as a cause of redislocation is still uncertain. Hass (1951) considered that anteversion was unimportant under the age of three. Platou (1953) thought that anything over 30 degrees required correction,

but Shands (1958) showed that the angle may diminish spontaneously after the hip is reduced. Muller and Seddon found that 70 per cent of hips with estimated anteversion of over 45 degrees became subluxated after reduction compared with 47 per cent of those with less than 45 degrees of anteversion.

Laurent (1953) drew attention to an abnormality to which insufficient attention has been paid: frontal inclination of the socket—an acetabular anteversion—which may well be a more important factor. Langenskiöld (1952) also held this view; his remedy for this condition is transplantation of the insertion of iliopsoas to the outer side of the femur.

FIG. 12
Hip requiring varus and rotation osteotomy.

The need for operation to correct anteversion can be determined by taking radiographs with the hips in neutral and in full medial rotation. If the latter view shows the position of the head in the acetabulum to be significantly improved, osteotomy should be carried out. If open reduction of the hip or acetabular reconstruction is carried out, the most stable position of the hip is determined before the wound is closed. The degree of medial rotation will then indicate whether rotation osteotomy is required.

In this series rotation osteotomy was done in twenty-eight hips (24·8 per cent) in children under three, all with anteversion of over 45 degrees; five (18 per cent) of the hips remained unsatisfactory. There were in the same group twenty-seven hips in which osteotomy was not done in spite of an estimated anteversion of over 45 degrees: the failure rate in these was 26 per cent. The difference is not great. In the patients over three rotation osteotomy was done in nineteen hips (36 per cent), all with anteversion of over 45 degrees, and the failure rate was 36·8 per cent. There were ten hips in which osteotomy was not done although anteversion was thought to be over 45 degrees, and the failure rate was 30 per cent.

These figures suggest that the importance of femoral anteversion may have been overstressed in the past. Other factors, notably acetabular anteversion and valgus of the femoral neck may be equally, if not more, important.

Excessive valgus of the femoral neck (Trevor 1958) can be corrected by taking a subtrochanteric wedge based medially, and any anteversion can be corrected at the same operation. Of eighty osteotomies done since 1953 twenty-one were for the correction of valgus as well as rotation. Figure 12 shows such a case: the radiograph is taken in full medial

rotation and shows both femoral heads well seated. On the normal (right) side the outline of the epiphysis is semicircular, and a line perpendicular to the epiphysial plate passes through the lower part of the sacro-iliac joint. On the left side the medial part of the epiphysis is flattened, giving it the appearance of a peaked cap; a line perpendicular to the epiphysial plate passes lateral to the sacro-iliac joint: varus as well as rotation osteotomy is indicated.

Capsular arthroplasty—Capsular arthroplasty was performed on ten hips in this series and on another eighteen since the end of 1953. Colonna (1953) employs his operation in some types of case in which we use open reduction and acetabuloplasty. We have confined capsular arthroplasty to patients who were either too old for direct reduction, or to those in whom a previous operation had failed, or in whom there was acetabular aplasia of such a degree as to preclude open reduction. It was therefore the last resort short of arthrodesis, and indifferent results in such cases should not be allowed to detract from the merits of capsular arthroplasty when carried out in accordance with the strict conditions laid down by its originator.

Colonna stated that ten years is the upper age limit in unilateral and eight years in bilateral cases. Only four of our ten (pre-1953) patients were within this limit. We had one success and three failures; in one there was redislocation, in the other two avascular necrosis with some loss of movement. Yet even these three patients have enjoyed useful function for six or more years and may continue to do so for some time to come.

The arthroplasty was a salvage operation in the six patients over the age limit (two were thirteen at the time) and fair results were obtained in all. We have yet to decide whether this is worth while, but, in the unilateral case, subsequent arthrodesis will certainly be simpler than if nothing had been attempted. In bilateral cases before the age of six one can obtain satisfactory results by open reduction and acetabuloplasty; between six and eight years capsular arthroplasty is probably the operation of choice; over the age of eight the patients' interests are possibly best served by withholding surgery until the hips become painful.

TABLE VI
RESULTS OF CAPSULAR ARTHROPLASTY

	Good	Fair	Poor
1949-1953	1	7	2
1954-1958	4	13	1

Since 1953 we have operated on a further eighteen hips. Four of these have given satisfactory results; there has been one poor result due to redislocation; and the remainder have been fair: avascular necrosis has occurred in three (Table VI).

This bald statement of the results gives an unduly depressing picture. Patients and their parents are pleased with what they regard as good results in the cases that we have graded only as fair.

COMPLICATIONS

Avascular necrosis—Almost a quarter of the children under three, but only 15 per cent of the older ones, developed this complication (Table VII). In all, the radiographs showed irregularity, increased density and often the appearance of fragmentation in the epiphysis. Residual deformity of the femoral head is more common if epiphysial changes first appear after the age of three, and after four years it always impaired the final result. Thus, although the complication is less frequent in the older children, the prognosis is worse.

The incidence was higher in patients treated in a Lorenz plaster than in those immobilised in the Batchelor plasters. From the evidence obtained at open reduction that the most stable position is usually one of medial rotation, the indications for using a "frog" plaster are rare.

Nicholson (1954) showed that the frog-leg position in plaster affects the intravascular pressure, the most sensitive vessels being the profunda femoris and the medial and lateral circumflex femoral arteries. This effect is abolished by adductor tenotomy, and perhaps we should return to the practice of doing this routinely.

Manipulative reduction carries a higher risk of avascular necrosis than does reduction on a frame (Scott 1953) or open reduction. The condition is not uncommon after acetabuloplasty in children under the age of three; and even after a shelf operation, in which the disturbance of the hip itself is minimal, avascular necrosis can occur in children over three. It occurs too, and understandably, after capsular arthroplasty.

TABLE VII
AVASCULAR NECROSIS

	Under 3 (per cent)	Over 3 (per cent)
Incidence . . .	24.8	15
Failure rate . . .	25	37.5
Frog plaster . . .	37.5	28.6
Batchelor plaster . . .	16.2	12.5
Frame reduction . . .	12.5	11.7
Manipulation . . .	33.3	20
Open reduction . . .	15	10
Acetabuloplasty . . .	31.3	—
Shelf operation . . .	—	10.5
Colonna operation . . .	16.7	25

TABLE VIII
CASES WITH PROLONGED STIFFNESS

Avascular necrosis . . .	8
Shelf operation . . .	4
Colonna operation . . .	2
Open reduction . . .	2
Splintage . . .	1

The duration of the process, judged radiologically, varied from four months to four years but bore no direct relation to the end-result; transitory changes may be followed by considerable permanent deformity. The importance of the condition has certainly been underestimated in the past. Figure 13 shows the radiographic appearance of a hip reduced by manipulation seven months before, and immobilised in lateral rotation. The following four films (Figs. 14 to 17), taken at yearly intervals, show the slow development of the process and the permanent flattening of the head. The more serious degrees of avascular necrosis are accompanied by stiffness of the hip, and when this happens we feel that the condition should be treated like Legg-Calvé-Perthes' disease by relief from weight bearing until revascularisation has occurred. **Stiffness**—Prolonged stiffness of the hip occasionally presents a problem. It occurred in seventeen (10.2 per cent) cases. The associated factors are shown in Table VIII. The

commonest cause is avascular necrosis. The stiffness will normally yield to treatment by traction followed by exercises in the pool, but occasionally operation is required. One boy who had been treated elsewhere in a Denis Browne splint for sixteen months required Soutter's soft-tissue release and subtrochanteric osteotomies on both hips before his legs could be brought together. This adds force to the argument against immobilisation in the frog-leg

FIG. 13

FIG. 14

FIG. 15

FIG. 16

FIG. 17

FIGS. 13 TO 17

Figure 13—Avascular necrosis affecting the left hip seven months after manipulative reduction of a congenital dislocation seven months before. The succeeding Figures (14 to 17) show the progress at yearly intervals.

position. Stiffness is occasionally due to calcification and ossification in the capsule and abductors of the hip (Fig. 18): it may occur in cases treated conservatively as well as in those operated on, and can affect the normal as well as the dislocated hip. Removal of the ectopic bone gives a disappointingly small increase in the range of movement.

FIG. 18

Ossification in a normal hip after an uneventful reduction of the other hip on a frame, followed by acetabuloplasty.

SUMMARY AND CONCLUSIONS

1. The results of treatment of 134 patients with congenital dislocation of 167 hips are reviewed.
2. Late diagnosis is still a major problem.
3. Subluxations rarely give rise to poor results, but in dislocations first treated over the age of five years there is a one-in-three risk of failure.
4. Manipulative reduction is successful less often than reduction on a frame and carries a higher risk of avascular necrosis.
5. Closed reduction on a frame was satisfactory in 58 per cent of patients under the age of three years, and can succeed up to the age of five.
6. Open reduction was required in 20 per cent of cases under the age of three, and can be used successfully up to the age of six.
7. Seven anatomical barriers to closed reduction have been recognised and two or more are commonly found in one hip when open reduction is performed.
8. The acetabular roof may fail to develop after reduction, especially if this is delayed. A C.E. angle of under 20 degrees does not necessarily forebode this, unless measured on an arthrograph. Sclerosis of a sloping acetabular roof is an indication for operation. Acetabuloplasty is the proper operation for a sloping acetabulum and can be done successfully up to the age of twelve. Over this age, a shelf operation should be performed; this is appropriate also in younger patients in whom the curvature of the acetabulum is normal but does not extend far enough laterally. These operations were required in 38 per cent of hips treated in patients under the age of three, and in 64 per cent over this age. There is a one-in-three risk of avascular necrosis when acetabular reconstruction is done in patients under three.
9. Anteversion, if excessive, should be corrected by subtrochanteric osteotomy, and any valgus of the femoral neck should be corrected simultaneously.
10. Unilateral dislocations in patients over the age of six are best treated by Colonna's operation. In our few bilateral cases over this age our results have been disappointing.
11. Avascular necrosis is less common but more serious when it occurs over the age of three. Manipulative reduction and the use of frog-leg plasters are two avoidable factors which appear

to increase its incidence. The more serious degrees are accompanied by stiffness of the hip, and when this sign is present weight bearing should be avoided.

12. Prolonged, though rarely permanent, limitation of movement occurs in some 10 per cent of cases. In a few, operative correction was required.

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