1958

# Congenital dislocation of the hip joint : with special reference to early diagnosis and treatment

Donald Wesley Rohren
*University of Nebraska Medical Center*

# CONGENITAL DISLOCATION OF THE HIP JOINT: WITH SPECIAL REFERENCE TO EARLY DIAGNOSIS AND TREATMENT

Donald Wesley Rohren

Submitted in Partial Fulfillment for the Degree of
Doctor of Medicine

College of Medicine, University of Nebraska

April 1, 1958

Omaha, Nebraska

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# INTRODUCTION

Perhaps no other chapter of medicine presents greater possibilities in preventive pediatric-orthopedic medicine than congenital dislocation of the hip. This condition was first recognized as a definite entity by Hippocrates some 24 centuries ago. Although the congenital nature of the condition and some of the clinical symptoms were understood at that early date, many aspects of the entity are still poorly understood. In almost all areas, etiology, pathogenesis, diagnosis, and treatment, there are constantly changing concepts. Early diagnosis and early effective treatment are in their infancy. Roentgenography has aided considerably in diagnosis since its discovery at the turn of the century. However, new signs and symptoms which will lead to earlier clinical diagnosis are constantly being recognized. Because of these advances in earlier clinical diagnosis, methods of treatment are becoming more effective. Indeed, improved results of treatment are not to be expected from newer methods and techniques of open or closed reduction. The concept of earlier diagnosis leading to more effective treatment is embodied in the statement made by Dr. Vittorio Putti (42) of Italy almost

30 years ago: "One must reduce the age limit (for beginning treatment), indeed, abolish it completely, and fully accept that principle which all orthopedic surgeons follow in the treatment of all congenital deformities and which one sees no reason to repudiate in that of congenital dislocation of the hip---that is, to begin treatment the very moment the deformity is observed, even if that be on the day of birth." Therefore, early diagnosis is the key to effective treatment and good, lasting results.

The following review of recent, pertinent literature on congenital dislocation of the hip will deal primarily with the treatment of this malady and secondarily with advances in early diagnosis. Some brief discussion of the most recent concepts of pathogenesis and other allied aspects will be included for the sake of completeness.

## TERMINOLOGY

In order to understand more completely the subject at hand, definitions of terms which will be used throughout the discussion must be included at this time.

1. Dysplasia (Hart, 47): Congenital dysplasia of the hip is an interruption of growth

forces of the rapidly growing mesodermal elements which form the hip joint as a whole. There is interruption of the normal endochondral ossification of the hip joint. The resulting deformity of the dysplasia may be potential or real and is usually seen primarily in the acetabulum as an inadequate roof or buttress for stability of the femoral head or in the capital epiphysis of the femur. Dysplasia does not refer only to the acetabulum, but also to all parts of the hip joint.

2. Subluxation (incomplete dislocation): This is a subdivision of dysplasia, and is the condition that occurs when the femoral head is contained within the acetabulum; but it is eccentrically located. The X-ray signs are sloping acetabulum roof and lateral displacement of the femoral head. According to Steindler (7) subluxation is never followed by true dislocation, and the head always remains in contact with the original acetabulum.

3. Luxation (complete dislocation): In this condition the femoral head is completely

out of the acetabular fossa, usually lying superior to the acetabular rim.

4. Preluxation: This is the forerunner of true or complete dislocation. The femoral head is not displaced from the acetabulum. The salient features of this are obliquity of the acetabular roof, tardy appearance of the bony nucleus of the femoral head, and lateral displacement of the upper end of the femur.

## INCIDENCE AND OCCURRENCE

Congenital dislocation of the hip is by far the most common of all congenital malformations. In an 11 year period from 1906 to 1917 at the Orthopedic University Clinic of Vienna the statistics of Lorenz revealed that congenital dislocation of the hip was three times as frequent as congenital club foot, and six times as frequent as congenital torticollis. These ratios differed somewhat in smaller statistical surveys.

Congenital dislocation of the hip is much more common in females than in males. An overall estimate usually places the ratio as 6:1, females over males. Several statistical surveys are presented

by Hass (48), and the average incidence is 85% in females and 15% in males.

Congenital dislocation of the hip is more often unilateral than bilateral. Unilateral dislocation is approximately twice as common as bilateral dislocation, and the involvement of the left side is approximately one and one-half times as frequent as right-sided involvement.

The geographic distribution of congenital dislocation of the hip is a very interesting topic in itself. There is a very high incidence in certain countries and regions, whereas in other regions, very few or no cases are observed. There is a high incidence reported in Tyrol, Holland, and parts of Germany. On the other hand, the condition is very rarely encountered in Switzerland. An extraodinarily high frequency of congenital dislocation of the hip is found in northern Italy. In this area the condition is endemic and incidence has been reported as high as 19% of the population in certain provinces.

Congenital dislocation of the hip also occurs with different frequency in the various races. It is very rare in the yellow race and almost unknown in the Negro race.

Explanations for the peculiarity of incidence of the condition geographically and racially have been sought, but none are conclusive to the point of infallibility. According to M. Lange (Hass, 48) increased incidence of congenital dislocation is due to crossing of racial peculiarities as is seen along the borders of Germany where different races live in close proximity. The high incidence in the northern provinces of Italy is attributed by Poli to the high incidence of consanguinity among the people of this area. As far as the irregular incidence in the colored races is concerned, it is thought that it is governed by certain racial factors; and it seems plausible that the tendency toward the malformation or its exemption may be just as dependent upon a racial gene as are the color of the skin or the structural peculiarities of the face.

This problem must be left for future heredobiologic investigations to center interests upon areas of highest incidence of the condition.

## ETIOLOGY

The etiology of congenital dislocation of the hip is uncertain. Genetic and hormonal factors, and biological and mechanical influences have all

been theorized as being responsible. Geographical and anthropological and racial factors, nutrition, vitamins, endocrines and prenatal posture and trauma may be important etiological factors.

The exact mechanism which produces the dysplasia, which is the underlying, all-important condition according to Hart (40,47) and Hass (48), is not understood. The mechanism of displacement of the femoral head from the acetabulum is not difficult to understand. According to Hart (40,47), displacement of the femoral head is favored by : (1) the fetal and early postnatal position of instability of the hip joint; (2) the direction of the prenatal and natal forces of muscle pull and uterine pressures and the forces of weight bearing during postnatal life; (3) the absence of any solid and strong obstacle or buttress over the superior, posterior and inferior surfaces of the femoral head normally; (4) the plasticity of the dysplastic, inadequately ossified cartilaginous acetabulum; and (5) the physiological relaxation of musculo-tendinous and ligamentous or capsular structures of the hip during fetal and neonatal life secondary to hormonal influences.

According to Hart and Hass the basic defect is the dysplasia, and dislocation and subluxation

are sequelae.

Hass (47) feels that the congenital dislocation should be classified as typical and atypical types. The etiology of the typical dislocation is similar to Hart's explanation, that is, it occurs as an extra-uterine development and as a sequelae of the dysplasia. This type of dislocation is endogenous in origin, and heredity plays an important role. The atypical or teratologic type is intra-uterine in origin and is considered to be exogenous. Heredity in this type is coincidental if it does occur.

The typical dislocation does not occur until after birth and is due to a defect or dysplasia of the structures of the joint. "There is an unknown hereditary factor which exerts a marked inhibition on the normal transofrmation of primordial cartilage into bone," (Hass, 48). Whether the dislocation occurs from the dysplastic joint is dependent upon the reactive capacity of the basic tissue. If the disturbance of the normal reactivity is slight, under normal functional stimuli, a normal joint may develop. On the contrary, if the disturbance of the reactivity is more marked, subluxation or luxation may develop or an osteochondritis or osteoarthritis may be encountered at a later date. Hart's five conditions

above are probably the responsible disturbing factors leading to the sequelae.

## PATHOGENESIS AND PATHOLOGY

The pathogenesis of congenital dislocation of the hip is difficult to explain because of the lack of definite knowledge about the etiology. The inciting factor causing the dysplasia being an unknown, one must begin the explanation from a slightly further-advanced point, namely after the dysplasia has occurred.

It is a fairly well-accepted fact that the dysplastic hip is formed in embryonic or fetal life. Relatively few dislocate during intra-uterine life, and some may never dislocate but go on to spontaneous cure. Before weight bearing begins the hip is usually in a state of subluxation or preluxation. As a result of the function of weight bearing, abnormal muscle pull and hip joint instability, the femoral head continues to migrate from the subluxated or preluxated position to complete dislocation from the acetabulum. The head usually displaces superiorly and posteriorly from the fossa, however, capsular relaxation and elongation occur first followed by an incipient lateral dislocation of the head,(Massie and Howorth, 3).

The most important factor responsible for dislocation is weight bearing on the dysplastic joint. If the dysplasia is diagnosed early enough, treatment may be instituted and prevention of complete dislocation is effected.

The pathology of the complete dislocation can be categorized according to the different structures affected. The muscles arranged in the longitudinal axis of the thigh are relaxed, and those running at a greater or lesser angle to the longitudinal axis are tightened. As the greater trochanter rises, the gluteus maximus becomes relaxed; and the gluteus medius becomes relaxed and shortened. The piriformis is shortened, while the gemelli, the quadratus, and the obturators are lengthened. The iliopsoas first shortens, and then as posterior displacement of the head occurs, it is lengthened. The middle and lower portions of the adductor magnus, and to a lesser degree, the adductor longus become shortened.

The joint capsule shows marked changes. It is thickened, elongated and frequently shows an hour-glass constriction, (Fig. I). The inferior portion is matted to the acetabular fossa, and the medial and upper portions may become adherent to the ilium, (Fig. II).

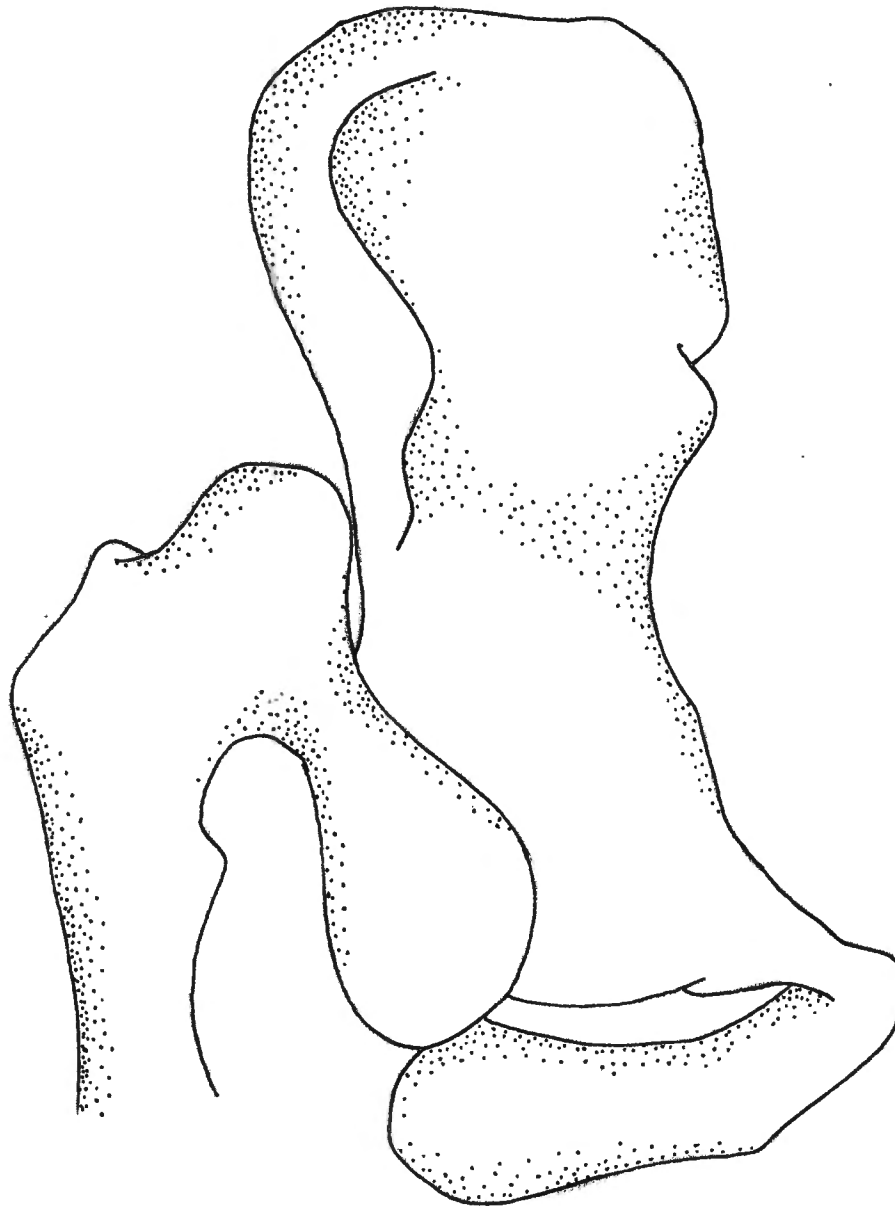


Figure I. Hour-glass constriction of capsule. (Steindler, 7)

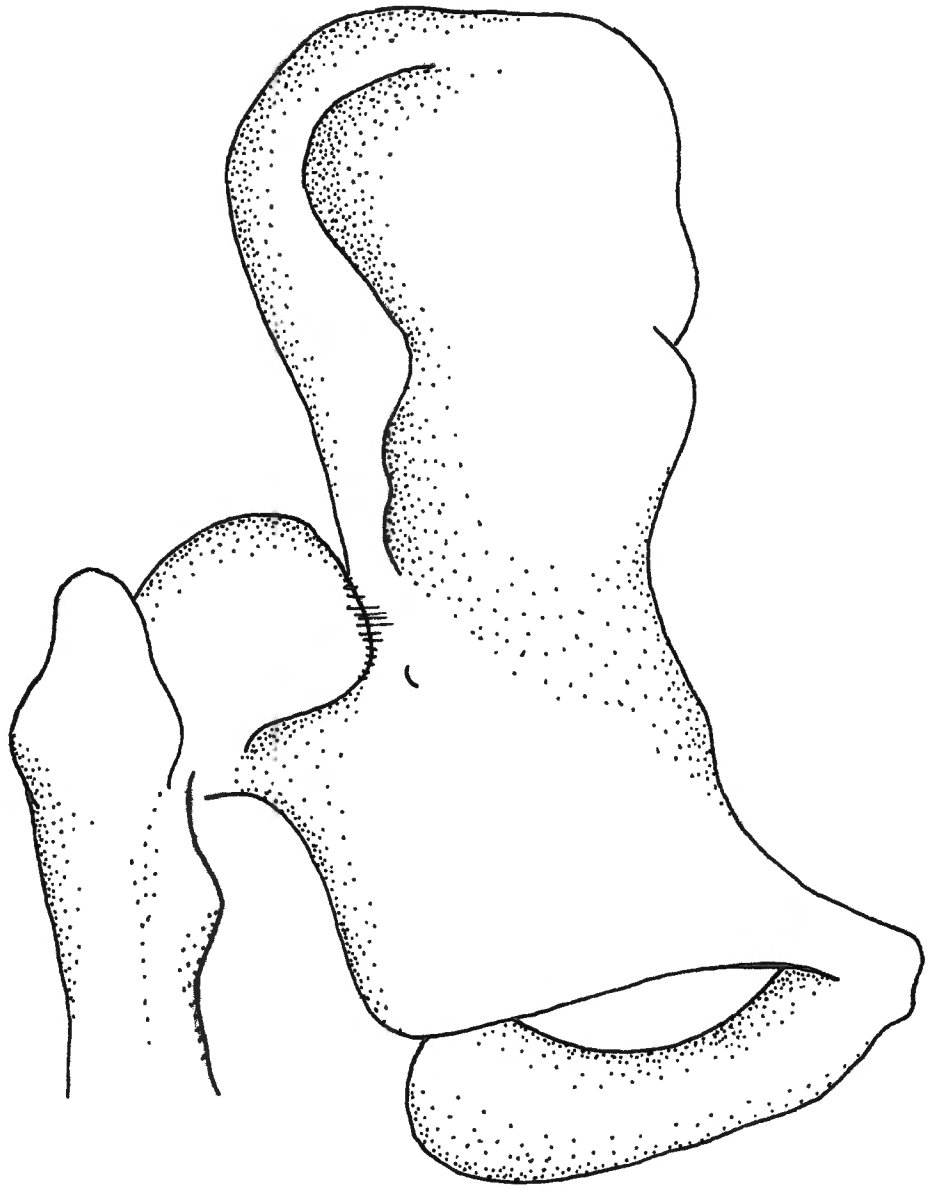


Figure II. Capsule adherent to ilium. (Steindler, 7)

The iliofemoral and pubofemoral ligaments are shortened. The ischiofemoral ligament becomes elongated.

The acetabular cavity is underdeveloped, hypoplastic, triangular, and filled with fat. It may be so shallow that it appears convex. The oblique acetabular roof ossifies late, remaining cartilaginous longer than usual. The ligamentum teres is present at the time of birth, but in one-half of the cases it disappears by the sixth year due to attrition.

The femoral head is deformed, the nucleus is retarded, and the nucleus is laterally displaced. The head is triangular or cup-shaped. The neck is often anteverted, and the angle of inclination may be increased so that coxa valga develops. The anteversion is normally 35° at birth, but it may be increased up to 90° in congenital dislocation.

The changes that occur in the joint have been brought out more clearly since the development of arthrography, (Fig. III).

## DIAGNOSIS

This part of the discussion of congenital dislocation of the hip will be dealt with in somewhat

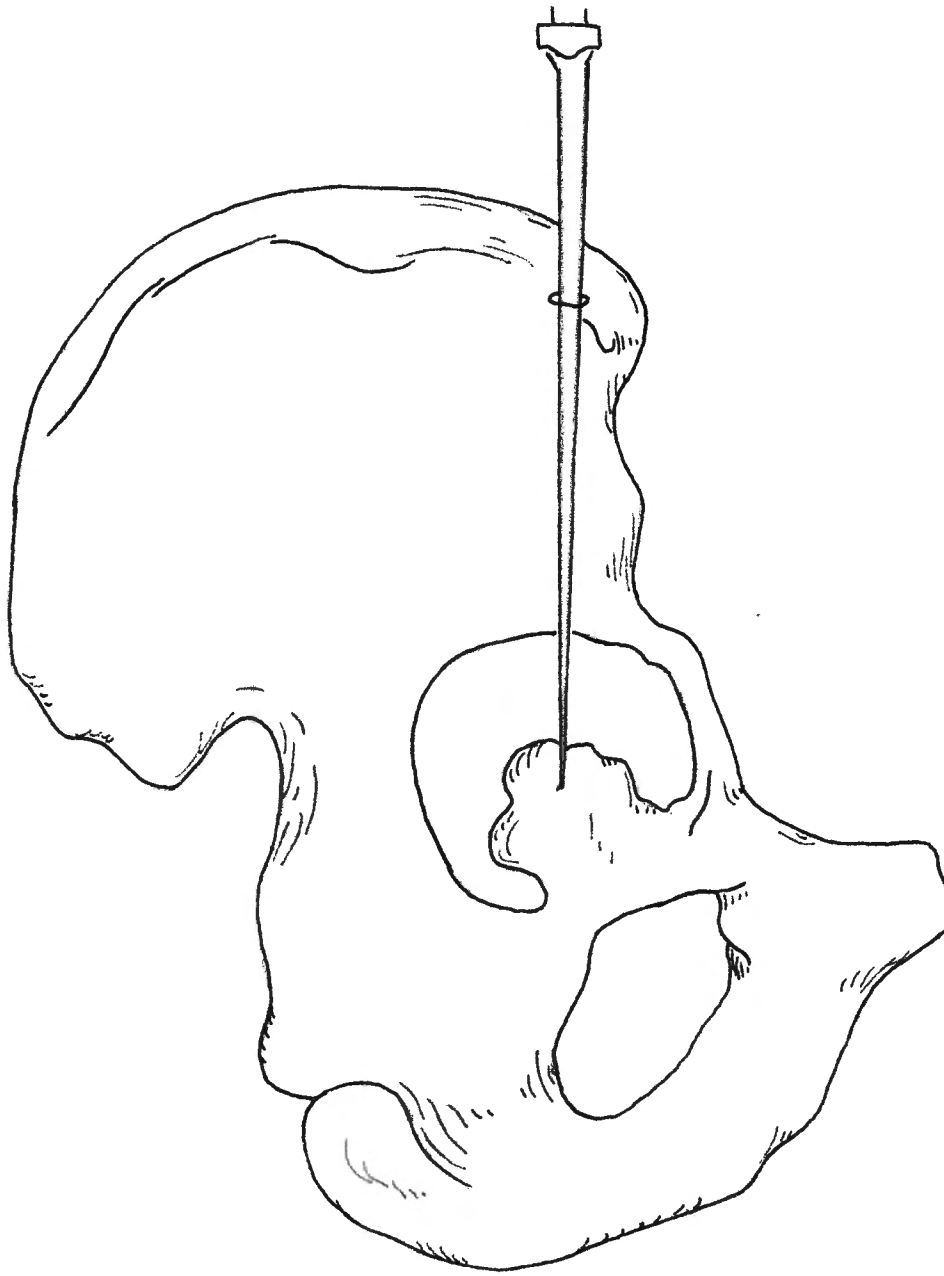


Figure III. Arthrography. A contrast medium is injected into the joint space, and an X-ray is taken. Information regarding the structures of the joint is obtained in this way. (Steindler, 7).

more detail and is divided into clinical and roentgenographic sections. The former will be considered first.

The femoral head, during infancy and before weight bearing begins, is usually preluxated or subluxated but not dislocated. The clinical findings vary with each infant, but all the findings depend upon the degree of dysplasia of the joint, the sequelae present, and the age of the infant.

Clinical findings before weight bearing, that is, during the first six months of life because creeping usually begins in the seventh month, are as follows: (Hart 40,47)

1. Ortolani's sign of the jerk, snap, or click: This is the earliest positive sign and is pathognomonic evidence of dysplasia of the hip with subluxation or luxation of the femoral head from the acetabulum. The jerk or snap is visible, audible, and tactile. The jerk is the result of the fovea of the femoral head suddenly meeting and overriding the acetabular rim. The demonstration of the sign is painless and is done by placing the infant flat on his back on a firm surface. The knees and hips are flexed $90^{o}$,

and the thighs are slightly abducted and internally rotated on the pelvis. The examiner's thumbs are placed over the medial aspect of the infant's knees and the fingers are spread over the lateral aspect of the thighs with pressure over the greater trochanters. Slight pressure is then exerted in the direction of the femoral shaft to effect maximum displacement of the femoral head from the acetabulum. Gradually and with equal pressure of the thumbs over the medial aspects of the knees, moderate pressure in line with the femoral shaft and with medial and upward pressure of the fingers over the greater trochanters, the knees are spread apart; and the hips are abducted and externally rotated. Normally the hip abducts to about 80°, however, with femoral head displacement abduction is blocked. With the above maneuver a sudden snap or jerk which is visible, audible, and tactile occurs. Maximum abduction then occurs after the jerk. The sign of the jerk of exit is then accomplished by reversing the above maneuvers. Occasionally this sign cannot

be demonstrated because of limited passive abduction of the joint due to contracture of the shortened adductor muscles. After several days or weeks of treatment with an abduction pillow or splint, the test becomes positive.

2. Findings secondary to pliability of the cartilaginous acetubulum and relaxation of the capsule and musculo-tendinous structures: These are manifested by diminished active and exaggerated passive mobility of the affected joint. There is telescoping of the flexed hip with pressure in the line of the femoral shaft. This telescoping occurs in luxation but only a "feeling of telescoping" occurs with subluxation because the capsule is not as stretched in the latter as in the former.

3. Findings secondary to shortening and contracture of the adductor muscles, tendons, and fasciae: These findings are limited passive hip joint abduction, asymmetry of the thigh folds and creases, slight shortening of the limb from pelvis to knee, and an abduction attitude of the affected limb.

The sign of limited passive abduction is consistently positive in dysplasia with subluxation, but it may or may not be present in luxated hips. Extra skin folds and creases occur along the adductor aspect of the thigh, and deeper and more cephalad inguinal and gluteal folds are found on the affected side.

4. Findings secondary to the degree of displacement of the femoral head from the acetabulum: There is true shortening of the extremity, the amount being dependent on the degree of displacement of the femoral head. This is a rare finding before weight bearing occurs, and the shortening found in infancy may be due to number 3 in this section. On the other hand, factors in number 3 may be responsible for displacement of the femoral head and the resulting shortening of the extremity.

There is some controversy as to whether the ratational attitude of the extremity is a diagnostically important feature. Hart does not think so; Hass does. Hass feels that the extremity assumes an attitude of external rotation when the hip joint

is dislocated or subluxated. Hart has found that the usual attitude is neutral rotation.

The above findings are the "academic" clinical signs, but the diagnosis is frequently made by the suspicion of the mother. The following signs are often observed by the mother and result in the bringing of the child to treatment: (1) one knee does not spread as far as the opposite one when changing diapers; (2) the infant does not move one extremity as freely as the opposite; (3) there is a difference in the rotational attitude of the extremities; (4) there is asymmetry of the labia; (5) the baby powder remains in one unusually deep skin crease; (6) the knee or popliteal and ankle creases of the extremities are at different levels and one extremity is shorter than the opposite; (7) a clicking sound or a palpable and visible jerk are present at the hip level; and (8) that one side of the pelvis or hip is prominent.

Symptoms in older children and adults are divided into static or postural and kinetic or dynamic signs. The posture is characterized by a marked lordosis caused by the increased inclination of the pelvis. The buttocks are widened and protruding, and the trochanter of the affected extremity is elevated.

In complete dislocations the femoral head bulges posteriorly under the gluteus maximus and is easily palpable. The dynamic signs are manifested by a waddling gait, particularly noticeable if the dislocation is bilateral. In unilateral dislocation there is a lurch to the affected side. The Trendelenburg sign is positive, indicating insufficiency of the gluteus medius.

The Trendelenburg sign is demonstrated by having the patient stand on the "dislocated" leg and raise the other leg forward with flexed knee. The pelvis tilts downward on the opposite side because the patient is forced to throw the body weight to that side to maintain his balance. This is due to functional weakness of the abductors of the hip joint, especially the gluteus medius and minimus. This sign is the most striking symptom of congenital dislocation of the hip in older children and adults.

There is one sign which is common to both infants and older persons. In attempting to form the figure "4" with two legs the affected extremity can be brought to lie only slightly above the knee on the normal side. The normal leg can be brought to lie about half-way up on the femur on the affected side.

As has been said earlier, early clinical diagnosis

is the key to effective treatment and lasting results. Every infant should be thoroughly examined in the newborn nursery, and if any of the clinical signs above are present, a roentgenographic study of the hip should follow.

Roentgenographic studies of the hips of infants up until the age of 2-3 months are difficult and the impressions may easily be erroneous. The center of ossification of the head of the femur does not appear until 2-3 months of age, and the interpretations of the roentgenograms are difficult for this reason. Certain conclusions can be drawn, however, from the films at this early age.

To prevent distorted views and erroneous interpretations proper roentgenographic technique is essential. The patient should be supine and relaxed. The lower extremities are parallel, the hips are extended, and the patella faces directly upward. The roentgen tube is centered over the midline of the body and directly over the superior border of the pubis. For special studies films may be taken of the extremities in internal and external rotation.

The abnormal findings may vary considerably with the age of the patient and the degree of malformation. The only finding present early may be evidence of

inhibition of endochondral ossification of the innominate bone or femur. Actual displacement of the femoral head is secondary to this dysplasia and is obivious in the roentgenograms after ossification of the head occurs.

The push-pull technique is also helpful in diagnosis. Films are taken with the flexed thigh pushed toward the pelvis and with it pulled away from the pelvis. This technique gives valuable information as to the degree of hip joint instability secondary to capsular relaxation, inadequate acetabular roof, and plasticity of the cartilaginous socket.

There have been many ways developed to interpret the roentgenograms by measurements, lines, quadrants, etc. Following are the explanations of the instruments of interpretation of the roentgenograms.

1. Hilgenreiner's Line (Y line) is a horizontal line drawn through the clear areas of the triradiate cartilages. Perkin's line is a line perpendicular to Hilgenreiner's Line on each side and is dropped from the upper outer edge of the acetabulum. These lines form four quadrants at each hip joint. In the normal hip the capital epiphysis of the femoral head is in the inferior medial

quadrant, (Fig. IV).

2. The acetabular index of the hip joint is measured by the angle formed by the junction of the Y line with a line passing from the depth of the acetabulum at the Y line through the upper outer edge of the acetabulum. This is a measure of the obliquity of the acetabular roof and is valuable in ascertaining the amount of dysplasia of the acetabulum. The upper limit of normal of the actabular index at birth is $28^{\circ}$. $30^{\circ}$ may be normal in a premature infant. About $20^{\circ}$ is normal at 2 years of age, (Fig. V).
3. Shenton's or Minard's Line in a normal hip is an even arc formed by the medial border of the neck of the femur and the superior border of the obturator foramen. This line is broken and interrupted in the dislocated hip, (Fig. VI).
4. Upward displacement is measured by the distance between the proximal end of the shaft or the nucleus of the capital epiphysis and the Y line as compared with the normal.
5. Lateral displacement is measured by a line from the spine of the femoral neck to the

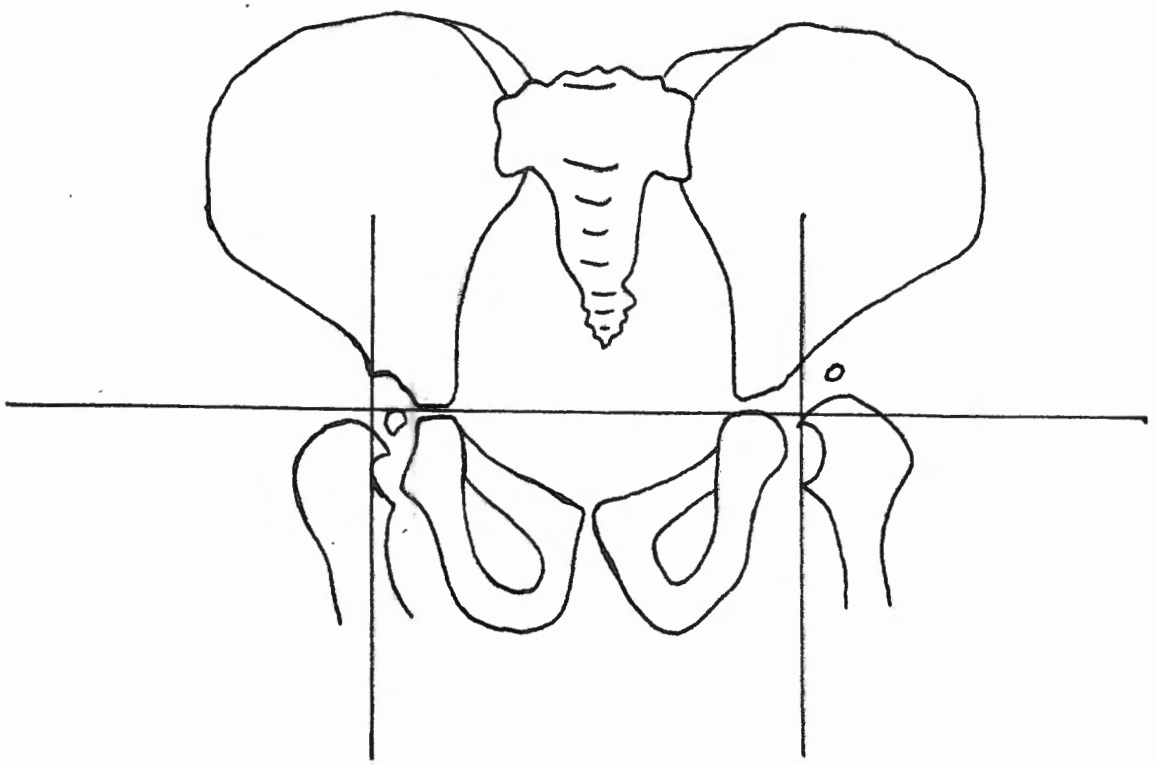


Figure IV. Quadrants formed by Hilgenreiner's Line (horizontal) and Perkin's Lines (vertical). The right hip is normal. The left hip is dislocated.

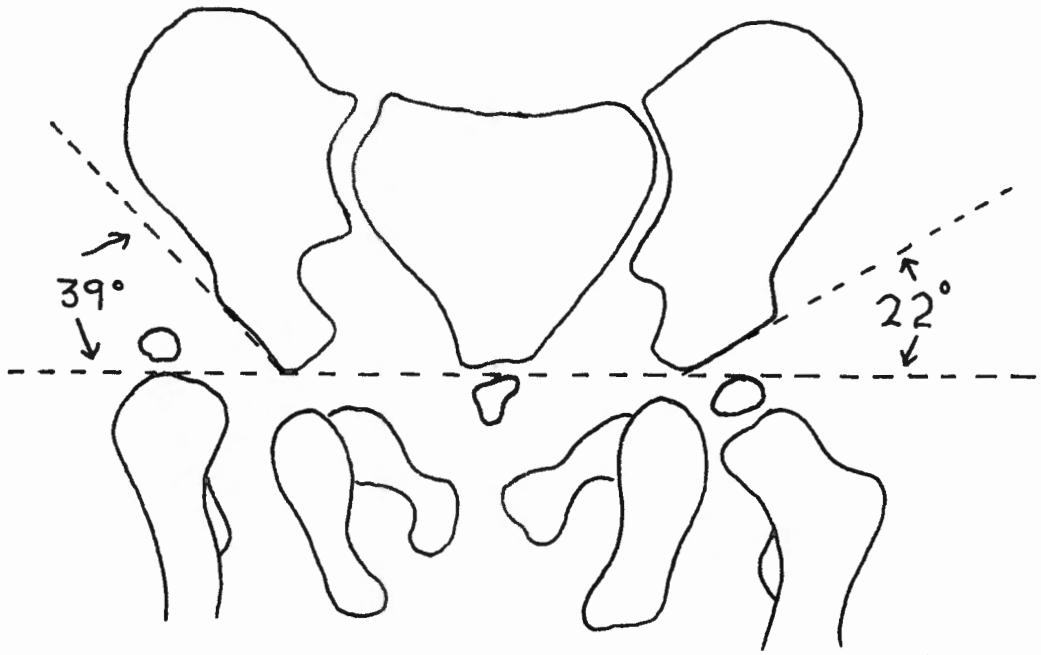



Figure V. Acetabular Index. The left hip is within normal limits. The right hip shows increased obliquity of the acetabular roof due to dysplasia. (Hart, 40, 47).

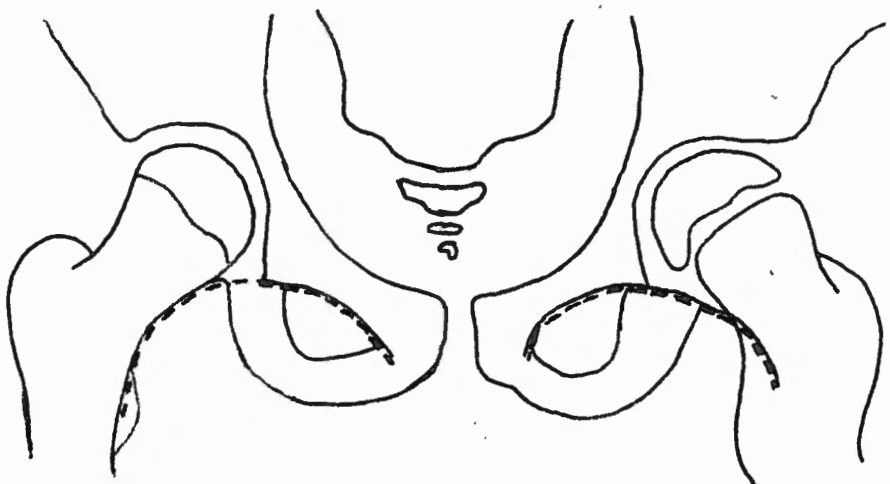


Figure VI. Shenton's or Minard's Line. The arc is broken in the left hip where there is dysplasia. (Hart, 40, 47).

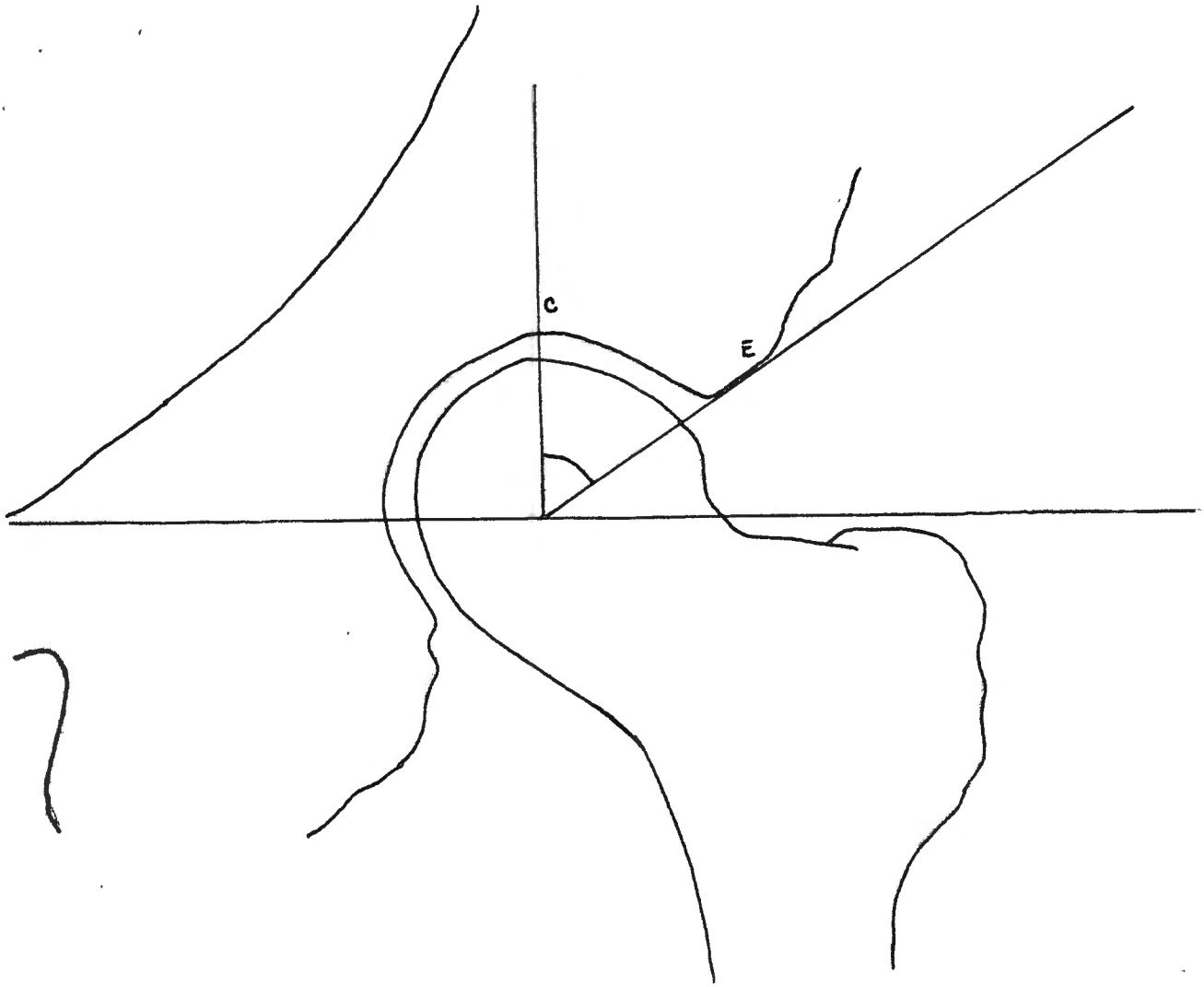



Figure VII. The C-E Angle. This angle is normally about 26° degrees. In dislocation or dysplasia the angle is diminished. (Wiberg, 8, 31)

ischium shadow or to the outer border of the tear-drop shadow or floor of the socket as compared with the opposite normal.

6. The U-figure or tear-drop shadow is a normal X-ray shadow. It is formed in the acetabulum, the outer border of the shadow being the floor of the socket. It may be absent or distorted in a dysplastic hip.

7. The C-E Angle is an angle formed by two lines drawn from the center of the femoral head. One line is drawn through the outside edge of the acetabulum and the other straight upward. The angle between these two lines is normally 26°. In the displacement of the head or dysplasia the angle is diminished, (Fig. VII).

Other roentgenographic findings include epiphyseal dysplasia of the femur; bilabiation of the inadequate acetabular roof; hypoplasia of the ilium; delayed closure of the ischiopubic juncture or synchondrosis; absence of a sharply defined, well ossified acetabular roof; and adduction attitude of the extremity.

Arthrographic studies may provide valuable information, especially regarding the depth of the socket and the relationship of the head to the fibrocartilaginous limbus, (Fig. III).

Both clinical and roentgenographic findings are necessary for diagnosis, the latter following the former in most cases. When one or more clinical signs are positive, it is, indeed, necessary to take X-rays, if for no other reason than to rule out dysplasia or dislocation. Plummer (35) has correlated the clinical and roentgenographic findings in a study of 9 month old Japanese infants. (See Charts I and II).

The results of this study as shown in the charts point out the fact that both clinical and roentgenographic examinations are necessary to diagnose many cases of congenital dislocation of the hip. Since the diagnosis of this condition is the basis of the whole problem, much more could be written about this phase. This paper is meant to deal primarily with treatment of congenital dislocation of the hip, and further discussion of diagnosis is beyond the scope of this article.

## TREATMENT

The most dramatic achievements in the treatment of congenital dislocation of the hip have been made in the last few decades. Prior to this marked progress there was almost a century of laborious

CHART I

| | | Asymmetry of thigh creases | % | Limitation of abduction | % | Positive Click | Abnormal Roentgen-ogram | % |
|---|---|---|---|---|---|---|---|---|
| Females | 109 | 37 | 33.9 | 21 | 19.2 | 3 | 20 | 18.3 |
| Males | 118 | 44 | 37.9 | 23 | 19.5 | 1 | 7 | 5.9 |
| Totals | 227 | 81 | 35.6 | 44 | 19.4 | 4 | 27 | 11.8 |

Incidence of positive findings in 227 nine month old infants with regard to dislocation of the hip. (Plummer, 35)

CHART II

| Roentgenographic Interpretation | | Asymmetry of thigh creases | Limitation of abduction | Combination of both | Positive Click | Negative clinical exam |
|---|---|---|---|---|---|---|
| Definite Dislocation | 12 | 2 | 1 | 2 | 2 | 5 |
| Potential Dislocation | 15 | 2 | 1 | 1 | 0 | 11 |
| Totals | 27 | 4 | 2 | 3 | 2 | 16 |

Correlation of clinical and roentgenographic findings in 27 nine month old infants with regard to dislocation of the hip. (27 cases with abnormal roentgenograms) (Plummer, 35)

struggling to attain effective treatment. The history of the treatment is best told by dividing it into five periods as Steindler (7) does. They are as follows: (1) The period from Dupuytren to Paci; (2) From Paci to Lorenz; (3) From Lorenz to Putti; (4) From Putti to the present; and, (5) The present status of treatment.

1. The period from Dupuytren to Paci: Dupuytren in the early 19th century made the first consistent effort toward treatment of congenital dislocation. His methods consisted essentially of the use of a retaining apparatus in the form of a belt or girdle. Parvaz in 1828 introduced the first method of gradual reduction by extension, but the results were almost always poor because of inability to retain the reduced head in the acetabulum. Instrumental extension by apparatus was first tried by de Mosley and Jaquier in 1835. This was doomed to failure because they were attempting to accomplish the reduction in one sitting. Pravaz's discouraging end results caused his closed reduction method to drop from the scene, and in the late 1880's open

operations for reduction were begun. A. Poggi of Italy was the first to reduce the intact head into an operatively deepened acetabulum. De Paoli combined a partial resection of the head with the enlargement of the acetabulum, and was actually doing an arthroplasty. These radical operative procedures ended in nothing but disappointment, and they fell into disrepute. A few years later, however, they were revived in improved form by Hoffa. Lorenz further modified open reduction methods, and a Hoffa-Lorenz method resulted which was very satisfactory for several years.

2. The period from Paci to Lorenz: In the last few years of the 19th century and the early 20th century the popularity of the open method declined; and a closed reduction method was developed and introduced by A. Paci, an Italian surgeon. The method consisted of four steps with the result being that the head was brought as close to the socket as possible so that, at least, a nearthrosis close to the true socket could be established. Lorenz subsequently took

up this method and modified it. He added to it the completion of reduction by implantation of the head into the true socket over the posterior or inferior lip of the acetabulum. This Paci-Lorenz method of closed reduction is still the one of choice whenever possible.

3. The period from Lorenz to Putti: During this period, the early 1900's, the open method was resurrected. Lorenz's contemporaries did not show the percentage of good results that he did, and open methods were again developed. Galloway in 1920 came out as an advocate of open reduction as the treatment of choice in children 20-30 months old. The points in favor of open reduction over closed methods were as follows: (1) Gill (16) pointed out that adhesions of the capsule interfered with true and complete reduction, and that a satisfactory acetabular roof failed to develop in most cases; (2) Kilner argued that the results of the open methods were superior, especially if the formation of a shelf was part of the procedure; (3) Howorth (3, 38) and De F. Smith

stressed that in order to obtain concentric reduction, release of the adherent capsule from the ilium and of the hour glass constriction were indispensable. The trend toward open reduction at that time has established it as an accepted procedure, and it is used at present as a supplement to be applied under special indications. During this period Lorenz, Kirmisson and Baeyer, and Schanz developed the subtrochanteric or intratrochanteric osteotomy.

4. The period from Putti to the present: Disappointment from past results of the closed methods prompted investigation of these methods in the late 1920's. Putti (42) found that the time of treatment should be advanced to an earlier age. It was shown that in the first six months or one year of life the existing preluxation could be reduced by simple abduction without manipulation and the reduction trauma could be avoided. Prior to this time two to three years of age was thought to be the optimum time for treatment.

The results of this conservative method of

reduction at an early age are sufficient proof that there has been marked progress in the treatment of congenital dislocation of the hip. Some orthopedists, however, adhere to the operative procedures, using eccentric and pseudoreductions as after-effects of the closed methods as their reasons. Recent investigations show that the earliest conservative treatment is the one of choice in most cases. The best results of the treatment are obtained by early functional after-care.

5. The present status of treatment: The closed method of choice is still the Paci-Lorenz method. To the open method are relegated the types of cases that are irreducible because of anatomical obstacles, and the recurrent dislocation. Looking to the future one may again see open methods resurrected. Somerville and Scott (6) in England have started advocating more liberal use of open methods, especially the shelf operation. Palliative treatment for older and untreated irreducible cases is looked upon differently,

and is not judged by the same standards as is reduction treatment.

## METHOD OF EVALUATING RESULTS

Since congenital dislocation of the hip does not occur in animals and, therefore, cannot be reproduced in experimental animals, its problems must be approached through studies of adequate numbers of patients. A sufficient period of time for observation of the patients should be allowed in order to draw significant conclusions. A study of the present-day methods of treatment is beyond the limits of even the largest clinics. Therefore, the experience of many clinics must be pooled.

One of the most difficult problems with which orthopedists of the present are faced is the evaluation of different methods of treatment. This difficulty is due to the lack of a uniform method of grading the results of treatment. Realizing the absence of a common grading system, many persons have set out to develop a good system that might be accepted by all.

In reviewing the methods of grading results, it has been found that certain measurements and ratings are used more than others, and these are the

ones which aid in the evaluation of the literature on treatment. One must keep in mind, however, that different authors using the same ratings may not use exactly the same criteria for these ratings. Generally speaking, the method used today consists of evaluation of symptomatic findings (subjective), physical findings (objective), and roentgenographic findings (anatomical).

Symptoms or subjective findings consist of hip pain, back pain, fatigue, and amount of activity. These are graded as to severity as follows: none, intermittent, mild, moderate, and severe. The physical or objective findings consist of limp due to hip mechanics, abductor power, limp due to leg shortening, and the hip-motion index. The roentgenographic findings consist of size of femoral head, amount of anteversion, shape of femoral head, obliquity of acetabular roof, and C-E angle changes.

The evaluation of the above findings are employed rather uniformly in most of the literature reviewed, and these will provide the basis for drawing conclusions as to effectiveness of various methods of treatment.

## CONSERVATIVE TREATMENT

Treatment of preluxation: Conservative treatment of congenital dislocation of the hip consists essentially of closed reduction with adequate functional after-treatment. The most conservative treatment possible is that which can be instituted in the first six months of life when the hip is in the phase of preluxation. No reduction maneuvers or manipulations are necessary at this early age. Treatment consists of placing the thighs in abduction and flexion, with partial immobilization in this position.

Various techniques and devices have been developed over the years in treating the preluxation. The most pupular at present is the Frejka abduction pillow splint, (Fig. VIII). This splint provides active and functional immobilization. The pillow is placed firmly between the flexed and abducted thighs from knee to knee. The pillow pressure gradually overcomes the adductor contracture, abducts the hips completely and levers the femoral head into its natural position within the dysplastic socket. Concentric reduction, which is essential, is obtained by abduction of the flexed thighs and not abduction of the extended thighs.

The pillow splint is so constructed that the

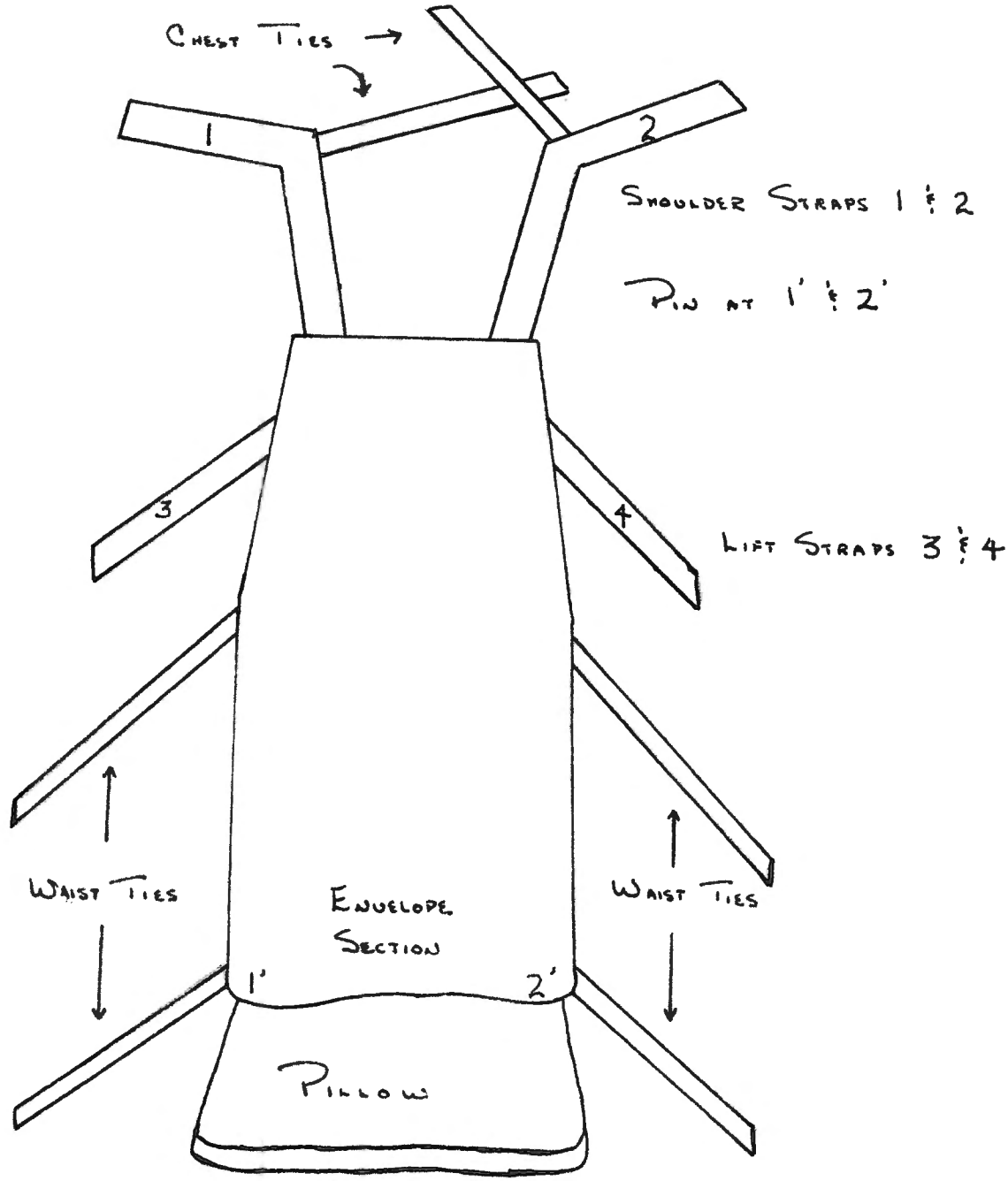



Figure VIII. Frejka Pillow Splint.
(Hart, 40, 47)

size of the pillow can be changed as the infant grows. The splint treatment is continued until an adequate acetabular roof and stable joint can be demonstrated roentgenographically. The average lenth of time of the treatment is four to six months.

The Chapple abduction diaper splint is effective in treatment of the very young infant who sleeps most of the time. The infant is placed in prone position and the legs are abducted and flexed. The diaper is then pinned to the sheet in three places to maintain the desired position.

Another device used for this type of treatment is an aluminum frame placed on the babies' back. There are six prongs on the frame. One pair fits over the shoulders, another around the flanks,of the child (one prong on each side), and the third pair fits around the posterior and lateral aspects of the flexed, abducted thighs. This frame was devised by von Rosen (2) because he felt that the Frejka pillow splint and the splints maintaining the functional immobilization position were causing aseptic necrosis of the femoral head with secondary deformation of the head.

In addition to treatment of preluxation with the above method, complete dislocations may be treated

in this way if they are recognized in the first several days or weeks of life, and if they are easily reducible by Ortolani's maneuver (same as diagnostic maneuver above).

According to Hart (40, 47) the hip joint usually returns to normal after this treatment because of three factors: (1) spontaneous healing; (2) favorable biomechanics provided by the splint; and (3) early treatment before the addition of serious secondary obstacles or sequelae. Various other devices have been developed to splint the hips in this fashion while providing a favorable development of normal stimuli of motion and pressures. There are walkers, slings, and plates that have been developed for this use, however, descriptions of more devices is not essential to the discussion of treatment.

The important points to be gained from this method is that the thighs are abducted and flexed so that the head is brought into the acetabular fossa; and immobilization is not complete; but of the functional and active type which is necessary for stimuli for growth of the head and roof.

Closed Reduction Techniques: After the first six months, or one year of life, the choice of

treatment is the closed or bloodless reduction. The Paci-Lorenz method is still the one of choice. It consists of three steps, and is accomplished by bringing the femoral head over the posterior rim of the acetabulum. The three steps are:

1. The anesthetized infant is placed on his back with a folded towel beneath his pelvis. An assistant fixes the pelvis by exerting downward pressure upon it with both hands superimposed. The operator grasps the distal end of the slightly inward rotated thigh with one hand, and places the fingers of the other hand over the trochanter. The thigh is then flexed to the maximal limit, that is, until its anterior aspect contacts the abdomen. In this way the long abdominal muscles are relaxed, and the femoral head moves from its superior position in back of the posterior rim of the socket with the trochanter acting as a pivot.
2. The thigh is then brought into moderate abduction by slight traction, and with simultaneous outward rotation of its shaft, is swung in an arc from sagittal flexion into rectangular frontal abduction. In this way

the femoral head is approximated and brought to the level of the posterior rim of the socket.

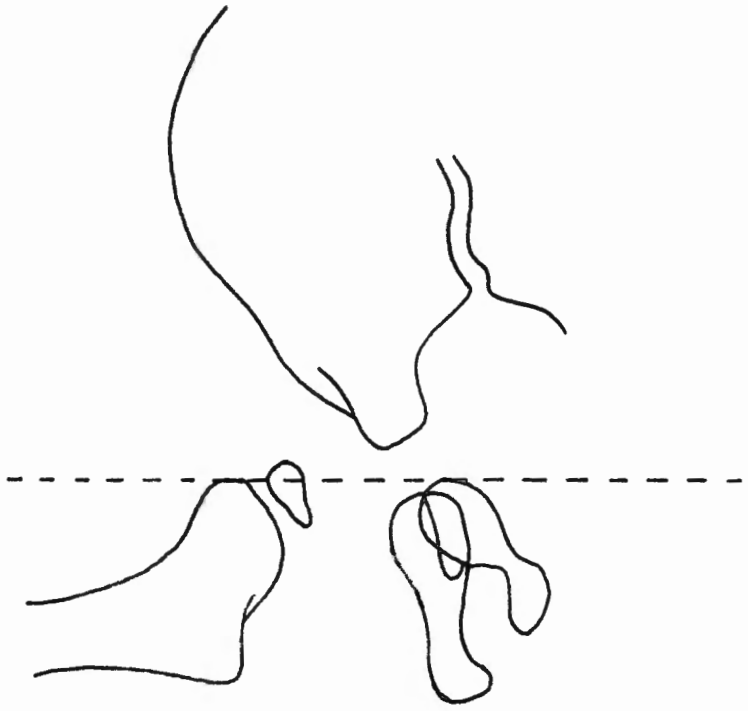
3. As the frontal abduction is cautiously increased by slow, powerful traction in the longitudinal direction of the thigh and downward pressure to produce hyperextension, an upward counterpressure is exerted by the hand on the trochanter. In this way the femoral head is forced to vault over the rim of the socket. This maneuver finishes the reduction. It is this manipulation that must be done as gently as possible in order to avoid traumatic injury to the epiphysis of the femoral head.

The closed reduction is accomplished by this method, or a modification developed by Ridlon. This latter procedure consists of the same three flexion, abduction, and inward rotation maneuvers as in the former; the only difference being that the thumb of the supporting hand is placed in front over the head, the index finger being over the neck, and the middle finger over the trochanter. Again, gentleness is of utmost importance in preventing trauma to the femoral head and its subsequent sequelae.

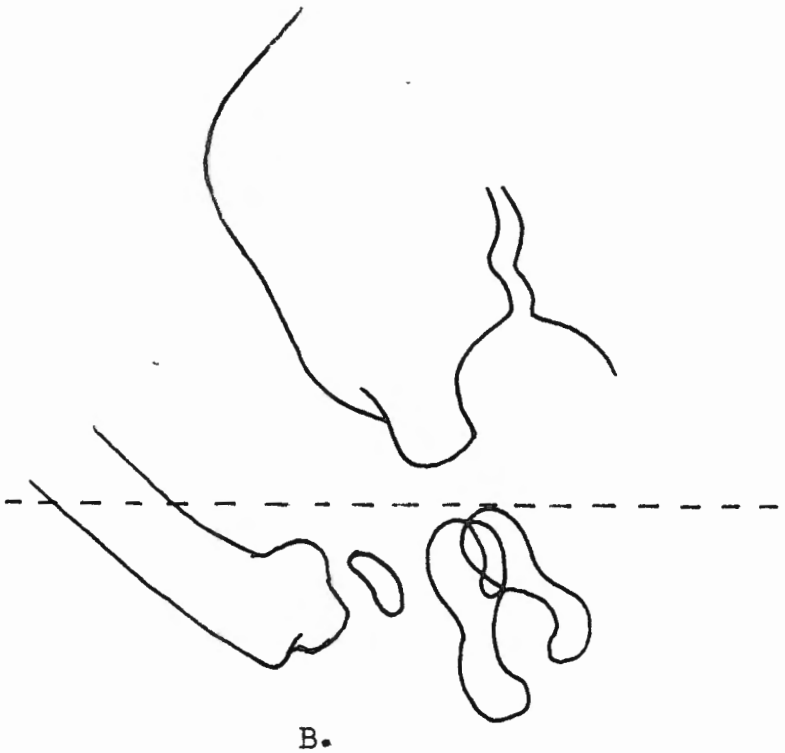
The criteria of a successful reduction according to Hass (48) are as follows: (1) There is an audible, visible, or tactile snap as the head slips over the rim of the acetabulum followed by another impact as the head meets the surface of the acetabulum. (2) The deep hollow in the inguinal flexure disappears. (3) The femoral head becomes palpable in its normal position. (4) The thigh may be noted to become considerably longer. (5) The thigh muscles become tense, and the knee may be in a contracted flexion position due to tension of the hamstrings. If only subluxation was present, all of these signs will be less marked. A more certain way to tell if the head is reduced is by roentgenographic findings following reduction. Figure IX shows the classical primary position and the accentuated primary position which is sometimes necessary for reduction.

If the reduction maneuver is not effective, it is thought to be unwise to continue manipulation because of trauma to the joint structures. Anatomical obstacles, age of the patient, and other factors which will be more fully discussed later may be responsible for the ineffectiveness of the reduction or retention of the head in the correct position.

Skeletal traction is employed by some orthopedists



A.



B.

Figure IX. A. Classical primary position after closed reduction. B. Accentuated primary position after closed reduction. (48)

before the reduction maneuver is attempted. This tends to stretch the contracted and shortened muscles and makes reduction easier. Another procedure pursuing the same objective is adductor tenotomy or myotomy. The adductors are stripped from their femoral attachments by kneading with the butt of the hand or by making an incision through which the fingers are introduced, and the adductors are located and stripped as a subcutaneous procedure.

Another method of closed reduction is the divarication. This consists of gradual abduction of the hips by traction. The traction is continued for about two to three weeks until the legs are nearly in a straight line with each other. This abduction method is felt to be superior to the Paci-Lorenz method because there is no chance of trauma and resulting osteochondritis. The abduction is maintained for about six months by splints or casts and is gradually reduced as described below.

Retention of the head in the desired position is the other important phase of closed reduction treatment. The thighs are placed in 90° abduction, 90° flexion, and 90° external rotation. This is the Lorenz position and is maintained by a double spica cast. The plaster goes down to the ankle on

the affected side and stops below the knee on the normal side. This immobilization is continued until X-rays reveal that the acetabulum is developing, and there are good prospects of a stable joint. This usually takes from mine to eighteen months, the plaster requiring changing every three to four months.

The amount of flexion, abduction, and rotation is gradually reduced over the months if it does not interfere with joint stability. The final cast may be in 30° flexion, 30° abduction, and neutral rotation, thus allowing walking in the last few months. Toward the end of the period of fixation, the cast may be bivalved and removed daily for exercises and massaging. It takes from six months to one year for walking to become normal.

I. V. Ponsetti (15) reported on a group of 103 closed reductions. He used the Paci-Lorenz method followed by 3 months in the Lorenz position and 3 months in the Lange position (reduced abduction and inward rotation). The results are compared with 20 cases of open reduction and 44 cases of shelf operation as to anatomical and functional end-results. (See Charts III and IV)

Just as the treatment for preluxation is most effective in the first six months to one year of life,

CHART III

| | Closed Reduction | Open Reduction | Shelf Operation |
|---|---|---|---|
| I. No symptoms | 47 | 4 | 0 |
| II. Slight pain on excessive walking | 8 | 2 | 1 |
| III. Limp, free motion, no pain | 20 | 4 | 7 |
| IV. Limp, diminished motion, no pain | 16 | 4 | 16 |
| V. Limp and pain | 10 | 3 | 11 |
| VI. Limp, limitation of motion, pain | 2 | 3 | 9 |
| TOTALS | 103 | 20 | 44 |

Comparison of the functional results in the three major types of treatment. (Ponetti 15, 46)

CHART IV

| | | Closed Reduction | Open Reduction | Shelf Operation |
|---|---|---|---|---|
| I. | Well-developed hip joint | 12 | 0 | 0 |
| II. | Moderate deformity | 38 | 3 | 4 |
| III. | Dysplasia, no subluxation | 31 | 10 | 16 |
| IV. | Subluxation | 8 | 3 | 4 |
| V. | Head in secondary acetabulum | 6 | 2 | 15 |
| VI. | Redislocation | 8 | 2 | 5 |
| | TOTALS | 103 | 20 | 44 |

Comparison of anatomical results in the three major types of treatment. (Ponetti 15, 46)

the closed reduction is considered to be most effective in the age range of one to five years if unilateral and one to four years if bilateral. Even in this age range open reduction and reconstructions may be necessary because of anatomical obstacles, soft tissue contractures, or inadequate acetabular roof.

The after-treatment of these cases that have been treated by closed reduction is a necessary part of the regime. It consists of controlled functioning, that is, the legs are free to move in any direction except outward rotation and adduction. The legs are kept in abduction by means of a bar or splint, e.g. the Denis-Browne splint. This is continued for two or three months after the immobilization period. The child is X-rayed every month, and can walk after this period of after-treatment.

Causes of Failure of Closed Reduction: The causes of failure of closed reduction methods are as follows: (Hass, 48; Ponsetti, 15) Redislocations, which may be early or late are the main cause of failure. Early redislocations are due to (1) poor primary position due to interposition of soft parts, (Fig. X), (2) inadequate amount of time of retention in good primary position, (3) unfavorable anatomical

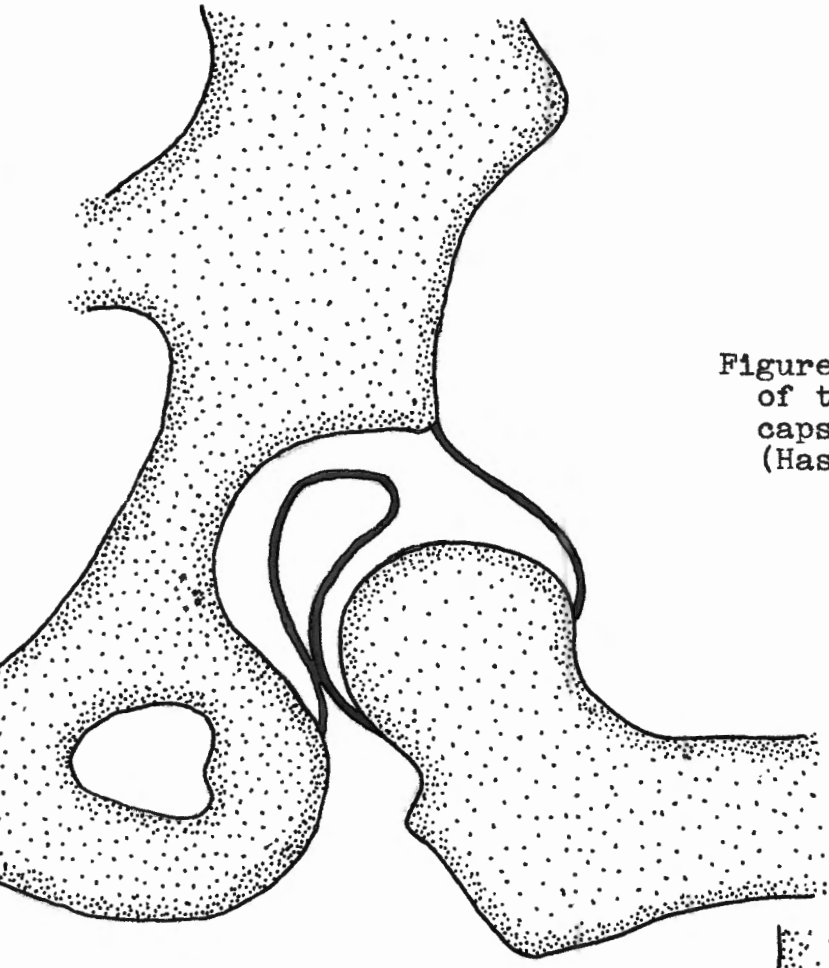


Figure X. A. Interposition of the inferior leaf of the capsule after closed reduction. (Hass, 48).

A.

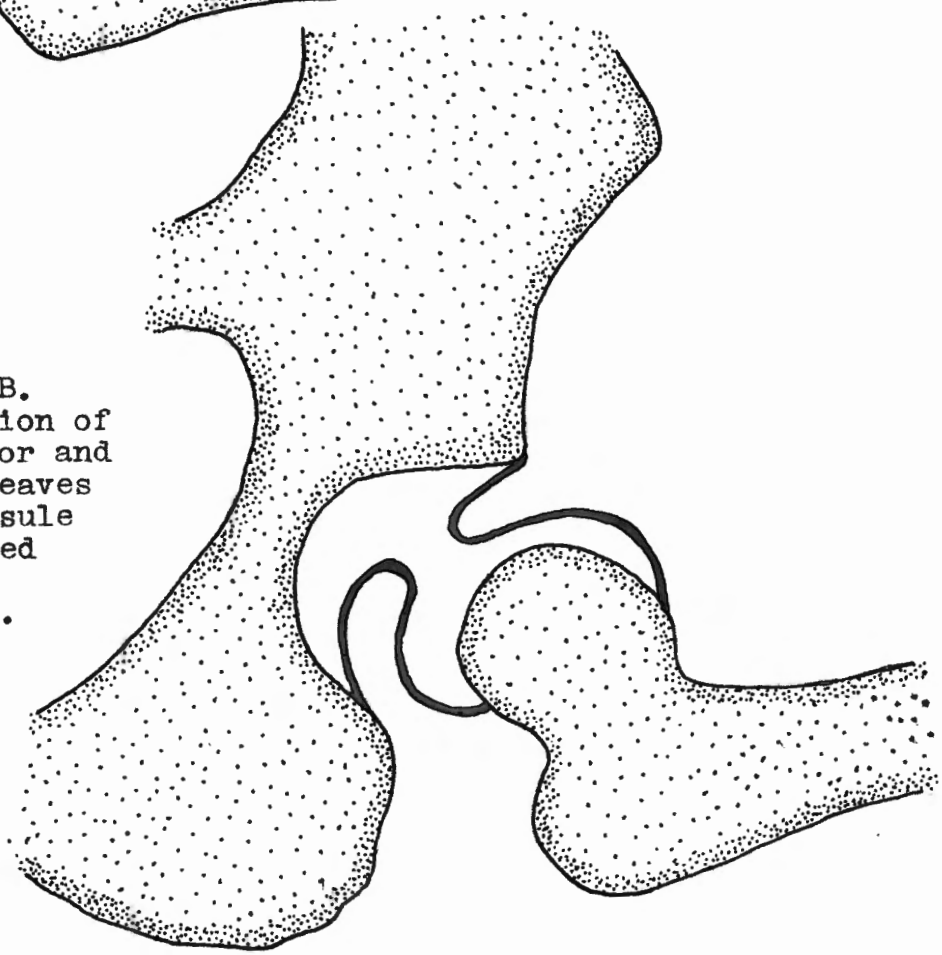
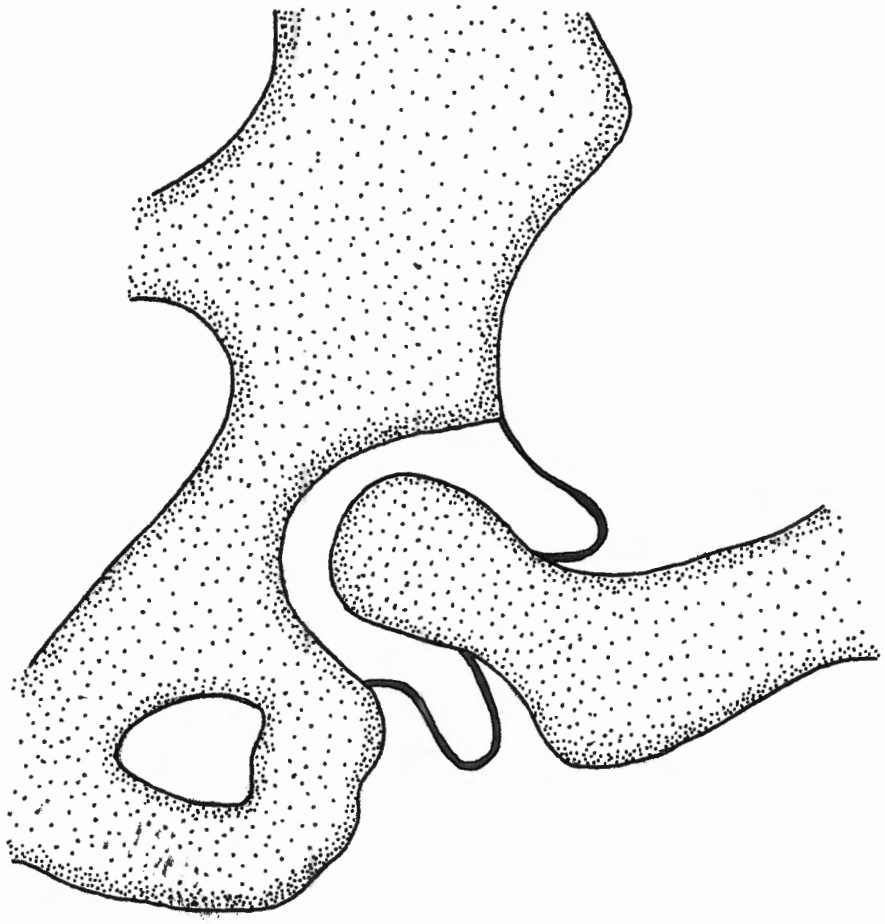


Figure X. B. Interposition of the inferior and superior leaves of the capsule after closed reduction. (Hass, 48).



B.



C.

Figure X. C. Position of the capsule in concentric reduction. (Hass, 48)

conditions leading to eccentric formation of the acetabulum, (4) absence or retardation of development of the roof of the acetabulum, and (5) rigid flexion contractures in older children appearing during the period of after-treatment. Late redislocations are due to (1) trauma or body weight increase with age, (2) an anatomically incompletely restored joint resulting in retardation of development of the socket and disparity of size between the head and socket, (3) adductor contractures, and (4) anteversion of the femoral head.

Post reduction deformities of the head and upper end of the femur are also responsible for failures in closed reduction. The deformities often found are epiphysitis of the upper femur, cystic atrophy of the ossified nucleus of the femoral head, and fragmentation of the ossified nucleus of the head. These changes may be due to trauma at the time of reduction or to inferior viability of the joint structures which is enhanced by tearing of capsular vessels at the time of reduction.

Post-reduction changes in the acetabulum may be the cause of failure. They are osteosclerosis and cystic atrophy of the acetabulum. The latter may disappear and have no effect on the joint with increase of age.

## OPERATIVE TREATMENT

The operative treatment for congenital dislocation is generally considered as a supplement to the closed reduction. In cases where closed reduction has failed or seems impractical the open method is used. Open and closed methods should not be compared statistically because the former is actually supplementary to the latter, and any good results from the open method should be added as an increment to the total of good end results. In this section open reduction, reconstruction operations, and palliative procedures will be discussed.

Indications for Open Reduction: A few orthopedists still feel that open reduction should be the primary treatment even in very young children. Most surgeons today, however, feel that open reduction is indicated only in cases in which closed reduction has failed or is expected to fail. Hass (48) has set down the following indications for open reduction: (1) In children under three years of age the only indication for open reduction as primary treatment is the interposition of the lower leaf of capsule, (Fig. X,A). (2) In children of three to six years of age if unilateral dislocation is present, and of

five years of age in bilateral cases, open reduction is indicated if closed reduction has failed. (3) In cases of redislocation occurring at the end of the period of immobilization, when the patient begins to walk, open reduction is preferable to repeated manipulation except in selected cases. (4) In all cases beyond the age period when closed reduction might be expected to yield satisfactory results, that is, after six years of age open reduction is indicated. Most surgeons also place an upper age limit. of 10 years on open reduction because of increase of poor results after this age.

Techniques of Open Reduction: Many methods of open reduction have been developed through the years, but to simplify and shorten this discussion only several of the more widely accepted techniques will be described.

Colonna's technique (7, 19, 48) which was first described in 1932 is still an acceptable method. It consists of two stages. The first stage is traction, skin or skeletal, with or without adductor tenotomies. The head is brought down to the level of the socket in this way. The traction is either a gradual procedure over several days or weeks or it may be done at one sitting; the latter being Colonna's original

technique.

The second stage consists of exposing the hip joint by the lateral route. After adequate exposure is obtained, the tip of the greater trochanter is resected and turned upward with its attached muscles. The capsule is then separated from the overlying group of muscles, and is divided at its narrowest point to expose the femoral head. The shaft of the femur is externally rotated,and the capsule is freed from muscles posteriorly. The redundant capsule is then made into a sac to cover the femoral head. The proximal residual portion of capsule about the socket is removed as completely as possible. The site of the original acetabulum is then found, and a cavity is curetted out at this site. The capsule-covered head is then placed in the cavity. No attempt to fix the capsule to the socket is made, since in most cases adherence between the two is effected within a few weeks. The greater trochanter is replaced and sutured in its former site. The hip is then immobilized in complete extension and about $20^{\circ}$ abduction , and a unilateral plaster spica is applied from the nipple to the toes.

Again, effective after-treatment is essential

for good results. The cast is removed in about four weeks and active and passive motions are begun. Weight bearing is permitted when a considerable range of active and passive motions have been attained in bed.

Gill's technique consists of a more inferior approach to the capsule. Two incisions are made in the capsule. One is in the horizontal plane and the other perpendicular to this. The latter enables the head to pass through the hour glass constriction of the capsule and into the wound. The original acetabular cavity is then enlarged by removal of fibrous and fatty tissue,and the head is placed in the acetabulum. Gill also does a shelf construction at the same time as the open reduction. The reconstructive procedures will be discussed later.

The principles to open reduction according to Gill (16) are: (1) It must be possible to place the head in the socket without undue tensions on the soft structures or excessive pressure on the articular cartilage. These structures should not be injured during replacement of the head. (2) The acetabulum should be deep enough to admit the entire head. (3) The acetabular roof should be reconstructed by a shelf operation if it is defective to the extent that it will allow the head to slip out

of the socket. Care must be taken in open reductions to avoid gouging or injuring in any way the articular cartilages of the acetabulum and femoral head.

The immobilization following open reduction is shorter. The after-treatment is about the same as in closed reduction. Weight bearing is avoided until an adequate acetabular roof is seen on X-ray.

The causes of failure of open reduction are generally the same as in closed reduction, that is, redislocation, muscular contractures, and deformities of the joint structure. In addition to these there is also a chance of developing an ankylosis of the joint if the articular cartilages are damaged.

The results of the open reduction on the whole are somewhat poorer than closed reduction. This is probably due to the fact that many times open reduction is resorted to after closed reduction has failed. Undoubtedly, the cases in which open reduction is done are more difficult problems.

Reconstructive Procedures: The arthroplastic or reconstructive procedures are the shelf operation and the rotational osteotomy.

The idea of the shelf operation was concieved by Koenig in 1891, but the first person to undertake

it in the United States was Ferguson in 1904. The procedure consists of turning down a bone flap or placing a bone graft over the head of the femur to prevent its gliding upward over the inadequate acetabular roof.

Indications for the shelf operation according to Wiberg (8, 31) are: (1) subluxation or dysplasia after either open or closed reduction of dislocation, (2) after seven years of age as primary treatment because of fear of necrosis of the femoral head, (3) in immediate (early) redislocations, (4) if there is a tendency toward subluxation in follow-up films, and (5) even if there are slight physical symptoms of acetabular dysplasia at the critical age (6-7 years). It is thought to be technically difficult to form a shelf in children younger than 5 years of age. Another contraindication is dysplasia or subluxation with secondary osteoarthritis in the destructive phase.

The techniques of shelving are as numerous as are the techniques for other types of treatment of congenital dislocation. According to Jakobsson (4) there are two fundamentally different groups of shelving techniques. In one type the objective is

to enlarge the upper articular margin. Under this type are included Koenig's, Lance's and Spitzy's techniques. In Koenig's method a bone flap from the ilium is pried down above the head. In Lance's method the bone flap is widened anteriorly with a bone graft. In Spitzy's method a graft is driven in above the acetabular margin above the head. The other type of shelving has as its objective the bringing down of the sloping head into a horizontal plane by prying down the whole roof or margin. In Albee's method the margin is pried down, in Jone's the roof is pried down, and in Gill's a bone flap is pried down with downward reflection of the roof. Hass's method consists of prying down the roof and use of a bone graft to hold it in position. (Fig. XI)

After the shelf operation is performed, a plaster spica is applied to the limb in abduction of 45°, followed by traction of the leg for about six weeks. Partial weight bearing may be permitted at six weeks, but full weight bearing is not permitted until about six months after operation. (See Chart V)

The shelf operations are all similiar. The principle involved is always the same, namely, to correct the acetabular obliquity by reflecting the

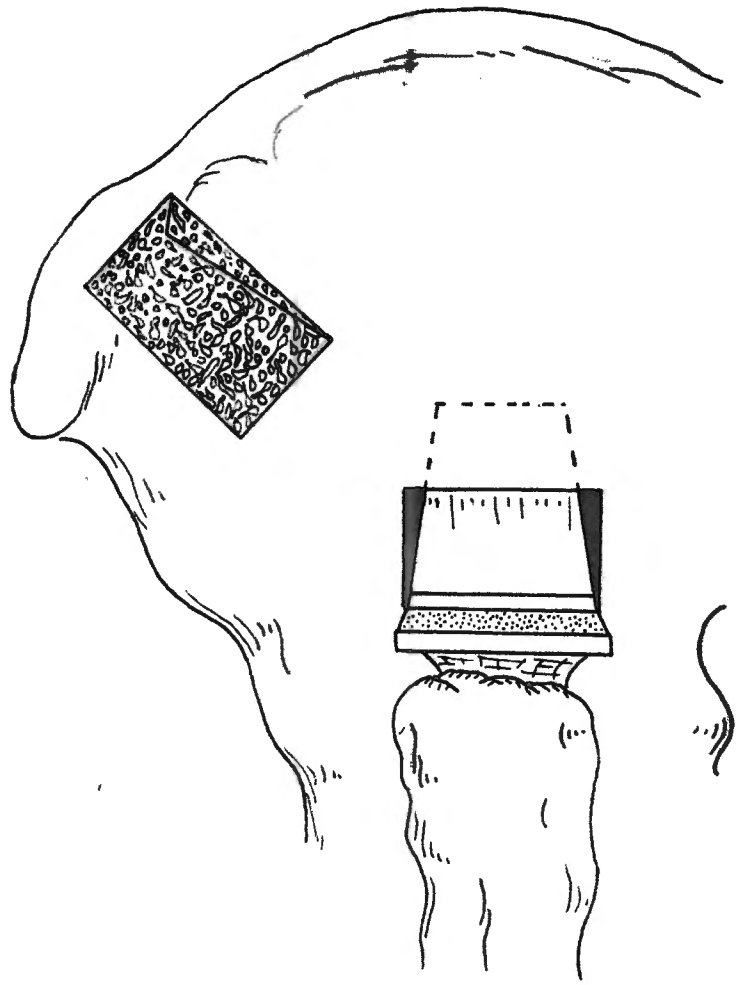


Figure XI. A. Hass's Technique of the Shelf Operation. A bone plate is removed from the iliac crest and outer table of the ilium and is wedged between the ilium and the bone flap. (48)

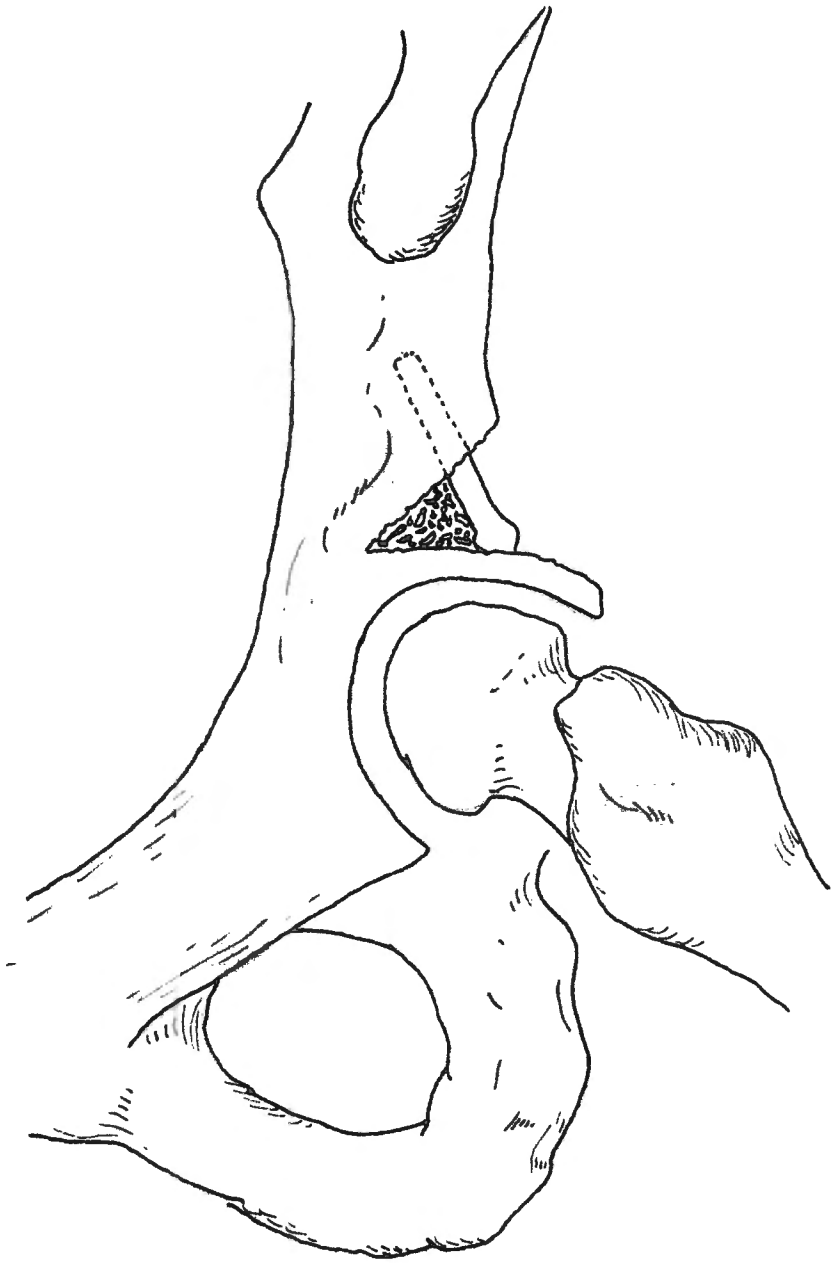


Figure XI. B. Lateral view after completion of the operation. (48)

CHART V

| Age at operation (years) | Patients | Hips | Results | |
|---|---|---|---|---|
| 0-3 | 5 | 6 | Excellent | 2 |
| | | | Fair | 1 |
| | | | Poor | 3 |
| 3-5 | 6 | 6 | Excellent | 1 |
| | | | Good | 4 |
| | | | Fair | 1 |
| 5-7 | 10 | 11 | Excellent | 4 |
| | | | Good | 3 |
| | | | Fair | 1 |
| | | | Poor | 3 |
| 7-9 | 5 | 5 | Excellent | 1 |
| | | | Good | 3 |
| | | | Poor | 1 |
| 9-11 | 2 | 3 | Fair | 3 |
| Over 11 | 5 | 5 6 | Excellent | 1 |
| | | | Good | 3 |
| | | | Fair | 1 |
| TOTAL | 33 | 36 | | |

Results of shelf operations in 36 hips. (Muller and Seddon, 26)

CHART VI

| | Hips | Result | |
|---|---|---|---|
| Site unknown | 1 | Poor . 1 | |
| Much too high | 14 | Excellent. 4<br>Good . 4<br>Fair . 3<br>Poor . 3 | 57% |
| Slightly high | 12 | Excellent. 2<br>Good . 5<br>Fair . 3<br>Poor . 2 | 58% |
| Anatomical | 9 | Excellent. 4<br>Good . 4<br>Poor . 1 | 90% |

Analysis of shelf operations with regard to site of shelf. (Muller and Seddon, 26)

roof downward, and maintaining this position.

The following considerations should always be observed: (1) the femoral head must be concentrically reduced in the primary acetabulum, (2) the shelf should be constructed as close as possible to the original acetabular margin, (See Chart VI), (3) the shelf should be constructed of acetabular tissue and a bone graft used only to maintain the shelf in position, (4) the operation should be extra-articular so that the articular cartilage is not disturbed, (5) the shelf should be strong enough to prevent breaking down under weight bearing, (6) it should be turned obliquely downward to prevent upward sliding of the head, and (7) the limb should be immobilized until the shelf is consolidated.

The other reconstructive procedure is the rotational or derotational osteotomy. This is a corrective procedure for anteversion of the femoral head of over $45^{\circ}$. This procedure consists of dividing the femur just below the lesser trochanter and then rotating the distal end of the femur and the rest of the leg to the desired position (that is with the head in the socket). The problem encountered in this treatment is the difficulty of ascertaining

whether there is sufficient anteversion to warrant osteotomy. The two pieces of femur are then united in their new relationship by wires or pins or may merely be immobilized in a plaster spica until united.

There are various techniques of this procedure, the variations being in the level of division of the femur. The most widely accepted level at present is just below the lesser trochanter.

Palliative Procedures: The palliative procedures are reserved for the old irreducible dislocation which has never been treated or is a failure of more conservative methods. These procedures are also done on complications of the more conservative methods.

In the cases of irreducible hips an osteotomy which provides bony support of the pelvis at the site of the socket is done. The femur is bifurcated with an oblique sectioning at the level of the socket, and the upper end of the distal fragment is placed into the socket. The proximal fragment is not manipulated. In this way the body weight is no longer suspended by ligaments and capules, but rests firmly on the shaft of the femur. This is the Lorenz method. In Schanz's method two screws are driven into the femur and the femur is divided between these screws.

The femur is then pushed medially until an acute angle is formed between the two fragments of the femur. The lateral ends of the screws then approximate each other, and the head is brought into the socket. Hass's method consists of making a triangular plug in the upper end of the distal fragment which is inserted into a slot made in the lower end of the proximal fragment. The proximal fragment is so angulated that the lesser trochanter is placed in the socket.

Other procedures consist of adduction or abduction osteotomies to relieve adductor or abductor contractures respectively.

Arthrodesing procedures are done in some cases of painful osteoarthritis which is a complication of the more conservative methods.

The palliative procedures are usually indicated in older persons who have never been treated or who have failures or complications of the more conservative methods of treatment. They are done for the relief of moderate to severe symptoms such as pain, fatigue, instability, or incapacitating deformities.

## SUMMARY

This has been a review of literature on congenital dislocation of the hip with special attention to early diagnosis and various methods of treatment. It is admittedly not exhaustive, however, the pertinent literature has been read, and conclusions will be made from this material.

The terminology pertinent to this deformity has been defined and discussed. Brief discussions of the incidence and occurence, pathogenesis and pathology, and etiology have been included.

It was found that the malady is endemic in certain areas of Europe, and almost non-existent in some parts of Asia. There is also a peculiar racial incidence. The white race is afflicted the most, the yellow race less, and the black race the least. Females are affected six to seven times as frequently as males.

The etiology is uncertain. There are many factors which have been implicated, a few of which are hormones, mechanics and pressures of the intrauterine environment, vitamins, and nutrition. It is known that the dysplasia is congenital, but the

actual subluxation and dislocation are sequelae of this dysplasia.

The pathology encountered in the fully developed dislocation is characterized by marked changes in the capsule consisting of constriction, elongation, and adherence to the ilium. There is also deformity of the acetabulum, of both the roof and the socket proper. The femoral head may also be deformed, and contractures or redundancies of the surrounding muscle groups may be present.

The diagnosis of congenital dislocation was divided into clinical findings and roentgenographic findings. The most important of the clinical signs is the Ortolani's click. This occupies such a position of importance because it can be found early, thus, enabling earlier treatment which is subsequently more effective. Other clinical signs are the limited abduction, telescoping the thigh, increase in number and depth of skin creases, and shortening of the extremity. Findings in the older patients were the positive Trendelenburg, marked lordosis, elevated trochanters, and waddling gait.

Roentgenographic findings consist of retardation of endochondral ossification of the acetabular roof,

epiphyseal dysplasia of the femur, and displacement of the femoral head. Many measurements and indices are included which are tools for interpretation of the X-rays.

Treatment of congenital dislocation was discussed briefly from the standpoint of history. The main strides in treatment have been made in the last sixty years. Open methods were first used; then the closed methods came into vogue; then open methods were resurrected; and finally at the present the closed method is again the treatment of choice when supplemented by open methods in certain cases. Certain factions at present are again advocating the open method as primary treatment.

The discussion of treatment was divided into conservative or closed methods, operative or open methods, reconstructive operations, and palliative procedures.

The treatment of preluxation is the simplest and the most effective. It consists of functional immobilization in abduction, flexion, and external rotation. This treatment is employed during the first six months to one year of life before the head is subluxated or dislocated. The Frejka pillow

splint is probably the most popular device used for this treatment.

The closed methods of reduction are used in the cases of subluxation or dislocation during the age period of one to five years. The technique of choice is the Paci-Lorenz method followed by about three months of immobilization in the Lorenz position and then three months in the Lange position. There are variations in length of time of immobilization depending upon the case. The criteria that one usually follows in evaluating response to treatment are the appearance of the acetabular roof and concentricity of the femoral head in the acetabulum.

The causes of failure of open methods are interposition of soft parts, muscular contractures and abnormal development of the acetabulum or femoral head. The last may be the consequence of trauma during manipulations.

The open methods of reduction are looked upon at present as a supplement to the closed methods. If the hip has not been treated by about five years of age, or if poor results from closed methods have been achieved, the open methods are resorted to. The purpose of open methods is the same as any type

of treatment, that is, placing the femoral head in the acetabular socket. The open reduction consists of cleaning any excess of soft tissue out of the socket, reconstructing the articular capsule, and placing the femoral head in the socket. There are some surgeons who also do reconstructive procedures such as the shelf operation at the time of open reduction. The main cause of failure of the open reduction is deformity or ankylosis of the joint resulting from operative trauma to the articular cartilages.

The reconstructive procedures consist of the shelf operation and the rotational osteotomies. The shelf operation is rather widely used and is indicated in untreated cases over five or six years of age and in redislocations after other methods of treatment have been used. It consists of placing a shelf at the superior margin of the acetabulum to form a buttress for the femoral head. The rotational osteotomy consists of dividing the femur and rotating the distal end of it, and is indicated in cases of anteversion of the femoral head over $45^{\circ}$. These procedures are done somewhat as last resorts. If these fail and the joint is incapacitating to the

individual, palliative procedures are indicated.

The palliative procedures are done in old untreated dislocations, or in complete failures of other methods. They are performed in order to relieve the patient of severe, disabling symptoms. Arthrodesing procedures or bifurcations in which the joint is fused or the upper end of a distal fragment of femur is placed in the socket respectively, are done in these cases. These procedures are done merely for the purpose of relief and not with the hope of cure.

The treatment of congenital dislocation of the hip is a very interesting and challenging phase of orthopedics. The methods of treatment can be visualized as a spectrum, ranging from the most conservative to the most radical. The results of treatment can also be placed along this spectrum with the greatest number of good results falling along the end of the conservative methods. An all-important factor which influences the fact that the greater number of good results are obtained by conservative treatment is the age of the patient at the time of treatment. Early diagnosis is the key to effective treatment. The earlier the patient is treated, the greater the chance of good results from the more conservative methods of treatment.

## CONCLUSIONS

The conclusions to be drawn from this review of literature will be limited to the aspects of diagnosis and treatment of the congenital dislocation of the hip. The conclusions are:

1. Every infant should be examined in the immediate neonatal period for congenital dislocation of the hip.
2. Careful clinical examination will usually suffice to separate the normal from the abnormal hips.
3. Roentgenograms should be taken to confirm the clinical diagnosis and ascertain the exact nature and degree of deformity.
4. If the clinical examination is entirely negative in the neonatal period, suggestive signs will usually show up; and the parents will bring the child in before one year of age when effective treatment may be instituted.
5. Treatment should be started immediately upon discovery of the deformity.
6. The earlier the treatment is begun, the greater are the chances for good results.

7. The earliest treatment consists of active functional immobilization so that there is a stimulus for normal development of the structures of the joint.

8. Before one year of age, if there is no subluxation or dislocation, the deformity is treated as in 7.

9. From one to five years of age closed reduction methods are used as primary treatment.

10. After five years of age and in redislocations the open methods are employed.

11. The results of open methods should not be compared statistically with closed methods since many of the cases in which the open methods are used are failures of the closed methods. Any good results from open methods should be added to the total of good results from all methods.

12. The shelf operation is used to correct the persistent acetabuluar roof obliquity. The critical age for evaluation of this deformity is five to eight years. If during this time the obliquity persists, the shelf operation is indicated.

13. Derotational or rotational osteotomies are done for correction of anteversion of the femoral head of over $45^{\circ}$.

14. Many of the complications of both open and closed methods are due to trauma to the joint structures at the time of reduction. Trauma and forceful manipulations should be avoided.

15. Palliative procedures are the last resort and are done for relief of severe symptoms in untreated cases, irreducible dislocations, and poor results of more conservative methods.

16. Above all, early diagnosis is essential to effective treatment and good, lasting results.


## ACKNOWLEDGEMENTS

I wish to express my sincere appreciation to Dr. W. H. Weingarten for his advice and counsel in the preparation of this thesis. I wish to thank my wife, Charlotte, for the preparation of the illustrations.

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