OPEN REDUCTION OF CONGENITAL DISLOCATION OF THE HIP

O. SCAGLIETTI and B. CALANDRIELLO, FLORENCE, ITALY

From the Orthopaedic Department, University of Florence

The purpose of this paper is to assess the value of elective operative reduction for congenital dislocation of the hip. The question has been considered before by many surgeons but without any general agreement. We consider it again now for two reasons: 1) progress of surgical technique and of anaesthesia has made the operation safe even for very small children; and 2) the criteria of success have changed so that it is no longer enough to reduce the dislocation and keep the hip reduced; too many hips which appeared to be satisfactorily reduced have eventually developed arthrosis. It is because we are expected to achieve a hip which remains functionally and radiographically normal for the rest of the patient's life that we assess anew the value of open reduction.

The principal questions are when to perform an open reduction, how to perform it, and what it can achieve.

INDICATIONS

It has been held that the principal indication for open reduction is the failure of closed reduction. With this in general we concur, but with the following reservations: 1) closed reduction should be attempted only when it has a reasonable chance of success; 2) closed reduction must be easy and atraumatic: if reduction is not easy it should be abandoned at once.

There are also dislocations in which it is not reasonable even to try closed reduction. These are mainly: 1) the dislocation is of Putti's "embryonal" variety, the dysplasia and displacement being so marked—even approaching the arthrogriptic state—that one feels they originated during the embryonic stage; 2) the dislocation is associated with a lesser degree of dysplasia but is in an older child; one cannot fix an exact age limit nor can one fix an exact degree of dysplasia, but a combination of increased age and dysplasia indicates operation when neither alone would do so; 3) generally speaking, closed reduction in children over three years of age is not advisable.

The condition of the femoral head and acetabulum, the position of the head above, in front of, or behind the acetabular line, and the angle of the neck of the femur, all must be taken into account in assessing the reducibility or irreducibility of the dislocation. The decision on the importance of age and dysplasia should rest on very careful clinical, radiographic and arthrogramatic examinations. Arthrogramy does not always give a clear picture, however accurate the technique may be. In general the arthrogramatic interpretation conforms with the clinical and the radiographic findings, but the experience and clinical acumen of the orthopaedic surgeon remain pre- eminent.

There are some cases in which an operation of necessity provides the last chance of improvement after repeated damage by violent attempts at closed reduction or some other not very able performance. Results in such cases are not included in this study. Many of the unfavourable results in former series were due to the inclusion of cases in which open operation was undertaken as a last resort.

TECHNIQUE OF OPERATION

Some of the surgeons who favour open operation for congenital dislocation like a limited or conservative operation; others prefer a more radical operation.

The first group advocate a restricted approach with as little interference as possible with the joint and the related soft parts. Somerville (1953) is an example of this group; he is...
convinced that the constant cause of failure to reduce is interposition of the limbus. Therefore, through a small anterior iliac incision he exposes the upper surface of the capsule, opens the joint, hooks up the limbus and removes it whole. He then goes on to do a rotation osteotomy some weeks later. This technique is based on two assumptions: 1) that the limbus is invariably the cause of failure of reduction; 2) that the limbus can always be removed in the manner described. Of the latter assumption we say nothing, because we lack experience of the method, but the former we find not very credible in the light of our anatomical findings in 187 operations. Virenque and Pasquié (1956) also favour minimal interference: they use the approach of Hueter, and they also remove the limbus. They spare the ligamentum teres unless it is definitely preventing reduction.

In contrast with these are the more or less radical operators. They hold that the damage done by a more radical approach is compensated for by a clear vision of the structures preventing reduction and by the ability to remove them completely. The earliest protagonist of this view was Putti (1935). He believed that the operation must replace the femur in; the acetabulum, while respecting most scrupulously the bony parts of the joint. A wide exposure was necessary so that all "non-osseous" obstacles might be removed. The head of the femur must then be eased into the acetabulum, which itself must not be touched in any way. We have followed Putti, though we have modified his technique in some respects. Of the same mind was Leveuf (1948) who, approaching the hip on the medial side of the sartorius, divided the tendons of the rectus and iliopsoas.

The other approaches (Lexer-Murphy, Ollier and Gibson) all give a good view of the femoral head and of the acetabulum, but they do not allow inspection or dissection of the anterior part of the hip, where, as we hope to show, the main obstacles to reduction are present. The technique of Rohlederer (1951) and Langenskiöld (1953) ought to be mentioned: they hold that the tendency to lateral rotation of the leg is one cause of redislocation and so they transplant the iliopsoas from the lesser trochanter to the lateral aspect of the femur.
Figure 3—Appearances at operation: congenital dislocation of right hip. 1) Capsule covering femoral head. 2) Inlet to acetabulum. 3) Iliopsoas. 4) Femoral nerve. Note how the iliopsoas prevents reduction of the hip.

Figure 4—Appearances at operation: congenital dislocation of right hip. 1) Capsule covering femoral head. 2) Inlet to acetabulum. 3) Iliopsoas. Note how the capsule is trapped between the head and the iliopsoas.

Figure 5—Diagram showing the relation of the iliopsoas to the capsule in congenital dislocation of the hip.

The authors' technique—The patient is anaesthetised and traction is put on the legs. The incision starts just below the middle of the iliac crest. It follows the curve of the crest to the anterior superior iliac spine and thence descends longitudinally for about 10 centimetres (Fig. 1). Entry is made between the sartorius and the tensor fasciae latae, which is detached from its origin; some detachment of the gluteus medius and minimus from the ilium may be necessary. Both heads of the rectus femoris are divided and the muscle belly is reflected laterally. The capsule is now exposed: it is freed from surrounding muscles until it is completely visible (Fig. 2).

We are now ready to deal with the obstacles to reduction, which can be divided into two groups.

Extra-articular obstacles—These consist mainly of muscles just round the joint which, under the influence of the dislocation, have changed direction, length and shape: the most important are gluteus medius and iliopsoas.
Because of the ascent of the greater trochanter the gluteus medius is shortened, which makes it difficult to pull the head of the femur down to the level of the acetabulum. Its origin from the ilium is partly divided.

The iliopsoas deserves particular attention because of its close relationship to the articular complex of the hip. Normally the tendinous part of the iliopsoas crosses the anteromedial surface of the joint, passes over the capsule and goes on to its insertion in the lesser trochanter. When the head of the femur is not in the acetabulum, the tendon of the iliopsoas is stretched so tight that it crushes the capsule against the mouth of the acetabular cavity. As the femoral head rises to what one might call the iliac position, the pressure of the psoas tendon against the capsule increases and the capsule is more or less strangled (Figs. 3 to 5). At times quite tough adhesions are formed between the capsule and the psoas tendon. In cases of mild dislocation this impediment is easily overcome by flexing the hip, but in severe cases it is a pronounced obstacle to reduction. In order to deal with it we carry out a "Z" lengthening of the tendon (Fig. 6). First the tendon with the terminal part of the psoas muscle is freed from adhesions to the capsule and to adjoining structures, care being taken not to damage the femoral nerve which is very close on the medial side. Extreme lateral rotation of the leg is helpful at this point. The tendon is then split lengthwise and "Z" elongation is carried out. The capsule bears a linear impression where the tendon has pressed. In the formation of the so-called capsular isthmus the tendon of psoas plays at least a part. Division of the psoas tendon has three advantages: 1) it lessens the difficulty of reduction and occasionally is an essential step in achieving it; 2) by making it easier to bring the head down to the level of the acetabulum it reduces later pressure on the capital epiphysis; 3) it affords a wider approach to both medial and lateral aspects of the joint.

**Intra-articular obstacles**—After the extra-articular obstacles have been dealt with the intra-articular stage of the operation begins. First the capsule is opened. Some surgeons are mainly concerned with keeping the incision in the capsule as small as possible so as to interfere as little as possible with the blood supply to the head. This is understandable but the advantage of a sufficiently wide exposure should not be sacrificed. The whole of the acetabulum must be seen easily. We make an oblique incision on the front from the inlet of the acetabular cavity to the base of the greater trochanter (Fig. 7). If necessary we extend this with a small incision round the cervical insertion of the capsule; the capsular flaps are clipped and opened out. The view of the inside of the joint is then complete and one can see the structures impeding reduction (Fig. 8). These are:

a) **The capsule**—This may well be the structure that undergoes the greatest alteration in shape, development and structure. Its upper part sustains the upward thrust of the head of the femur and it bulges upwards and outwards and comes to form a sort of hood which contains the dislocated head. This hood, under the stimulus of pressure and friction, thickens and becomes adherent to the iliac blade, and so in long-standing dislocations it forms the lining of the false acetabulum. Usually the capsule reaches to the base of the neck of the femur, but in some cases it is attached to the rim of the head at the edge of the articular cartilage (Figs. 9 and 10). Hence in such cases the neck of the femur is not in the articular cavity. Putti (1935) called this attachment of the capsule "the peri-cephalic insertion," and as he pointed out it

---

**Fig. 6**
Diagram showing method of lengthening the iliopsoas tendon.
Figure 7—Diagram showing the capsular incision. Figure 8—Diagram showing the joint opened and the display of the structures within. Note the "limbus" and the ligamentum teres.

Figure 9—Photograph of specimen. Figure 10—Diagram showing the method of attachment.
prevents full entry of the head into the acetabulum. Apart from its anomalous insertion, the capsule may become adherent to the cartilaginous surface of the head of the femur. This is sometimes so marked that the head is completely enclosed in a cuff (Figs. 11 and 12). It may of course be that these adhesions are caused by attempted closed reduction, and in fact we do not remember seeing them in an untouched hip.

Another capsular feature impeding reduction is the isthmus—the constriction between the acetabular and capital parts of the capsule, which used to be called hour-glass constriction. It may sometimes be wide enough to allow the head to pass, but it may be so narrow as to be quite impassable. It is not clear whether the extreme narrowing is due to internal adhesions or to the action of external factors compressing the capsule, the most likely of which would be the tendon of the iliopsoas. The isthmus is an acquired anatomical variation which becomes worse with age and with the increasing ascent of the head. Obviously if the head cannot go through the isthmus, reduction is impossible. Reduction may seem to succeed but in fact the two articular surfaces may fail to make contact because they remain separated by a double layer of capsule. These capsular defects must be dealt with. The “peri-cephalic” attachment of the capsule must be detached, adhesions divided, and the isthmus made wide enough to allow the head to pass with ease, even if this involves removing the part of the capsule forming the isthmus.

b) The limbus—Much controversy has arisen about the role of the limbus both in the original process of dislocation and in the mechanism of reduction. It was considered of great importance by Leveuf (1948). He used the limbus to distinguish between subluxation and dislocation, which he regarded as entirely different entities. In the former, the head of the femur had pushed the limbus in front of it; in the latter the head had, as it were, jumped the limbus which then retreated inside the articular cavity. This view is not shared today by many orthopaedic surgeons, and in general, subluxation is regarded as a stage on the way to complete dislocation. With regard to reduction, it is thought that if the head can pass over the limbus it will enter the acetabulum and can become perfectly centred; if on the other hand the limbus is not surmounted but is carried by the head into the acetabulum, which it partly blocks, complete reduction and centering cannot take place. In the opinion of some authors (particularly Somerville (1953)) interposition of the limbus is always the cause of failure of reduction.

In our own experience only 35 per cent of the hips we opened showed this semilunar flap or partial diaphragm hanging like a screen from the upper rim of the acetabulum (Figs. 13 to 15).
When present it was seen very clearly, but we were undecided whether it was purely the limbus or a fold of capsule, or both. Certainly the structure is often much thicker and bigger than the limbus of a normal hip should be for the age. Putti (1935) held that it was not before the second or perhaps even third year that the limbus could start to have an effect on the mechanism of reduction: he held also that up to the second year the limbus was not sufficiently differentiated to be able to obstruct the movement of the head into the acetabulum. Our own experience tends not to confirm this view. Moreover, we noted that the structure lacked continuity with the other fibrocartilaginous parts of the joint, which extend ring-wise round the whole rim of the acetabulum. When removed from its attachment, it appears to consist of a fold lying free with each side covered with membrane. In cross-section the membrane on the side nearer the acetabulum is thicker, stiffer and of a whitish transparency, whereas the surface against the head is thin, soft and greyish in colour. Sometimes the two sides are quite separate and the
The nature and formation of the "limbus." Figure 16—Findings at operation: congenital dislocation of left hip in a child of three. Well developed limbus present. Figure 17—The limbus removed. Both end-on (left) and frontal views show it to consist of a double fold.

Sections of the limbus. The tissue is partly cartilaginous (Fig. 18) and partly fibrous with a synovial covering (Fig. 19). The folded nature of the structure is clearly seen (Fig. 20). (Figs. 18 and 19, × 35; Fig. 20, × 7).
fold can then easily be opened and stretched flat. At other times there is no cleft and the substance appears solid. One side is fibrocartilaginous while the other is of dense fibrous tissue, like that of the capsule (Figs. 16 to 24).

These reasons have led us to disbelieve the view that the limbus by itself commonly intervenes between the head and the acetabulum. Our opinion is that the structure found between the head and the acetabulum, and generally supposed to be the limbus, is actually a double fold of capsule enclosing the limbus (Figs. 25 to 27). The genesis of this double fold may be as follows. Normally the labrum of the acetabulum lies along its bony rim, a concave
inner surface fitting the surface of the head of the femur, and a convex outer surface in contact with the capsule and synovial membrane of the joint. The capsule is attached to the bone round the acetabulum directly beyond the labrum, and is in fact inserted into the labrum at

several points (Fig. 25). During the upward migration of the femoral head, the labrum is turned outwards and pressed against the outer surface of the ilium. Similarly the upper part of the capsule becomes a flap interposed between the iliac surface and the outer surface of the labrum or limbus. It becomes adherent to the latter and the two finally form what has been called the limbus (Fig. 26).

When the femoral head has reached its highest point and has left the limbus behind, the natural elasticity of the latter causes it to retract towards the acetabular cavity, taking with it of course the capsular flap which has become part of it. In this way a semilunar diaphragm, consisting of the limbus on the inside and capsular material on the outside, is formed between the dislocated head and the mouth of the acetabulum (Fig. 27). The outer covering is continuous with the hood of capsule which covers the displaced femoral head. Probably the up and down movements of the dislocated head during walking, causing alternate stretching and relaxation, contribute to the hypertrophy of the labro-capsular fold. This explains the big limbus found in the hips of children who have already been walking. When the labro-capsular fold or limbus is present it must be removed completely as near as possible to the acetabular rim.

c) The ligamentum teres—In congenital dislocation the ligamentum teres may or may not be present. Some authors are of the opinion that, even when the ligament is not found, it has been present originally but has been worn away either by the process of dislocation or later as the displacement became greater (Ortolani 1948). No doubt there are such cases, for sometimes a remnant of the ligament is found inserted in the surface of the head (Fig. 28), or one may find a trace of it in the fundus of the acetabulum together with the usual fibro-fatty pad; in other instances not the slightest trace can be found at either place. It seems likely
therefore that absence of the ligamentum teres may be one of the features of the congenital malformation, the dysplasia essential to dislocation.

The following case report illustrates the variability of the ligamentous dysplasia. A girl aged eighteen months had bilateral congenital dislocation of the hip which had been diagnosed before walking. Conservative reduction having failed, open operation was carried out, on the right side first; the ligamentum teres was completely absent. Two days later the child died from hyperthermia pallida. At necropsy the left hip was seen to have a hypertrophic ligamentum teres (Figs. 29 to 31).

The ligamentum teres therefore may be: 1) congenitally absent, 2) initially present but later torn or worn away during and after dislocation, 3) present and abnormally long and thick, usually rather flattened like a thick ribbon (Figs. 32 to 34).

Because a hypertrophic ligamentum teres must obstruct or even prevent reduction of the head into the acetabulum, it must be removed. This raises the question of its importance in the blood supply to the femoral head. Our experience persuades us that the ligamentum teres plays no important part in the blood supply. It is greatly stretched and flattened, and at the femoral end in particular is pressed against the head of the femur, and it is therefore extremely unlikely that any important blood vessels pass through it. Moreover, microscopical examination has shown that although there are one or two tiny arteries at the acetabular end, none can be found at the femoral end; only dense fibrous bundles can be seen (Figs. 35 and 36). When at operation the ligamentum teres is cut near its femoral end, blood flows from the distal but not from the proximal part, whereas when it is cut at its acetabular origin, blood does

FIG. 29

FIG. 30

FIGS. 29 TO 31
Variability in size of ligamentum teres. Appearances of hips of child of eighteen months with bilateral dislocation who died after operation on right hip. Figure 29—The right hip at operation: note absence of ligamentum teres. Figure 30—The left hip at necropsy: note the large ligamentum teres. Figure 31—The radiograph.
in fact flow from the ligament. This shows that though blood enters the ligament it does not succeed in passing along it to the femoral head.

4) The head and neck of the femur. Owing to the lack of acetabular influence and to abnormal stresses, the head of the femur becomes deformed. Figure 37, for instance, shows the head pear-shaped. Sometimes the articular cartilage may flake off and disappear, leaving underlying spongy bone, which may look like a sieve (Fig. 38). We do not believe that the head should be reshaped or that the acetabulum should be excavated. These measures have led to stiffness and even to complete ankylosis.

It is common to find anteversion of the femoral neck. This has been regarded as one of the causes of redislocation or of residual subluxation. The degree of anteversion has been measured by various methods which we regard as rather time consuming and never wholly accurate, but we are satisfied that anteversion, however severe, has never in itself prevented open reduction. It is merely necessary to rotate the leg sufficiently for the head to enter the
acetabulum. It is very rarely necessary to perform an osteotomy at the time of operation; usually the anteversion is spontaneously corrected by the influence of muscle action and by the indirect effect of one hip on the other, both these influences acting on rapidly growing bone which might well be called plastic. If natural correction of anteversion does not occur, then some months or even years later a rotation osteotomy can be performed. It is, however, not necessary to do the osteotomy to obtain reduction.
e) The acetabulum—The deep part and sometimes most of the acetabulum is filled not only with the ligamentum teres but also with fibro-fatty tissue which usually adheres to the ligament (Fig. 39). All this must be removed because it either prevents reduction or prevents proper centering. The cartilage covering the roof of the acetabulum (facies lunata) is very important in containing the femoral head, tends to be more or less always deficient, and must be preserved. After reduction this deficiency, like the others, fortunately tends to be made good during subsequent development. The stimulating effect of the head in the acetabulum causes a progressive development until the head may be completely covered, just as in a normal hip. However, if, as happens sometimes, this does not occur, then after a suitable length of time acetabuloplasty with reconstruction of the roof must be carried out. If the patient is already fairly old (in this context, three or four years of age) a particularly aplastic acetabular roof must be corrected at the time of the open reduction. The technique we use is described later. Ordinarily after reduction, which is obtained quite easily once the obstructing factors have been removed, the hip is immobilised with the leg in 30 degrees medial rotation and 40 degrees abduction.

Before the wound is closed it may be necessary to free the upper part of the capsule from the iliac surface. The consequent excess may be removed and sutured, or may be folded and sutured, but it must be close fitting and under some tension in order to resist any tendency to redislocation. The divided muscles are sutured, the psoas being lengthened; the rectus, gluteus medius and gluteus minimus usually return to their original positions. We usually have a radiograph before we close the wound completely. Plaster is then applied with the hip in the position of reduction.

**AFTER-CARE**

Immobilisation in plaster is continued for two months with radiographic checks (Figs. 40 and 41). Antibiotics are regularly given during the first few days after operation, until fever subsides.

After removal of the plaster an abduction apparatus is used: we are not much concerned which type, so long as it keeps the legs abducted and medially rotated and at the same time allows some degree of mobility (Fig. 42).

A successful operative reduction is not in itself sufficient to guarantee an ultimately good result. It has merely brought into correct relation parts of a morphologically abnormal joint which can only achieve normality by the effect of natural forces. The care of the patient after operation is very important and everything possible must be done to foster the proper development of the joint. Free movement and later weight bearing must be allowed only if clinical and radiographic findings show that they are safe. Epiphysitis is rare and is not usually of any great ultimate significance, because the joint usually becomes quite normal (Figs. 43
to 47). The condition of the acetabular roof is more important and requires assessment, which sometimes is very difficult. The abduction apparatus is worn for a period of time depending on the progress of the hip. It is discarded gradually over a period during which supervised exercises are done. Slight inadequacy of the roof and some residual signs of epiphysitis do not forbid movement without weight bearing; in fact we suspect that movement stimulates normal growth. Weight bearing, on the other hand, is a more difficult question, and has to be deferred for varying periods of time after operation, until the acetabular roof has developed sufficiently to contain at least two-thirds of the femoral head. We follow up our patients even when their hips seem quite normal: at first we see them once every six months, and later on every year until they reach adult life.

SECONDARY OPERATIONS

In most cases development is normal, the epiphysis of the head grows properly, the acetabulum and the head adapt themselves to one another, and the valgus and anteversion correct themselves. Occasionally, though, acetabuloplasty or osteotomy are necessary.

The technique of acetabuloplasty—By a Smith-Petersen approach the joint is opened and the lateral aspect of the iliac blade is exposed. The leg is under traction and is medially rotated; the head of the femur is put into the acetabulum and a radiograph checks that it is correctly centred. A curved incision about one centimetre above the upper rim of the acetabulum is
made into the iliac wall, and then this curved flap of bone is levered down until it covers the projecting part of the head. The bone flap is kept in position by a number of small bone pegs taken from the tibia (Figs. 48 and 49). The patient is immobilised first in plaster and later in the abduction apparatus until the new roof of the acetabulum is well incorporated in the pelvic wall (Fig. 50).

Osteotomy—A watch is kept for anteversion or coxa valga, but usually these disappear spontaneously and completely. Occasionally the spontaneous reaction to normal stresses is inadequate and coxa valga subluxans develops. This needs correction because the valgus shape and the anteversion impair the development of the acetabulum. The need for operation is not very urgent and we may wait even a few years before carrying out the correction. Both deformities are corrected simultaneously by intertrochanteric osteotomy (Figs. 51 to 53).
ANALYSIS OF MATERIAL

We have operated on 187 hips in 162 patients during the years 1947 to 1959 inclusive. One hundred and thirty-seven patients had unilateral and twenty-five bilateral dislocation.

Of the unilateral cases sixty-three (46 per cent) affected the right, and seventy-four (54 per cent) the left hip. There were 140 girls and twenty-two boys. Seventy-two per cent of the patients were operated on before the age of three (Table I).
INDICATIONS

In ninety-one hips (48 per cent) open operation was undertaken as the first treatment, in thirty-five (18 per cent) of these because of the patient’s age, and in fifty-six (30 per cent) because of anatomical conditions.

In ninety-six hips (52 per cent) operation was undertaken because of failure of closed reduction, the initial attempt having been made by ourselves in forty-two of these hips. Our attempts at closed reduction were always carried out with the patient deeply anaesthetised, and we stopped as soon as obstacles were encountered. In twenty-five instances we desisted immediately because of the clinical impression of irreducibility. In twenty-two patients failure of reduction was revealed by radiography either immediately before or just after application of plaster. We cannot say what techniques were used for attempted reduction in the other fifty-four hips, but most of the patients had been in plaster for several months.

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Number of children</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 1</td>
<td>18</td>
<td>11</td>
</tr>
<tr>
<td>1–2</td>
<td>52</td>
<td>32</td>
</tr>
<tr>
<td>2–3</td>
<td>47</td>
<td>29</td>
</tr>
<tr>
<td>3–4</td>
<td>24</td>
<td>15</td>
</tr>
<tr>
<td>4–5</td>
<td>21</td>
<td>13</td>
</tr>
</tbody>
</table>

FINDINGS AT OPERATION

Gluteus medius—In six operations (3.2 per cent) shortening of this muscle was recorded as a factor preventing reduction. The real frequency was probably greater, because the approach we use involves detachment of part of the gluteus medius, so reducing its obstructive capacity. Sometimes we have at the end reattached the gluteus medius a little lower than normal, stitching its origin into the peristeum, though in any case the position of 45 degrees of abduction tends to relax it.

The iliopsoas—As already mentioned, we always perform a “Z” elongation of the psoas muscle. This makes it easy to bring down the head of the femur and to display the lower half of the acetabulum. In ninety-eight hips (52.4 per cent) the psoas was a very real obstacle to reduction, its tendinous part seeming almost to seize the capsule and to strangle it.

Pericephalic insertion of the capsule—We observed this in sixty-three hips (33.6 per cent). Sometimes it was caused by previous attempts at closed reduction or subsequent immobilisation, or both, but occasionally it was found in primary reductions and was then presumably congenital. The adherence of the capsule to the neck and head of the femur varied from an attachment to the perimeter of the articular surface to a partial covering of this surface. We always detached the capsule.

Capsular adhesions—When there were adhesions between one part of the capsule and another there had almost been an attempt at closed reduction, and we concluded that the adhesions were acquired.

The “limbus-capsule fold ”—This anomaly, usually referred to as the “limbus,” was observed in sixty-nine hips (35 per cent). In many patients, especially those less than two years of
age, it did not exist or was so slight that the head could easily pass it and make a perfectly good fit. In children over two years it could be considerably developed and we had the distinct impression that walking on a dislocated hip stimulated hypertrophy (Figs. 14 and 15).

**Ligamentum teres**—This was congenitally absent in thirty-seven hips (19.8 per cent), without any remnant at all either on the head of the femur or in the fundus of the acetabulum. In fifty-eight (31 per cent) we found remnants of ligamentum teres, most often as an atrophic fragment in the fundus together with the fibro-fatty tissue. In ninety-two hips (49.2 per cent) the ligament was found complete in various conditions—sometimes thin and soft, practically reduced to a synovial fold; in others thick, strong but flattened, and sometimes frayed and damaged over its whole length. We always removed it because it obstructed complete reduction.

**Head of the femur**—In thirty-nine hips (20.9 per cent) the head of the femur was deformed. Usually it was pear-shaped (probably from flattening against the ilium), sometimes it was oval (from pressure of the ligamentum teres), and sometimes the articular cartilage was exfoliated, even exposing spongy bone.

**Neck of the femur**—We recorded neither the angle of the necks nor the degree of anteversion, because we thought that to do so during operation would waste time, and that the measurements would be relatively inaccurate and of no practical importance. Some anteversion of the neck was evident, as judged by the degree of medial rotation necessary to reduce the head completely into the acetabulum. In only three hips (1.6 per cent) did anteversion prevent us from centering the head without osteotomy.

**Acetabulum**—Shallowness of the acetabulum was due mainly to obliquity of the roof which was always present to a varying extent. On eleven occasions (5.9 per cent) a reconstruction was carried out at the same time as the reduction. These were done in patients with pronounced acetabular aplasia who were already four to five years of age, and who seemed extremely unlikely to acquire a satisfactory acetabular roof spontaneously. The fundus of the acetabulum was always filled by a mass of fibro-fatty tissue containing the ligamentum teres. In sixty-seven hips (35.8 per cent) hypertrophy of this fatty tissue and the firmness of its fibrous element were an important factor preventing the proper seating of the head. We always cleared out the obstructive tissue regardless of the haemorrhage which sometimes occurred. This was always easy to deal with, and since this fundus of the acetabulum is not lined with articular cartilage and plays virtually no part in articular movements, it is not necessary to treat it so scrupulously as the part of the acetabulum covered with articular cartilage.

**Disparity of the head and acetabulum**—In nine hips (4.8 per cent) the head was too large for the acetabulum, and in others it was misshapen. Never did we ream the acetabulum or reshape the head. All one can do is to place the head as properly as possible in the acetabulum and keep it there. Only the natural development of the two parts of the joint, brought thus into contact, can ultimately shape them normally.

**The most frequent combinations of anatomical obstacles**—In only eleven hips (12 per cent) was there only a single obstacle to reduction. The most frequent combinations were the following: 1) tight psoas muscle; hypertrophic ligamentum teres; fibro-fatty tissue in the fundus of the acetabulum—fourteen hips (7.5 per cent); 2) tight psoas muscle; pericephalic insertion of the capsule with or without adhesions—fifteen hips (8 per cent); 3) limbus; hypertrophic ligamentum teres and fibro-fatty tissue in the fundus—twenty-three hips (12.3 per cent); 4) tight psoas; pericephalic adhesion of the capsule; deformity of the head—fifteen hips (8 per cent); 5) tight psoas; limbus—nineteen hips (10 per cent); 6) limbus; fibro-fatty tissue in the fundus—eighteen hips (9.6 per cent); 7) hypertrophic ligamentum teres; pericephalic adhesions—twelve hips (6.4 per cent). The incidence of other combinations of anatomical obstacles was negligible.

*Vol. 44 B, No. 2, May 1962*
COMPLICATIONS

Operative mortality—There were three deaths after operation (1·6 per cent). Two were the result of shock and probably could have been prevented by more liberal blood transfusion. The third was from the syndrome of "pallid hyperthermia of Ombredanne" which defied all attempts to combat it. These deaths occurred many years ago and today with the advances in anaesthesia and anti-shock technique these children would probably not be lost.

Infection—Thirteen wounds (7 per cent) became infected, but infection was always limited to the soft tissues and rapidly responded to treatment. On four occasions (2·2 per cent) it was necessary to open the plaster in order to release pus. Infection of the soft parts had no influence on the ultimate result: the joint was never infected though we did observe stiffness due to periarticular fibrosis, and this necessitated a longer period of re-education.

Circulatory disturbances—These were never severe enough to be regarded as real complications. A few instances of peripheral static oedema occurred but this disappeared rapidly when the plaster was eased. We had no cases of phlebitis.

Injury to nerves—In the children over five years of age there were frequently indications of temporary nerve injury, at times fairly severe; but in the younger patients, up to the age of five, this happened very rarely. When the age is a little advanced or the head is very high, stretching of the sciatic nerve may occur after reduction, and we later took the precaution of having the knee bent during immobilisation in plaster. Only very occasionally did we then have any paresis or paraesthesia—the lateral popliteal was the nerve usually affected.

Redislocation—By this we mean redislocation in plaster revealed by the control radiograph. Such redislocation occurred in fifteen hips (8·1 per cent). Reduction under anaesthesia, closed in twelve cases and open in three, was completely successful, and the ultimate results were unaffected.

SECONDARY OPERATIONS

Reconstruction of the acetabular roof—This was carried out twelve times (6·5 per cent) between one and five years after reduction. Unless reconstruction of the roof appears necessary during the initial open reduction, it is difficult to predict the extent of spontaneous reconstruction; the younger the patient the better the chance. At least a year must elapse before one can decide that it cannot be left to nature.

Osteotomy—This was performed sixteen times (8·7 per cent), the interval after reduction varying from two to eight years. We believe that before dealing with valgus and anteversion we should wait much longer than for reconstruction of the roof, because in many cases there is slow spontaneous correction under the stimulus of function. Recurrence may follow premature osteotomy.

PERIOD OF TREATMENT IN ABDUCTION

The average duration of treatment in abduction apparatus was six to eight months (Table II). The average time before weight bearing was allowed was fifteen months (Table III). It was longer in bilateral than in unilateral cases and especially long if there were some complication such as osteochondritis.

RESULTS

Review of other workers' results—If a valid comparison of the results of different surgical methods is to be made, objective data must be uniformly used. Nearly every writer has used a personal standard to assess the results, and consequently reliable comparison is impossible.

Galloway (1926) reported the results of seventy-six open reductions: thirty-one cured; thirty-three good; five doubtful and seven bad. Farrell and Howorth (1935) reported the results of 122 operations, seventy-seven with good function. Kidner (1931) recorded the results of thirty-four operations: fifteen excellent; eleven good; two fair; three mediocre. Scaglletti (1939) commented on the outcome of fifty-four hip operations at the Rizzoli Institute: 25 per cent
good; 35 per cent fair; 40 per cent unfavourable. Leveuf (1948) analysed results of 116 operations: 81 per cent good or perfect results. Somerville (1953) limited the intervention on the joint itself to removal of the limbus. The results in twenty-three patients were reported as favourable, but precise figures were not given. Laurent (1953) included lateral transposition of the psoas in the operation: all but eighteen of his seventy patients had subsequent subluxation, mostly occurring soon after the operation. Rivarola (1954) distinguished between primary open

<table>
<thead>
<tr>
<th>TABLE II</th>
<th>DURATION OF TREATMENT IN ABDUCTION (184 HIPS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration of treatment (months)</strong></td>
<td><strong>Number of hips</strong></td>
</tr>
<tr>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td>6</td>
<td>43</td>
</tr>
<tr>
<td>8</td>
<td>58</td>
</tr>
<tr>
<td>10</td>
<td>37</td>
</tr>
<tr>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Over 12</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE III</th>
<th>INTERVAL BETWEEN OPERATION AND START OF WEIGHT BEARING (184 HIPS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interval (months)</strong></td>
<td><strong>Number of hips</strong></td>
</tr>
<tr>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>10</td>
<td>19</td>
</tr>
<tr>
<td>12</td>
<td>28</td>
</tr>
<tr>
<td>14</td>
<td>29</td>
</tr>
<tr>
<td>16</td>
<td>31</td>
</tr>
<tr>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>22</td>
<td>7</td>
</tr>
<tr>
<td>24</td>
<td>9</td>
</tr>
<tr>
<td>Over 24</td>
<td>17</td>
</tr>
</tbody>
</table>

reduction and open reduction in hips in which closed reduction had been attempted. In the former group—sixty-one cases—he gave 65 per cent good results.

Meary and Gourdon (1954) reported the results of operative treatment in thirty-three children under five years old. There were no excellent results, nine good results, ten fair, thirteen mediocre and one bad. Guilleminet (1955) analysed results in thirty-eight hips. Nineteen were good, ten fair, and nine were failures. Somerville (1955) gave further data on fifty-three patients in whom the limbus had been removed and rotation osteotomy had been performed. The results in all were considered excellent, but no accurate figures were given.
Zanoli (1955) reported 352 open reductions at the Rizzoli Institute between 1899 and 1950; on the whole, good results were obtained in about 50 per cent. The anatomical features were said never to be perfect, and a perfect functional result was apparent in only 12 per cent. Of course the period covered was a very long one and the material very mixed. Bertrand and Guias (1955) published the results of operative reduction in a series of 394 hips operated on at Pont l'Abbé. They recorded 75 per cent of good to very good functional results, and 73 per cent of good to very good radiographic findings. They add that in a series of 191 hips operated on in Paris the results have been slightly less good, but the percentages in this series are not stated. Virenque and Pasquié (1956) published results in seventy hips operated on by the method of Ollier, using an ample approach. They found marked stiffness in 30 per cent; limited mobility in 50 per cent; and normal mobility in 15 per cent. In 55 per cent osteochondritis of the hip affected the long-term results. In twenty-eight other hips, where Hueter's approach was used and the operation was kept as limited as possible, 100 per cent gained perfect mobility and osteochondritis occurred in only 7 per cent. However, the latter group consisted entirely of early cases.

Method of classifying results—We have classified our own results in the way requested by Professor Bryan McFarland for the Symposium at the International Congress in New York in September 1960, which is as follows:

Grade 1—A hip indistinguishable from normal, clinically and radiographically, some five, six or seven years after treatment (Fig. 54).

Grade 2—There might be some slight defects, clinically or radiographically or both—a little limitation of movement (say medial rotation and abduction), a very slight limp discernible to an acute observer, and perhaps by radiographs one could detect which hip had been dislocated—or in a bilateral case one could tell that both hips had been affected.

Grade 3—The child (and the child's parents) might have no complaints: there would be no limp that attracted attention, and the child would not be incapacitated for ordinary life including games: but on examination there would be some limitation of movement (not marked but discernible) or perhaps a little limp though not a real dip, or both; and in the radiographs perhaps a deviation from normal that made it perfectly obvious that there had been a dislocation.

Grade 4—Function not much better than without treatment, with either a fairly pronounced limp, including perhaps a dip, or else enough stiffness to prevent a normal place in school life, and probably radiological defect portending later osteoarthritis, secondary subluxation (Fig. 55).

Grade 5—A child worse off than without treatment, with one stiff hip in a bad position or two stiff hips in the mean position, or an ugly gait due to osteotomies that had gone wrong (Fig. 56).

Although this system is not without imperfections (it is perhaps a little too subjective), it classifies results with sufficient clarity. Its wide adoption would make possible a valid comparison of results of different forms of operative and non-operative reductions by many different operators throughout the world.

The time between treatment and the assessment of the result ought to be clearly stated. One cannot speak of a definite result until the joint has reached a certain degree of development, and this moment is difficult to determine.

McFarland (1956) in his system of classification states that, when a one-year-old child is treated the result may be assessed in say five years, whereas if a child is three to four years old, an interval of six, seven or eight years must elapse before the result can truly be judged. Although we agree substantially, we believe that these intervals are unnecessarily long: as a rule the result can be assessed two to three years after treatment finishes. This does not mean that after more than two or three years the result may not become less favourable, but it does mean that at that time it should be possible to predict whether the result will become
worse and to classify the hip accordingly. In classifying our results we have started after an interval of six months and have continued our follow-up for as long as ten years (Table IV). Up to two years after operation the results must be regarded as preliminary and perhaps of little significance. After two years they are regarded as definite, though with the above mentioned reservation.

VOL. 44 B, NO. 2, MAY 1962
Our report of the results is based on 171 hips, because from the 187 hips operated on we have subtracted eight hips operated on less than six months before, five hips of children who were not available for the first follow-up examination at six months, and the three hips of the children who died after operation.

**Analysis of our results**—A review of the results in 171 hips followed up for at least six months to at most ten years shows that fifty hips attained a Grade 1 result, and sixty-seven a Grade 2 result. In Grade 3 were thirty-three hips. In Grade 4 with unsatisfactory results there were fourteen, and in Grade 5—complete failure—were seven hips (Fig. 57). On the whole, we may regard the hips in Grades 1 and 2 as the good results: there were 117 of these (68·3 per cent). The hips in Grades 3, 4 and 5 represent the bad results: these total fifty-four (31·6 per cent). If the ninety-seven hips followed for less than two years are separately considered we find that in all there were sixty-seven good results (69 per cent) and thirty bad results (31 per cent) (Fig. 55). If we separately consider the seventy-four hips reviewed after more than two years,

<table>
<thead>
<tr>
<th>Length of follow-up (years)</th>
<th>Number of hips</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>½ to 1</td>
<td>29</td>
<td>17</td>
</tr>
<tr>
<td>1 to 1½</td>
<td>32</td>
<td>19</td>
</tr>
<tr>
<td>1½ to 2</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>2 to 3</td>
<td>22</td>
<td>13</td>
</tr>
<tr>
<td>3 to 4</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>4 to 5</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>5 to 6</td>
<td>14</td>
<td>8</td>
</tr>
<tr>
<td>6 to 7</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>7 to 8</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>8 to 9</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>9 to 10</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Over 10</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

in which we may regard the results as definite, we find that there were fifty good results (67·5 per cent) and twenty-four bad results (32·5 per cent) (Fig. 58). The figures for the early and the later results are very similar.

**Later results**—Forty-seven hips were reviewed at least five years after operative reduction. A comparison of the ultimate results with those recorded at the end of the second year of follow-up shows little difference between the percentages of success and failure (Fig. 59). When, on the other hand, we examined the individual cases, we found that there were more alterations than the percentage results suggested: several hips got worse as articular imperfections became more pronounced; others changed for the better as the reconstruction of the joint progressed. These cases compensated for each other until the comprehensive results showed a practically unaffected picture.

**Results related to age**—This relationship has always been considered very important because experience has taught us that the older the patient at the time the reduction is attempted the more difficult it is to obtain good results. In considering the influence of age we have included
only those cases in which the results have been followed up for more than two years after operation.

The best results were obtained when the patients were operated on at an early age (Fig. 60). We have concluded that the most suitable age for operation is up to three years: beyond that the percentage of good results decreases greatly. The percentage of good results in the one-year-olds is lower than that in the two-year-olds and three-year-olds; this may perhaps be because in the babies operated on under the age of one year the abnormality of the hip is usually particularly severe.

Results related to the indications for operation—The results of operations undertaken as a primary measure were the better of the two groups, no doubt because the hips in which closed reduction had failed had suffered a certain amount of trauma and immobilisation (Fig. 58). Our impression was that when the attempted closed reduction had not damaged the joint the results of operation for primary and for secondary indications were very much alike.

Results of open reduction in which additional operations were necessary—Acetabuloplasty was done on nine hips, of which two obtained a Grade 2 result and seven a result of Grade 3 or worse. Osteotomy was done twelve times; seven of these hips obtained a Grade 2 result and five a result of Grade 3 or worse. Although the numbers are rather small, they tend perhaps to indicate that the results of corrective osteotomy are better than those of the shelf operation. We have therefore tended lately more towards osteotomy.

Failure—Although one has to wait several years before a result can be assessed as good, only a few months suffice to reveal a failure. Improvement is confined to joints that from the beginning show a good reduction. We regard as failures Grades 5 and 4, and include Grade 3, though we feel that the standard thus set is very high. Fifty-four hips came into Grades 3,
4 and 5: twenty-one of these were in Grades 4 and 5—absolute failure. The causes of failure were redislocation (three hips—5 per cent); subluxation (twenty-seven hips—50 per cent), and osteochondritis (twenty-four hips—44 per cent).

**Redislocation and subluxation**—Fortunately the incidence of complete redislocation is very low—1.7 per cent in the whole series—and we think that with increased experience it will be lower still. On the other hand, subluxation is a frequent cause of failure—15.7 per cent in the whole series—and we ascribe it to the inability of the roof of the acetabulum to develop enough to contain the head of the femur adequately. Often the inadequacy is increased by valgus of the neck and anteversion of the head. It is difficult to determine whether inadequacy of the acetabular roof or coxa valga is the more important: probably they influence each other. The unfortunate significance of the consequent subluxation is that although the joints are not very abnormal during the first few years, they cannot escape arthrosis and consequent disability later on in life.

**Osteochondritis**—Osteochondritis, which occurred fairly often—24 per cent in the whole series—was not ultimately of serious significance; usually there was no permanent alteration, or insufficient to affect the final result. Of course if osteochondritis develops, weight bearing must be postponed for a longer time, in fact until the signs have disappeared. Very occasionally severe osteochondritis causes changes in the epiphysis and the neck of the femur incompatible with a good result, usually with coxa vara and occasionally a thick, irregular-shaped head, quite out of proportion to the acetabular cavity. Nothing can be done to correct these severe deformities. Apart from gentleness in operation and moderation in the position and time of immobilisation there is little that we can do to diminish the frequency of post-operative osteochondritis. It is certain that unreasonably prolonged attempts at closed reduction are bad.

**CONCLUSIONS**

A few points in this report deserve to be stressed.

**Indications**—It is important that the orthopaedic surgeon should decide at a very early stage which of the two methods, closed or open, he must use. These do not exclude each other but are on the other hand complementary. Nowadays the dislocated hip can be reduced by open operation with a very good chance of lasting success. This should be carried out if a hip cannot easily be reduced otherwise, or if there is any doubt that closed reduction has been successful—and as early as possible, preferably before the age of three years.

**Technique**—Ample exposure of the joint and removal of all obstacles to reduction are important. Reduction must be complete and stable but without stress, and there must be no interference with the articular bone and cartilage.

**After-care**—Reduction, however perfect, is only the first step towards recovery. The hip must be observed carefully and the most suitable moments for mobilisation and for walking must be chosen; this calls for nice judgment. When it is clear that the roof of the acetabulum is not developing or that persistent valgus and anteversion may encourage subluxation, a secondary operation should be undertaken at once. Radiography is necessary about every three months for the first two years.

**Assessment of results**—With a strict system of assessment, like McFarland's, we have observed 68.3 per cent favourable results in 171 hips treated by open reduction.
OPEN REDUCTION OF CONGENITAL DISLOCATION OF THE HIP

It is obvious that the problem of congenital dislocation of the hip has not yet been completely solved. But if we review the progress of recent years we come to the encouraging conclusion that much has already been achieved, and that the efforts of the many orthopaedic surgeons who have dedicated themselves to the treatment of congenital dislocation of the hip have not gone unrewarded.

REFERENCES


