CONGENITAL DISLOCATION OF THE HIP

M. BECKETT HOWORTH, M.D., D.SC. (MED.)
NEW YORK, N. Y.

FROM THE COLLEGE OF PHYSICIANS AND SURGEONS OF COLUMBIA UNIVERSITY, AND THE NEW YORK ORTHOPEDIC HOSPITAL, NEW YORK CITY, N. Y.

EMBRYOLOGY AND INFANT ANATOMY

THE SEARCH for the cause of congenital dislocation of the hip is concerned with the development of the embryo and the fetus, and the best surgical treatment of the condition, whether manipulative or open, is dependent upon a thorough understanding of the anatomy of the infant hip. Textbooks of anatomy and embryology are notably brief and often vague on the anatomy of the infant and the embryology of the hip, while, aside from the work of Strayer,[1] medical literature and the personal communications of those familiar with the embryology of other portions of the body are of little assistance here. Because of these considerations a study of the hip joints of available fetuses has been made.

There were 15 specimens ranging in fetal age between ten weeks and full term. As no hip with congenital dislocation was found in this group or could be located in the laboratories or museums of the Columbia University Medical Center in New York, the study was confined to normal hips. The muscles surrounding the hip joint were dissected in detail in the larger specimens, and the capsule of the joint, the femur and the innominate bone were studied in all instances. Dissections were made from various approaches in order to study various portions of the joint without disturbing them. Slides were made of sections from several of the hips and studied microscopically, but as these observations are irrelevant they will not be included here. Roentgenograms were made of the innominate bone and articulated femur in several instances.

The youngest femur measured 2 cm. over-all, and was estimated to be ten weeks old. The muscles of the hip and thigh were not differentiated from each other or their tendons, and consisted of pale homogeneous tissue. The gross proportions and relations of the capsule, femoral head and acetabulum were similar to those of the fetus at term and to the adult hip joint. The femoral head was smoothly rounded and hemispherical and fitted snugly into the well-formed acetabulum, where it was firmly held by a well-developed capsule. The femoral head and the acetabulum consisted entirely of cartilage, and measured 2 mm. in diameter. The femoral shaft was ossified through a length of 7 mm., and the iliac wing contained an ossification center 2.5 mm. across. The anteversion or anterior torsion (the angle between the longitudinal axis of the femoral head and neck and the transverse axis of the femoral condyles) was 15 degrees. The angle between the axis of the head and neck and the longitudinal axis of the shaft averaged 140 degrees. The motions of the joint, except extension which was moderately limited, closely approximated

those of the hips of young children. Thus, the hip joint may be considered perfectly formed in the embryo of ten weeks.

Seven hips of fetuses in the third, fourth, fifth and six months of life were seen, the femur varying in length between 3.3 and 8 cm. (Fig. 1 A, B). The muscles of these specimens were differentiated from each other almost completely and were easily identified, although they did not yet appear grossly to consist of muscle tissue and were poorly differentiated from their tendons. The blood vessels and nerves were easily distinguished. The gross proportions and relations of the structures at the hip were similar to those at term. The femoral head and the acetabulum consisted entirely of cartilage but ossification of the iliac wing had progressed to occupy one-half to two-thirds of its area and a large ossification center had formed in the ischium. There was a cartilaginous lip along the posterosuperior half of the margin of the acetabulum, comparable to the bony lip of the adult, and the labrum glendoidale had formed. The femoral head varied in diameter between 0.4 and 1.4 cm. The femoral shaft was still slightly flexible. The ligamentum teres was well formed but could be torn with little force. The anteversion of the femoral neck was 20 to 25 degrees, and the inclination of the neck to the shaft 120 to 140 degrees. The motions of the joint were complete except extension, which was limited to about 145 degrees by the twisting of the capsule. The fibers of the capsule were seen to run parallel to the neck with the hip flexed to 90 degrees, and, upon extension, to tighten by torsion, resulting in this limitation.

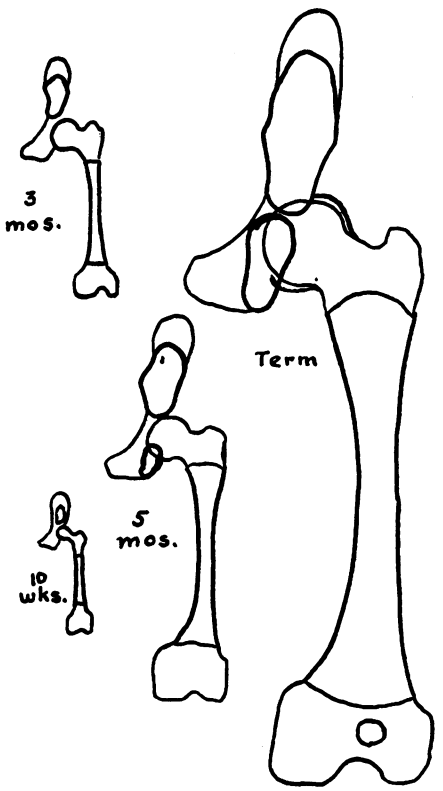


FIG. 1.—(A) Fetal specimens (½ actual size) at ten weeks, three months, five months, and term, showing size and shape of femur and innominate bone, with amount of ossification. Gross appearance similar to adult. Femoral head and neck and acetabulum are well-formed in cartilage, capsule and ligamentum teres well-developed.

Eight hips of fetuses in the seventh and ninth months were examined, the femora varying between 9 and 10.5 cm. in length. (Fig. 1 A, B.) The muscles were well differentiated and their tendons could be distinguished. Blood vessels and nerves were well developed. The ossified portion of the innominate bones occupied about five-sixths of the mass of each, but the acetabulum and femoral head were entirely cartilaginous. The anterior-inferior quadrant of the aceta-

bulum was shallow and the cartilage thin. The labrum glenoidale and the acetabular rim were well developed. The femoral head was 1.6 to 2.0 cm. in diameter. The ligamentum teres was 5 mm. in cross section and, in one instance, traction of several pounds was applied and a plug of cartilage to which it was attached pulled out of the femoral head but the ligament did not rupture. The Haversian gland was well developed. Anteversion varied between 20 and 40 degrees, and the inclination of the neck on the shaft was 110 to 120 degrees. Extension was limited to 160 degrees. The limitation of exten-

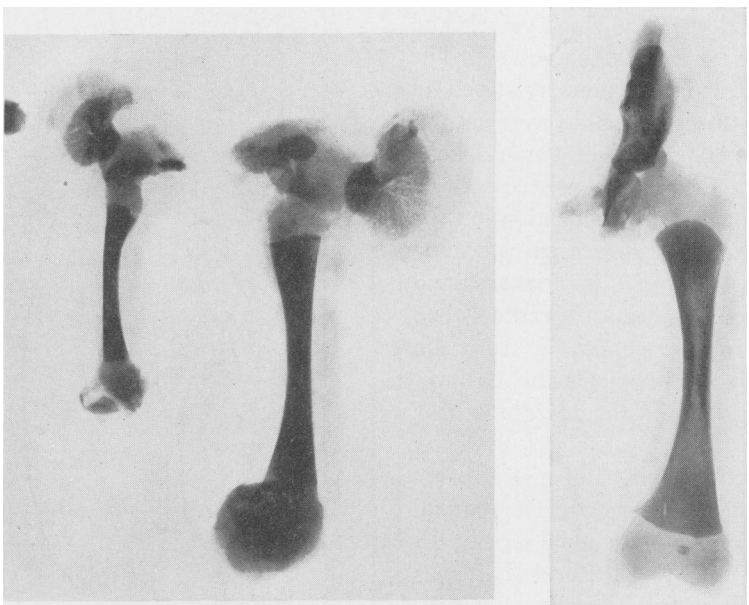


FIG. 1.—(B) Roentgenograms of fetal specimen at three months and at five months (actual size) and at term (reduced ½).

sion by the twisting of the capsule is considered to represent a phase in the evolution of the joint. (Fig. 2 A, B.) Young infants are found to have flexion deformities of the hips, gradually disappearing as the infants begin to stand. The hips of an infant of one year were studied also, but there were no additional findings of consequence.

The cause of congenital dislocation of the hip was not determined from this study. It was hoped that a clue could be obtained as to whether or not these dislocations are due to an hereditary defect, to a local metabolic disturbance or to the application of some force to the femur from uterine pressure or malposition *in utero,* but no defective hip was found, and no conclusion can be drawn here. It is likely that if the deformity is intrinsic to the development of the embryo it occurs in the anlage of the hip, as the joint is so well formed at and beyond the tenth week. There were differences in the male and female pelves of this group, comparable to those of adults, but none which would account for the great preponderance of congenital dislocation in female infants.

Should the deformity be the effect of the application of an abnormal leverage to the femur *in utero* it would appear that associated bowing of the flexible femur might follow such a force, but deformities of the femur are not found in

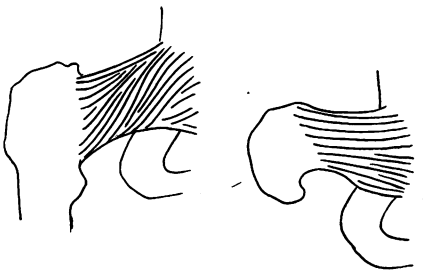
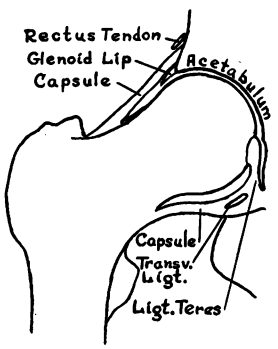


FIG. 2-A 2-B

FIG. 2.—(A) Hip joint capsule showing spiral twist of fibers in extension (from Spalteholz).
(B) These fibers are not twisted in the position of midflexion, but run nearly parallel with the neck.



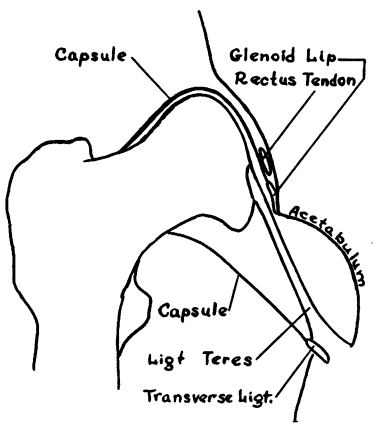


FIG. 3 FIG. 4

FIG. 3.—Normal hip, showing rectus tendon, capsule, labrum glenoidale, ligamentum teres, and transverse ligament.
FIG. 4.—Dislocated hip, showing outward and upward displacement of femur against ilium above acetabulum. Capsule and ligamentum teres elongated, capsule and transverse ligament pulled up over inferior portion of acetabulum. Labrum glenoidale and rectus tendon folded up against ilium. Acetabulum shallow, roof oblique, superior lateral margin defective. Femoral head flattened medially, protuberant inferiorly. Anteversion often present.

children with dislocated hips. No evidence has been found at birth or from operations upon young infants to support the possibility of dislocation by sudden trauma. It has been learned, through a personal communication from a research worker at the Rockefeller Institute, that congenital dislocation of

the hip occurs in rabbits, is apparently hereditary, and may be inbred. We have no evidence that the condition occurs in other animals, but an extensive search was not made.

Dislocation could be due primarily to a relaxed capsule or to a deformity of the acetabulum. At operation, the capsule has always been found elongated, necessarily, but the acetabulum is frequently too well formed to justify the supposition that it is the only primary factor. The ligamentum teres is not normally taut in the ordinary positions, so its relaxation could not be the cause of congenital dislocation. It does not appear that anteversion of the femur is the cause of dislocation, and it certainly is not the sole cause, as many dislocated hips have been found without abnormal anteversion. The position of flexion, external rotation and adduction would favor dislocation, and anteversion would increase this tendency. It appears that the inception of the deformity probably occurs in early embryonic life, and it is likely that relaxation of the capsule is the primary factor. It is desirable that hips younger than the tenth week be carefully studied and that a thorough search be made by pathologists, obstetricians and gynecologists for dislocations of the hip in fetal specimens in order that the cause of this condition may be determined.

There are special anatomic considerations related to these early specimens which are of great importance in the treatment of congenital dislocation of the hip. The greatest relaxation of the capsule is in the midflexed position; thus, the opening into the acetabulum should be largest with the hip flexed, and with a constricted capsule reduction should be more likely in some flexion than in extension. (Fig. 2 A, B.) Furthermore, the immobilization of the hip in forced extension and internal rotation is likely to result in a temporary ischemia by the torsion of the capsule and may be followed by coxa plana. When the acetabulum is too small to receive the whole femoral head it is desirable to enlarge it; in the infant there is a thick mass of cartilage in the superior acetabulum, a moderate portion of which can be removed with a gouge without exposing the ossified portion of the bones, but in the older child bone would be exposed at a depth of about one-eighth inch. The cartilage of the inferior acetabulum is thin and incomplete in the infant; thus, gouging of this area would probably result in opening into the upper thigh or the pelvis. Finally, because the acetabulum is cartilaginous it is difficult in the stabilization operation to construct a bony shelf which would be low enough to really support the hip.

PATHOLOGY

More than 100 hips have been examined at operation by the author, he being the responsible surgeon for 60 of the hips. The operative records of 85 additional hips have been reviewed. These studies form the basis for the following observations:

The femoral head in almost all instances was dislocated outward, upward, and forward, the capsule and rectus tendon being elongated to follow the head (Figs. 3, 4, 5 and 6). The capsule was usually somewhat thickened. The

muscles, tendons and fasciae attached to the trochanters and their neighborhood, and the innominate bone, were elongated or contracted to fit the altered mechanical situation. Abduction was limited by the leverage of the femur against the ilium, with the adductor muscles resisting. The posterior dislocations were few and almost uniformly occurred in older children.

It seems likely that the posterior dislocation is simply the ultimate result of the primary anterosuperior dislocations in which the capsule becomes greatly elongated, allowing the head to rise upward and swing backward on the ilium, since it is limited anteriorly by the tendons attached to the spines of the ilium. The greater proportion of posterior dislocations reported by others may be due to the greater percentage of older cases. It is probable that a posterior dislo-

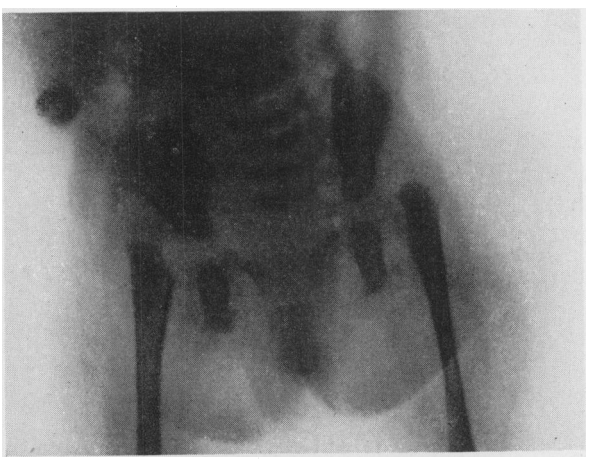


FIG. 5.—Roentgenogram of bilateral dislocation in specimen at 8th fetal month, showing clearly the lateral and upward displacement of the femur.

cation is more likely to occur in the absence of marked anteversion, which throws the head forward, and this is borne out by the fact that anteversion in these posterior dislocations was usually absent, whereas there was often a retroversion.

Telescoping (instability on pushing up and pulling down the leg) was present in varying degree, being less marked in the anterior dislocations and often as much as one inch in the posterior ones (Figs. 4 and 6). There was rarely appreciable relaxation on pulling the femur laterally or backward and forward in the anterior dislocations, but such relaxation was usually present with a posterior dislocation, being sometimes as much as one-half inch. Several of the hips were not completely dislocated, a portion of the femoral head remaining under the superior lip of the acetabulum, the head sliding in and out on manipulation.

The principal obstructions to bringing the femoral head down to the level of the acetabulum, which is necessary for the accomplishment of reduction, were the adherence of the capsule to the ilium above the acetabulum and the

contraction of fasciae and muscle sheaths (Fig. 4). While the capsule was not always pulled up enough to result in adherence to the ilium, in the remaining cases the cartilaginous superior margin of the acetabulum, the labrum glenoidale and the rectus tendon were turned upward and deformed in such a way as to produce the same effect. The adductor longus and gracilis are the muscles which most commonly interfere with traction, the rectus femoris, sartorius.

FIG. 6-A

FIG. 6-B

FIG. 6.—Roentgenogram of dislocated right hip as shown by displacement of femur laterally and upward. Telescoping, as shown by:
(A) Upward pressure—further displacement upward.
(B) Traction—femur down to nearly normal level in relation to acetabulum, in position for reduction.

tensor fascia femoris, iliopsoas, and gluteals being frequently contracted also. The fascia lata, particularly the iliotibial band, often offers strong resistance. The remaining adductors and the hamstrings rarely offer difficulty.

It was possible in many of the younger cases to bring the femoral head down to the level of the acetabulum by traction or flexion. In many such

instances an attempt was made to reduce the dislocation at open operation just before opening the capsule. It was found impossible in about half of these hips to accomplish the reduction, whereas about half of those reduced were found to redislocate easily upon bringing the thigh from the abducted position toward neutral. Upon opening the capsules the reasons for this difficulty were obvious.

The inferior portion of capsule was nearly always pulled up over the lower portion of the acetabulum and, in the children who had passed infancy, had become firmly attached to the margins of the acetabulum (Fig. 4). There was often also a slight side to side constriction of the capsule but in all hips up to

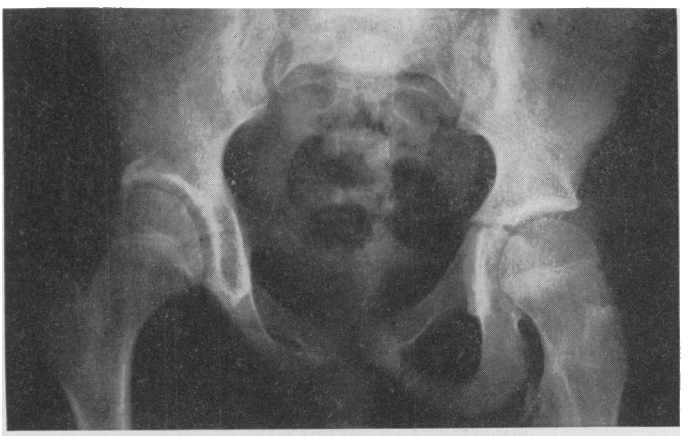


FIG. 6-C

FIG. 6.—(C) Result at age seven years, following failure of closed reduction at two months, successful open reduction at one year.

the age of six years, and in many of the older ones, the superior portion of the acetabulum was open and the superior portion of the capsule pulled upward away from the acetabulum. Thus, the deformity in the capsule is not a typical hour-glass contracture as so often described in the literature. Usually the transverse ligament of the acetabulum was pulled up with the capsule and hypertrophied, more effectively blocking the acetabular opening. Adhesions between the two synovial surfaces were rarely found. The Haversian gland, located in the acetabular fossa, hypertrophies in response to the absence of the pressure of the head. This hypertrophied gland was usually found to fill the inferior third of the socket. In some instances this tissue filled the whole acetabulum and gradually grew into and replaced the acetabular cartilage. In such hips the acetabulum was sometimes found to be obliterated by a mass of fibrous tissue. The ligamentum teres was elongated directly in proportion to the amount of dislocation. Often it maintained its usual diameters or became thickened, but in other hips it was greatly attenuated, split longitudinally, frayed, ruptured or absent. Some of the instances of ruptured or absent teres ligaments might have been due to the traumatism of closed manipulations, but

such conditions have been found in hips which were never manipulated. One or both stumps were usually found, except in the patients older than ten years. Occasionally the ligamentum teres presented evidence of recent injury. It usually oozed blood slightly from its proximal stump when divided at operation, but was only once seen to bleed enough to suggest that it was furnishing an important portion of the blood supply to the head.

The acetabulum was usually well formed in these infants, although in many hips the superior cartilaginous margin had been pushed up or even folded back upon the ilium, resulting in an oblique defective socket for the femoral head and a poor false acetabulum at the acetabular margin. Fig. 4. It appeared that the plastic cartilage had been molded by the pressure of the femoral head. If the capsule was sufficiently relaxed to permit complete dislocation upward on the ilium, the acetabular margin often escaped this deformity. In such cases the capsule was sometimes adherent to the ilium and cartilaginous in this area, forming a false acetabulum; in others the capsule was loose and movable and the femoral head had no fixed support. The depth of the acetabulum was not great enough to accommodate the head in about half of the hips, and in a smaller proportion the diameter of the head was greater than that of the acetabulum, whereupon the head could not be forced into it. These abnormalities were more frequent and more severe in older patients, the superior lip usually being absent.

The femoral head was frequently flattened medially; this was more common in the hips in which the head was impinging against the superior margin of the acetabulum. Near the junction of the head and neck inferiorly there was usually an enlargement of the bone, which was apparently due to the medial flattening of the head and probably associated with some circulatory disturbance. This elevation was frequently large enough to give the inferior half of the head a shape somewhat similar to that of a door knob. The femoral head and neck were often broadened. Occasionally there was some irregularity of the surface of the head in the older subjects.

TREATMENT

The ideal treatment of congenital dislocation of the hip is to secure the earliest possible reduction with the least possible traumatism, and with immobilization just long enough to result in permanent maintenance of the reduction. Such treatment should involve the least risk to the life of the patient from the anesthetic and from shock, and a minimal risk of infection. Simple open or closed reduction with immobilization would be insufficient to maintain the reduction of some hips because of the deformity of the femoral head or the acetabulum or the relaxation of the capsule, whereupon it is often necessary to correct these abnormalities to secure a good result. In other cases it is impossible to reduce the dislocation without unreasonable traumatism or division of tissues, followed by stiffness or weakness. The best alternative in such cases is the construction of a bony support for the femoral head in the dislocated position. The following statements in regard to treatment are based upon a

study of more than 100 closed and about 200 open operations and 50 shelf-stabilization operations, including follow-up examinations one or more years after operation, with particular reference to pain, fatigue, disability, limp, limitation of motion, telescoping and roentgenographic appearance.

It was found that forceful manipulations, even if successful in reducing the dislocations, often resulted in stiff hips and occasionally were complicated by such accidents as a fracture of the femoral neck. Subsequent open operations usually demonstrated that manipulative reduction was obviously impossible in most of the hips which were not reduced by manipulation (about 50 per cent). One-third of the dislocations which were apparently reduced recurred partially or completely. Accordingly, open operations gradually replaced closed operations in the older children, as they could be done with equal safety to the child, with less traumatism and with a greater chance of initial and final success. Obstructions to reduction, faulty acetabula and relaxed capsules could be corrected at open operation.

CLOSED REDUCTION

A closed reduction is the operation of choice in infants younger than one year. The hip can often be reduced under anesthesia by the simple maneuver of Hibbs: Flexion to 90 degrees, followed by abduction and extension, with manual lifting of the greater trochanter forward and sufficient internal rotation to counterbalance the anteversion present. It is unnecessary to use even the mechanical table with gentle leverage which Hibbs devised for the purpose, while such traumatizing procedures as that of Lorenz should be definitely avoided. Sometimes reduction can be accomplished by simple traction, internal rotation and abduction, but this is not the most favorable method as the capsule is twisted and narrowed upon extension. The hip should be immobilized after reduction in a plaster-of-paris spica in moderate abduction, and enough internal rotation to compensate for the anteversion, but the position should not be forced as the tension on the capsule may cause a circulatory disturbance which may result in coxa plana. The reduction should be verified by a roentgenogram; it is desirable to have the axis of the femoral head and neck directed toward or just below the center of the acetabulum. If a careful first attempt fails it is rarely possible to reduce the hip at subsequent attempts. The immobilization should be maintained for three to six months, varying with the stability of reduction. The child may be allowed to walk within two months of reduction. Weight-bearing is an aid to the proper molding of the joint surfaces if there is no tendency to subluxation.

There is a fair chance of success with a closed manipulation in children between one and three years old. Accordingly, at this age a single gentle manipulation may be attempted first when it is not obvious that such a procedure would be hopeless. The chance of failure with manipulation becomes progressively greater with increasing age after three years, so that in the hands of a surgeon familiar with the open operation it is undesirable to subject the child to a procedure which offers little probability of success except in an

occasional carefully selected case. However, when the surgeon is not familiar with the open operation, and it is not available in his locality, a closed manipulation is warranted at any age when there is a possibility of success. Adductor longus and gracilis tenotomies at the groin are often necessary in the older children and are far superior to the brutal methods of tearing these muscles, popularized by some of the earlier workers. Preliminary traction with adhesive tape or a Kirschner wire with such an apparatus as that of Thornton or the Taylor hip splint is often desirable, but it will usually require several weeks to secure a stretching which will permit reduction without great tension. Roentgenograms taken during traction will indicate the probability of bringing the head down to the level of the acetabulum (Fig. 6 A, B). The roentgenogram at this age will also demonstrate the obliquity of the acetabular roof, and a comparison of views taken standing and under traction will show the amount of relaxation of the capsule but will offer no clue to the width of the opening into the acetabulum.

OPEN REDUCTION

Open reduction of the hip should be attempted (in capable hands) after the age of one year whenever closed reduction fails, and should be the operation of choice in children past three years except in unusual instances. Open reduction should rarely be attempted in infants younger than one year because of the immaturity of the acetabulum, the additional operative risks of the anesthetic and infection by fecal contamination, and possible feeding complications. Operation should not, however, be delayed after this time because the deforming effect of weight-bearing begins to act as soon as the child begins to stand, months before he can walk alone. Reduction may be obviously impossible in children past eight years because of the absence of a socket or the extent of the dislocation as indicated by the standing and traction roentgenograms, but the possibility of reduction is often indeterminate at this age period and can only be decided at operation. As a shelf-stabilization operation is usually a desirable alternative, operation is justifiable even when reduction appears unlikely. Preliminary skeletal traction may be used if the femoral head remains high above the acetabulum in the roentgenogram made under traction.

The hip-joint is approached through the Smith-Petersen incision, care being taken to avoid injury to the vessels and nerves passing across the thigh just below the femoral neck, and the capsule is freed from the gluteus minimus above and the iliopsoas below. The capsule is incised anteriorly close to and parallel with the acetabulum and the joint explored. All procedures are performed with the utmost gentleness. Frequently the entrance to the acetabulum is not more than one-half of an inch in diameter and reduction is impossible without enlarging the opening. This is done by incising the capsule and transverse ligament inferiorly across the constriction. The capsule should never be cut superiorly, as its support may be lost and the cartilaginous lip of the acetabulum and the labrum glenoidale damaged. The femoral head may now be brought into the acetabulum by traction, abduction and internal rotation

or by the maneuver used in closed reduction. Usually it is found that the head cannot be entirely reduced because of the large mass of the redundant ligamentum teres and the enlarged haversian gland. The structures are therefore usually excised. The acetabulum may still be too small to hold the femoral head. The acetabular roof may then be enlarged and rounded by gouging the cartilage if it is sufficiently thick to allow this without exposing bone. When it has been necessary to gouge a new socket out of bone the hip almost always has become moderately stiff. Possibly this outcome could be avoided if the new socket were made sufficiently large and lined with fascia and the reduction maintained without tension, but this has not been done. Hey-Groves and Colonna report good results with freeing of the entire capsule medially and inserting it with the head into the acetabulum. The results with the shelf-operation have been so much better, particularly in the bilateral cases, than those in which a large area of bone was exposed in the acetabulum that the former is preferred. Occasionally the overgrowth of the cartilage of the head inferiorly is so great that reduction is obstructed. Some of this mass of cartilage may be trimmed away without stiffness resulting if bone is not exposed.

The capsule should be freed from the ilium superiorly when it is adherent. The rectus tendon, labrum glenoidale and superior cartilaginous lip of the acetabulum should be freed when they are everted, and allowed to come down to their normal levels. It is often impossible to bring the femoral head down to the level of the acetabulum without dividing some of the extrinsic resisting structures. An adductor tenotomy should be done first. It may be necessary to lengthen the rectus and sartorius tendons and the iliotibial band. The use of skids or forceful maneuvers for reduction is undesirable and unnecessary if the capsule and contracted structures have been properly released, or if preliminary traction is used. If it appears that the hip could not be reduced after lengthening these structures the possibility of reduction without great danger to nerves and the circulation of the joint and the extremity, and subsequent stiffness, is not sufficient to justify further procedures, particularly in view of the lack of such disability in older patients who have had no treatment whatever, and the favorable results of the shelf-operation.

When reduction is secured it is desirable to insure its maintenance. Frequently a large pocket remains in the capsule into which the head can easily redislocate, and usually the capsule will not contract sufficiently to obliterate this pocket. The relaxation is generally greater anterosuperiorly, due to the dislocation of the head in this direction. A crescent of this portion of the capsule is excised, large enough to correct the relaxation but not large enough to impair external rotation (Figs. 7 and 8).

The amount of anteversion and its effect are determined at operation. The hip is adducted with upward pressure with the knee forward, and again with the knee in sufficient internal rotation to correct the anteversion, and the angle of redislocation noted. If the femur dislocates as the abduction is reduced before reaching a neutral lateral position with the knee forward but remains

socketed to at least 20 degrees of adduction in internal rotation, it will usually be desirable to correct the anteversion. This is done three to six weeks after reduction by a transverse supracondylar osteotomy, the upper fragment being

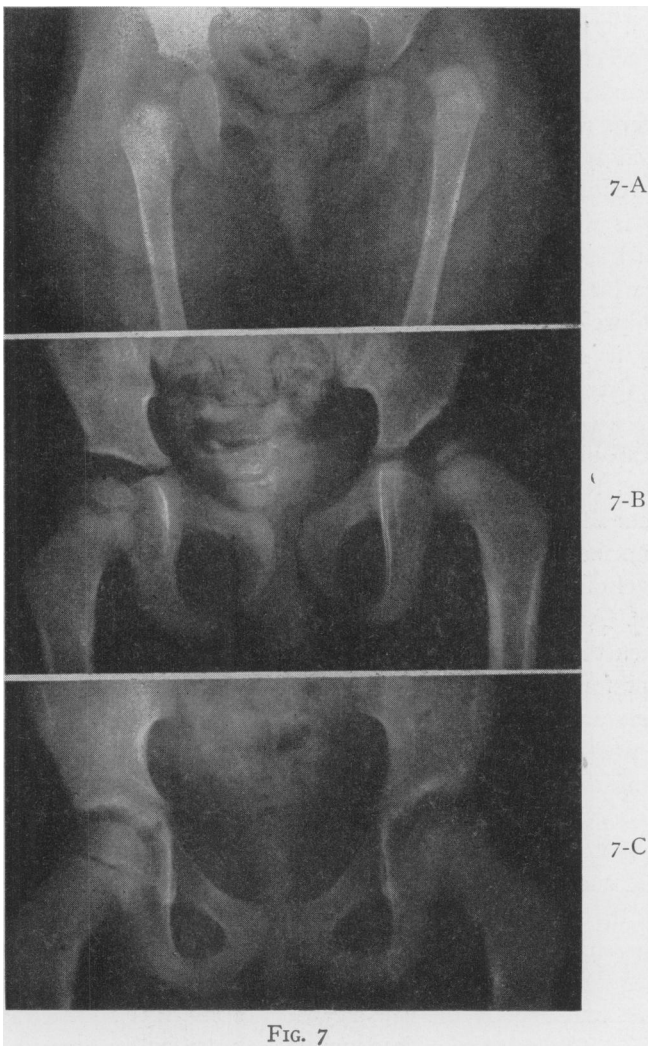


FIG. 7

FIG. 7.—(A) Subluxation left hip; closed reduction failed; open reduction at age nine months.
(B) Same hip at age two years. Acetabulum oblique, head displaced upward in acetabulum and slightly laterally. Degenerative changes in head due to circulatory disturbance (coxa plana).
(C) Same hip at age six. Acetabulum deep and round, coxa plana healed.

maintained in internal rotation by a steel pin driven through the femur below the greater trochanter and incorporated in the plaster. A Kirschner wire may be passed through the femoral condyles for control of the lower fragment (Figs.

9 A, B, C). The anteversion need rarely be corrected unless it is greater than 45 degrees.

The hip is immobilized in a plaster of paris spica from midthorax to toes, including the opposite thigh if it is advisable to fully immobilize the pelvis. The hip should not be held under tension in plaster, so that coxa plana may be avoided. The spica may be removed in six weeks if the reduction is very stable, but usually is left on for two months, rarely longer. When there is a probability

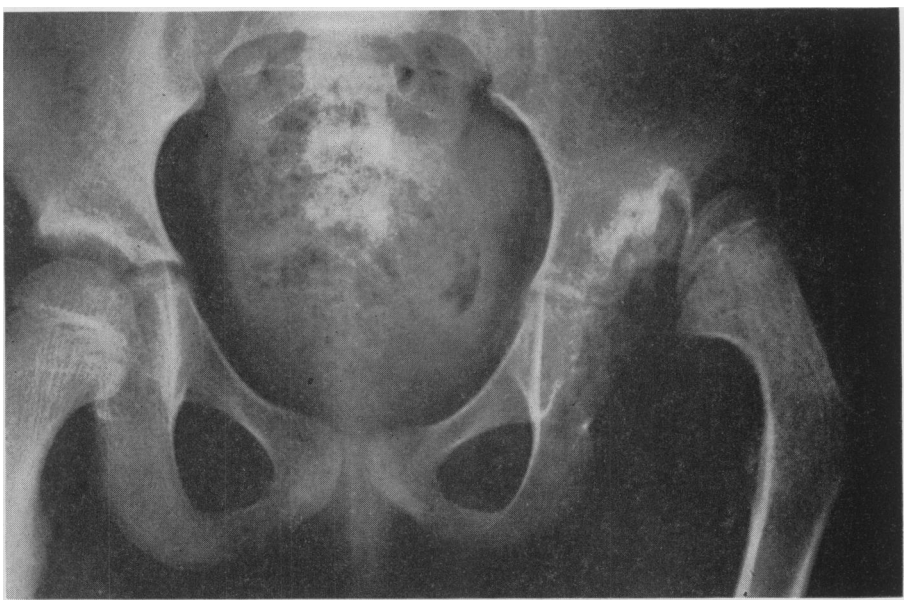


FIG. 8.—Dislocation left hip at age nine following open reduction at age seven, with osteotomy for anteversion. Acetabulum elongated and very shallow; head deformed, and dislocated opposite upper margin of acetabulum; coxa valga. A shelf operation should have been done.

of stiffness the plaster may be bivalved from the foot to the groin three or four weeks after operation and daily motion begun. The child is not allowed to walk at once upon removal of the spica but is kept in bed for one to four weeks, and massage and motion begun. Roentgenograms are made with traction and with upward push to demonstrate possible instability. When pain and spasm are absent, motion is fair or good, and there is no telescoping, walking is begun, first with crutches, then without support. The principles of treatment at this stage are to begin mobilization at the earliest safe moment and to delay weight-bearing until the extremity has recovered sufficient function.

SHELF STABILIZATION

It is usually impossible to secure a stable reduction with good motion in a congenital dislocation of the hip after the age of ten years. Some of the hips at this age are stable and symptomless in the dislocated position. Others are

painful and weak, moderate telescoping is demonstrated in standing and traction roentgenograms, and oblique views of the hip reveal the absence of any bony support. Sometimes in younger hips reduction is not obtained, or with the femur reduced the socket is so poor that the hip cannot be made stable by the methods previously described. In these types of cases it is desirable to support the hip by a bony shelf built above it to prevent instability and further dislocation. The hip may be pulled down by preliminary traction but it is

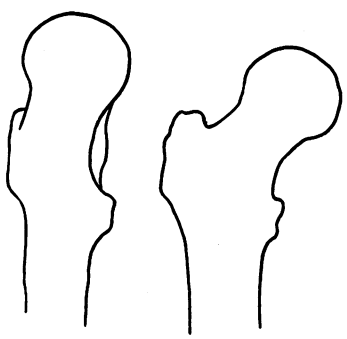


FIG. 9-A & B

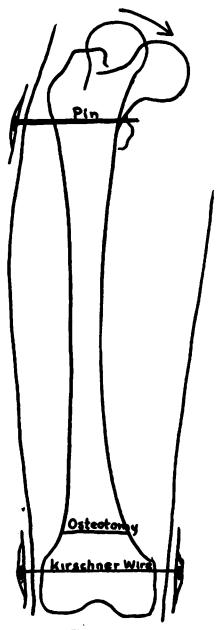


FIG. 9-C

FIG. 9.—Anteversion:

(A) Marked anteversion, favoring dislocation.

(B) Normal hip.

(C) Operation for correction of anteversion: supracondylar osteotomy, upper fragment held in internal rotation by pin through femur at level of trochanters, position of lower fragment may be maintained by Kirschner wire through condyles (outside joint capsule), both incorporated in plaster spica.

undesirable to leave it under any tension after the shelf is made, as such pressure often results in partial absorption and irregularity of the femoral head. The shelf may be turned down from the ilium, the acetabular roof may be turned down and wedged as advocated by Gill, or a shelf may be driven into a slot above the acetabulum (Figs. 11 A, B, C). The first type of operation has usually proven most satisfactory, and will be described (Figs. 12 A, B).

The hip is exposed as at open reduction except that most of the iliac wing is exposed subperiosteally, care being taken posteriorly to avoid injury to the gluteal vessels and nerves, and usually it is unnecessary to free the capsule

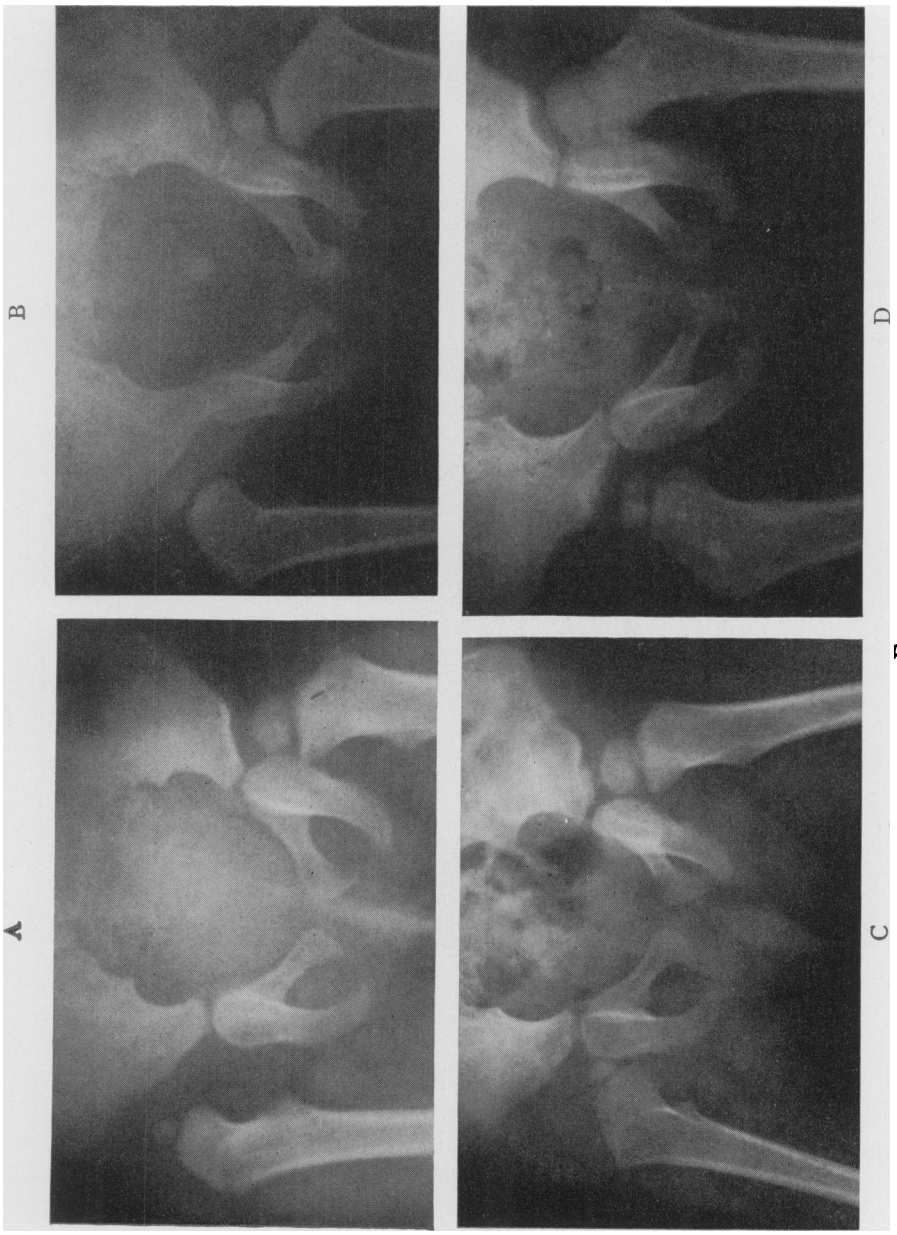
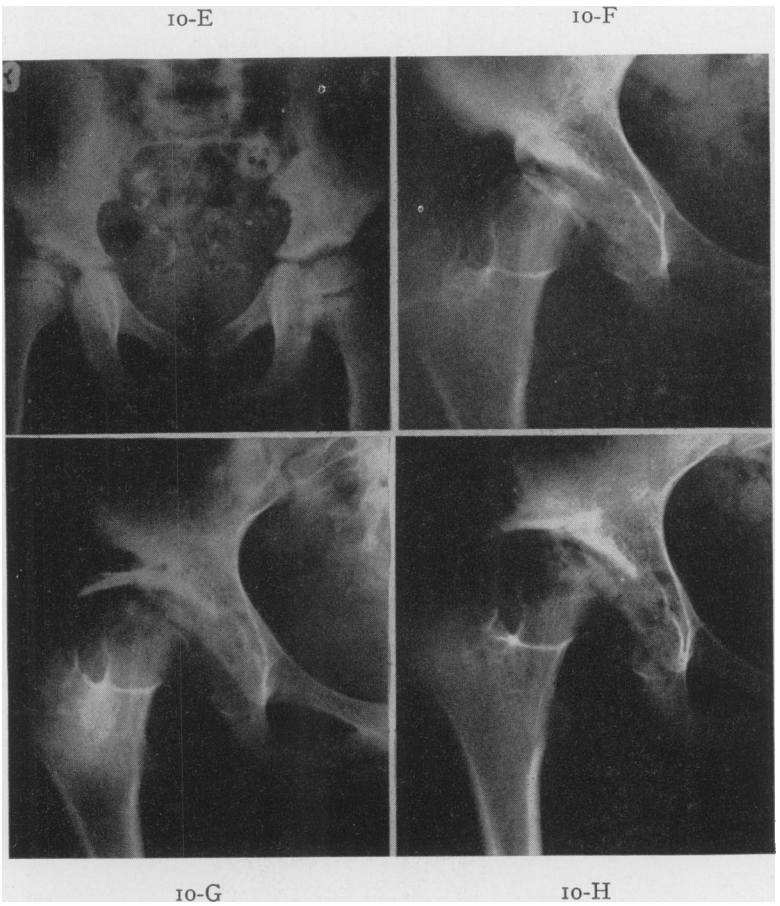


FIG. 10

FIG. 10—(A) Dislocation right hip age two years; acetabulum shallow and oblique; marked anteversion.
(B) Same in internal rotation to show correction of anteversion.
(C) Same, three months after open reduction.
(D) Same, age four, two years after reduction. Slight subluxation. Coxa plana.

inferiorly. Taut structures are divided or lengthened to release tension, as in the open reduction, unless the capsule is very lax as in the high posterior dislocations where any further release would result in risk of the head slipping from underneath the shelf. The capsule is not opened unless reduction is to be attempted. Lateral and anteroposterior relaxation are tested to determine the width and length of shelf necessary. The shelf should be large enough to cover



(E) Same, age seven; further subluxation. Coxa plana healed.
(F) Same, age fourteen, further subluxation; acetabulum elongated and shallow. Head deformed.
(G) Shelf operation at age sixteen; iliac slab driven into slot above acetabulum.
(H) Same, one year after shelf operation. Relief of pain; improvement in gait and strength of hip.

the crest of the head in any position which it can assume. The proposed shelf is marked on the ilium in the form of a broad inverted U. A slab of bone, large enough to brace the shelf, is cut from the lateral cortex of the iliac wing anterosuperiorly and smaller reinforcing slabs and large chips are cut from the

remaining available portion of the ilium in such a manner as to weaken the ilium as little as possible. The shelf is freed with curved osteotomes to its base, usually three-sixteenths to one-quarter inch thick, and turned down over the capsule and femoral head, where it is blocked by a large slab wedged between the lateral margin of the shelf and the upper margin of its bed at an angle of about 45 degrees to the ilium. Reinforcing slabs and chips are inserted to fill the gaps, and particular care is taken to have the shelf perpendicular to the extended thigh. When the hip has been reduced or is merely subluxated the shelf includes a portion, if not all, of the false acetabulum and, occasionally, the

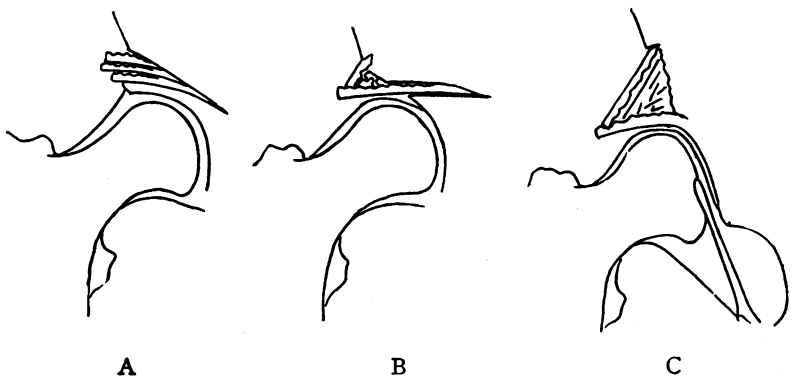


FIG. 11

FIG. 11.—Shelf stabilization operation:

(A) Hip reduced, roof of acetabulum turned down and wedged down by bone slabs cut from wing of ilium. For young children.

(B) Hip reduced, slab from iliac wing driven into slot at superior margin of acetabulum, and reinforced by block and chips above. For older children.

(C) Hip not reduced. Shelf turned down from wing of ilium and blocked there by slabs and chips from iliac wing. For older children and adults.

oblique portion of the acetabulum proper. The shelf does not become detached if handled carefully, additional support being furnished by the soft tissues at its base. Occasionally it is desirable to suture the slab to the shelf to prevent its slipping. The muscles are lifted forward over the shelf and carefully sutured to the tissues at the anterior inferior spine, the wound is sutured anatomically, as for open reduction, and a snug double spica applied to include the lower thorax and the foot of the affected side. The spica is worn for eight to ten weeks and weight-bearing begun two to four weeks later. The principles of postoperative treatment are similar to those for open reductions except that the solidity of the shelf for supporting the body weight must be determined roentgenographically.

ARTHROPLASTY, FUSION, AND OSTEOTOMY

Occasionally open or closed reduction results in a hip that is painful and somewhat stiff and deformed. The usual deformity is flexion, adduction and

internal rotation. There is little chance for improvement of these hips with exercises after two years from the time of reduction, and manipulation is likely to do more harm than good. Arthroplasty with the vitallium cup has rarely been tried in such hips under the age of ten years, but we have had one very good result in a child of five, and one fair result at the age of six, and good

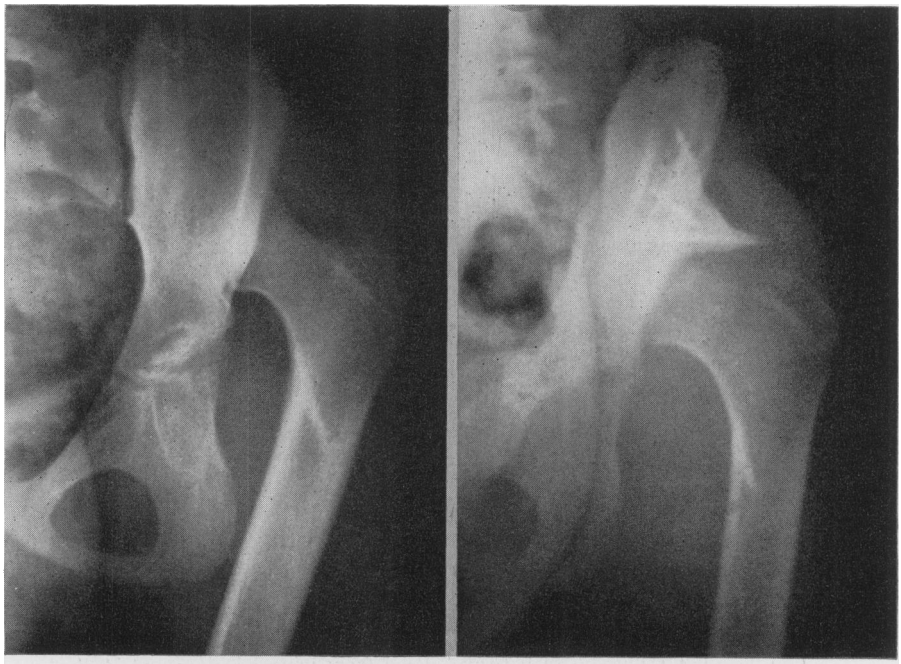


FIG. 12

FIG. 12.—(A) High dislocation of left hip with marked instability.
(B) Shelf turned down over head and reinforced with slabs and chips; one year after operation.

results in two adults. The cup was removed from the hip of the child of five after two years, and a well-formed head and acetabulum found. Arthroplasty is the operation of choice when both hips are affected, especially if both hips are stiff and deformed (Fig. 13). Hip fusion usually gives a better result if only one hip is affected, as there is no pain and the subject is able to stand, and even run, jump, dance and swim with the hip fused. We have performed only 13 hip fusions for congenital dislocation in the past 11 years, with almost uniformly good results. Both arthroplasty and fusion are difficult or impossible, however, if the hip is dislocated high on the ilium, as the iliac wing is so thin that there is not enough bone for either operation. A modified fusion may be done in such a case by using a tibial bone graft from the femur to the acetabulum or ischium through a subtrochanteric osteotomy. The Lorenz or the Schanz

osteotomy may be tried when both hips are dislocated high on the ilium, for relief of severe pain and instability.

CONCLUSIONS

The anatomy and development of the fetal hip from the tenth week to birth, the evolution of the anteversion and the torsion of the capsule, and the pathology of congenital dislocation of the hip as seen at operation from infancy to

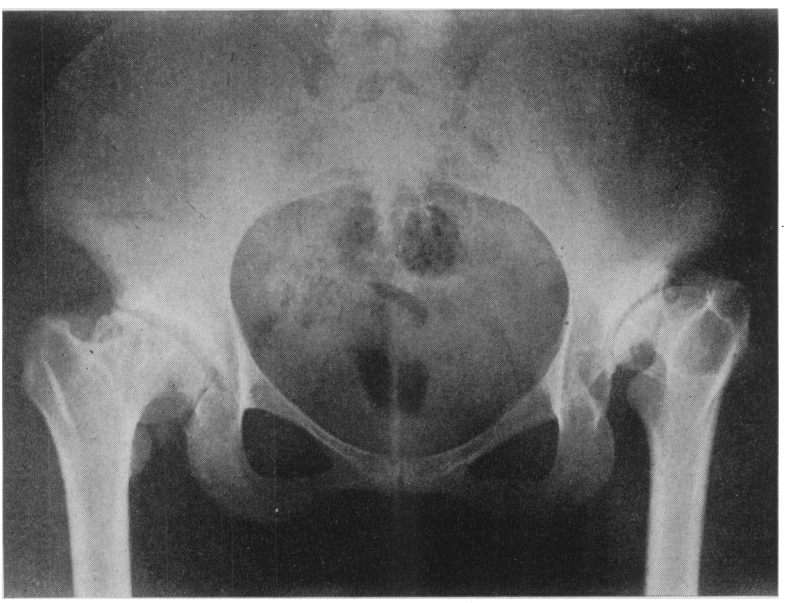


FIG. 13.—Bilateral congenital dislocation of hips, untreated, with marked deformity of femoral heads, necks, and acetabulums, and osteo-arthritis with cystic degeneration. Marked pain and disability. Suitable only for vitallium cup arthroplasty.

adult life are described. Congenital dislocations of the hip should be reduced as soon as possible after they are recognized, as the results are more favorable in proportion to the early age of the patient. Closed reduction is the treatment of choice for infants if it can be accomplished with little traumatism. Open reduction should be used for infants older than eight months if closed manipulations fail and for all older children when there is any possibility of securing a movable stable hip. Important anatomic points and variations in procedure, advisable for securing the best result in the individual case, are stressed. When open reduction fails or is inadvisable, the shelf-stabilization operation, or the vitallium cup arthroplasty should be used in selected cases, or an arthrodesis done. The results of the surgical treatment of congenital dislocation of the hip are very favorable when there is careful selection of type of treatment, due regard for operative technic and atraumatism, and proper after-care.

REFERENCES

1 Strayer, L. M.: The Embryology of the Human Hip Joint. Yale J. Biol. & Med., 16, 13, 1943.

2 Farrell, B. P., and Howorth, M. B.: Open Reduction in Congenital Dislocation of the Hip. J. Bone & Joint Surg., 17, 35, 1935.

3 Howorth, M. B., and Smith, H. W.: Congenital Dislocation of Hip Treated by Open Operation: A Report of 70 Cases. J. Bone & Joint Surg., 14, 299, 1932.

4 Ferguson, A. B., and Howorth, M. B.: Coxa Plana and Related Conditions at the Hip. J. Bone & Joint Surg., 16, 781, 1934.

5 Howorth, M. B.: Shelf-stabilization of the Hip. A Report on 53 Cases: With Particular Emphasis on Congenital Dislocation. J. Bone and Joint Surg., 17, 945, 1935.