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Staff Meeting Bulletin  
Hospitals of the » » »  
University of Minnesota

Dislocation of Hip

STAFF MEETING BULLETIN  
HOSPITALS OF THE . . .  
UNIVERSITY OF MINNESOTA

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William A. O'Brien, M.D.

I. UNIVERSITY OF MINNESOTA MEDICAL SCHOOL  
 CALENDAR OF EVENTS  
 April 9 - 14, 1945

No. 66

Monday, April 9, 1945

- 9:00 - 10:00 Roentgenology- Medicine Conference; L. G. Rigler; C. J. Watson and Staff; Todd Amphitheater, U. H.
- 9:00 - 11:00 Obstetrics and Gynecology Conference; J. L. McKelvey and Staff; Interns Quarters, U. H.
- 12:30 - 1:30 Pathology Seminar; The Influence of Maternal Diabetes on the Infant; S. Lofsness; 104 I. A.
- 8:00 - Sigma Xi Lecture; The Interior of the Earth; Rev. James B. Macelwane, St. Louis University; Museum of Natural History Auditorium.

Tuesday, April 10

- 9:00 - 10:00 Roentgenology-Pediatrics Conference; L. G. Rigler, I. McQuarrie and Staff; Eustis Amphitheater, U. H.
- 11:00 - 12:00 Urology Conference; C. D. Creevy and Staff; Main 515 U. H.
- 12:30 - 1:30 Pathology Conference; Autopsies; Pathology Staff; 104 I. A.
- 12:30 - 1:30 Physiology-Pharmacology Seminar; The Study of Human Performance as a Whole by the Simultaneous Observation of Component Functions; Ancel Keys and Josef Brozek; 214 M. H.
- 4:00 - 5:00 Physiological Pathology of Surgical Diseases; Physiology and Surgery Staffs; Todd Amphitheater, U. H.
- 4:30 - 5:30 Obstetrics and Gynecology Conference; J. L. McKelvey and Staff; Station 54, U. H.
- 4:00 - 5:00 Pediatrics Grand Rounds; I. McQuarrie and Staff; W-205 U. H.
- 4:30 - 5:30 Ophthalmology Ward Rounds; Erling Hansen and Staff; E-534, U. H.
- 5:00 - 6:00 Roentgen Diagnosis Conference; H. O. Peterson; 515 U. H.
- 8:15 - E. Starr Judd Lecture in Surgery; The Problem of Portal Hypertension in Relation to Hepato Splenopathies; Allen O. Whipple, Columbia University, Museum of Natural History Auditorium.

Wednesday, April 11

- 9:00 - 11:00 Neuropsychiatry Seminar; J. C. McKinley and Staff; Station 60; Lounge, U. H.
- 11:00 - 12:00 Pathology-Medicine-Surgery Conference; Peri-cholacystic Abscess; Possible Carcinoma of Gall Bladder; E. T. Bell, C. J. Watson, O. H. Wangensteen and Staff; Todd Amphitheater, U. H.

- 12:30 - 1:30 Pediatrics Seminar:
- 12:30 - 1:30 Physiological Chemistry Literature Review; Staff; 116 M. H.
- 4:30 - 5:30 Neurophysiology Seminar; The Physiology of Movements in Man on Basis of Action Potential Studies; James F. Bosma; 214 M. H.

Thursday, April 12

- 9:00 - 10:00 Medicine Case Presentation; C. J. Watson and Staff; Todd Amphitheater, U. H.
- 12:30 - 1:30 Physiological Chemistry; Intermediary Metabolism of Carbohydrates; M. F. Utter; 116 M. H.
- 4:00 - 5:00 Pediatric Journal Club; Review of Current Literature; Staff; W-205, U.H.
- 4:30 - 5:30 Ophthalmology Ward Rounds; Erling Hansen and Staff; E-534, U. H.
- 4:30 - 5:30 Roentgenology Seminar; Shift of Mediastinum in Pulmonary Diagnosis; T. B. Merner; M-515 U. H.

Friday, April 13

- 9:00 - 10:00 Medicine Grand Rounds; C. J. Watson and Staff; Todd Amphitheater, U.H.
- 10:00 - 12:00 Medicine Ward Rounds; C. J. Watson and Staff; E-214 U. H.
- 10:30 - 12:30 Otolaryngology Case Studies; L. R. Boies and Staff; Out-Patient Otolaryngology Department, U. H.
- 11:45 - 1:15 University of Minnesota Hospitals General Staff Meeting; Vitamin A in Pregnancy; Curtis J. Lund; Powell Hall, Recreation Room.
- 1:00 - 2:30 Dermatology and Syphilology; Presentation of Selected Cases of the Week; Henry E. Michelson and Staff; W-206 U. H.
- 1:30 - 3:00 Roentgenology-Neurosurgery Conference; H. O. Peterson, W. T. Peyton and Staff; Todd Amphitheater, U. H.

Saturday, April 14

- 8:00 - 9:00 Surgery Journal Club; O. H. Wangensteen and Staff; M-515 U. H.
- 9:00 - 10:00 Pediatrics Grand Rounds; I. McQuarrie and Staff; Eustis Amphitheater, U. H.
- 9:15 - 10:30 Surgery Roentgenology Conference; O. H. Wangensteen, L. G. Rigler and Staff; Todd Amphitheater, U. H.
- 9:00 - 10:00 Medicine Case Presentation; C. J. Watson and Staff; M-515 U. H.
- 10:00 - 12:00 Medicine Ward Rounds; C. J. Watson and Staff; E-221 U. H.
- 11:30 - 12:30 Anatomy Seminar; Thrombocytopenia; R. H. Reiff; I.A. 226.

## II. TRAUMATIC DISLOCATION AND FRACTURE DISLOCATION OF THE HIP JOINT

Malvin J. Nydahl

Traumatic dislocation and fracture dislocation of the hip joint is a serious injury. Before the automobile age this accident was a rarity, but with the general use of the automobile and with other accidents traumatic dislocation has greatly increased. Individual surgeons have reported case series numbering 29, 52 and even 80 cases.<sup>25,24,7</sup> One reviewer reported 50 cases in children which indicates that this accident occurs in this age group.<sup>10</sup> Most cases occur in those who are subject to great violence, namely, young adults, because great force is required to dislocate a hip. The hip is a stable joint. Its stability is largely due to the great depth of the acetabulum and to the glenoid ligament which surrounds its margin and grasps the head of the femur slightly beyond its middle, thus making an airtight socket into which the femoral head fits, and where it is held by suction. This suction is so great that even with capsule and ligaments severed considerable force is required to dislocate the hip. In addition, the ligaments of the hip are among the strongest in the body.

It is hoped that this report of 14 cases on record at the University Hospitals will draw attention to the frequent severe complications that are sequelae of this accident, in addition to emphasizing the urgency of prompt recognition and treatment of the condition. Many of the dislocations can be quite easily reduced; however, others are difficult and require the attention of well trained personnel. Reference to the table will bring out the fact that some of our cases went 2 weeks before the condition was recognized and treatment instituted. Case 1 was in a hospital for 7 weeks following his injury and was given treatment for other injuries that he received, but apparently the hip received no definitive therapy. The history states: "After discharge from the hospital, his left hip and leg continued to bother him with pain in left hip, thigh, knee, leg, and ankle aggravated by changes

in weather". One year later he was placed in a left hip spica for a period of 8½ months with the diagnosis of "possible tuberculosis". It was not until 3 years after the injury, when he was seen by 2 orthopedic surgeons, that the correct diagnosis was made.

If the patient is allowed to go for any period of time without treatment the reduction of course becomes more difficult and after several weeks or months numerous problems of treatment arise. The chance for manipulative reduction disappears. Operative reduction is shocking and it is almost inevitably accompanied by aseptic necrosis of the head of the femur. When one encounters a case of traumatic dislocation of the hip, attempt at manipulative reduction should be undertaken immediately. If the physician does not feel that he should attempt this himself he should get the patient into the hands of qualified personnel without delay.

Traumatic dislocations of the hip joint may be classified under 3 main headings: 1. Simple Dislocation; 2. Fracture Dislocation; 3. Central Dislocation.

### Simple Dislocation

Nelaton's line, which runs from the anterior superior spine to the tuberosity of the ischium, bisects the acetabulum and divides the external surface of the pelvis into the anterior and posterior portions. This line represents the summit of a ridge from which the bony pelvis slopes forward or backward, and as soon as the head of the femur is out of the acetabulum, it tends to slip forward or backward and comes to rest either in front of (below) or behind (above) Nelaton's line. Consequently, there are two varieties of simple dislocation: 1. Posterior dislocation where the head of the femur lies behind the acetabulum on the dorsum illi or the ischium or in the sciatic notch (dorsal, ischiadic and sciatic dislocation); 2. Anterior dislocation where the femoral head is in front of the acetabulum (the low or obturator and high or public dislocations). The posterior dislocations

are much more frequent. Bilateral dislocations are rare but may occur, and one hip may be anterior and the other posterior. Compound dislocations are rare and are often fatal.

### Fracture Dislocation

In discussing the classification of fracture dislocations reference is made to Henry and Bayumil<sup>18</sup> who give a good classification of fracture of the femur with dislocation of the ipsilateral hip. The literature up to the time of their report contained 42 recorded cases in which the dislocation and fracture had formed successive events of an immediate traumatic sequence. The first in this sequence is probably always the dislocation; however, they classified the varieties of the combined injuries in terms of the fractures. This classification is more readily acceptable to them than one for hip dislocations for which definitive terms have not yet been fixed. They state that the majority of authors agree in limiting the term "dorsal" to dislocations on the dorsum ilii. Others employ "dorsal" to signify backward or posterior and thus make the term "dorsal" include the iliac, sciatic, and ischiadic dislocations. It is sometimes impossible to discover from the records of femoral fracture with dislocation whether the term is used in its wider or narrow connotation. Further, it is the break in the femoral lever that dominates the question of treatment. They classify the cases, therefore, under the following 4 headings according to whether the femoral fracture affected (1) the head, (2) the neck, (3) the shaft or (4) some other portion of the femur. The above classification is good when the fracture is limited to the femur; however, many of the dislocations of the hip are accompanied by a fracture of the posterior superior lip of the acetabulum and this should be listed as a fifth type of fracture dislocation.

### Central Dislocation

Central dislocations are those dislocations of the hip joint with fracture of the ischio-pubic ramus in which the head of the femur is driven upward and inward forcing the femoral head through the floor of the acetabulum, thus producing

a central or intra-pelvic dislocation of the hip.

### Mechanism

The mechanism of dislocation in posterior dislocation is explained on the basis of the following anatomical fact. If the femur is adducted and flexed, the stability of the hip joint is considerably reduced because in this position the head of the femur is unprotected by the acetabulum and it lies almost entirely in contact with the joint capsule. In conditions such as paralytic or infective lesions which cause flexion adduction contracture or spasm may give rise to spontaneous dislocation of the hip. This is occasionally seen in cases of cerebral palsy with marked flexion and adduction spasm of the musculature. Similarly a powerful thrust applied to the long axis of the femur in a person holding the thigh in a flexed adducted position forces the head of the femur through the inferior relatively weak portion of the capsule which lies between the anterior and posterior Y ligaments. The head is lifted out of its socket and pressed through the capsule by a force applied to the femur in such a manner that it acts as the long arm of a lever while the anterior Y ligament or rim of the acetabulum acts as the fulcrum, and the head and neck of the femur act as a short arm. In the flexed, adducted, and internally rotated position the anterior Y ligament is tightened around the neck of the femur.

This injury has been described as the "dashboard dislocation" because, as mentioned above, this accident frequently occurs in automobile accidents, particularly in head-on collisions. Such an injury occurring in a person sitting in the front seat can be analyzed. If the right hip is posteriorly dislocated, for instance, the patient, at the time of injury, most likely was sitting with his right knee crossed over the left knee thus creating the typical flexion adduction position of the hip joint. Or if, in addition to the posterior dislocation the posterior superior acetabular margin is broken off and displaced with the femur, the patient at the time of the accident was sitting with the hip joint flexed,

without the knees crossed, the thigh was not adducted, and in this position the femoral head was still partly in contact with the acetabulum. In case 10 of our series the latter position was assumed at the time of injury. This patient caught her left heel in a fence while climbing over it and then fell on her left knee with the knee and left hip flexed, causing posterior dislocation and fracture of posterior superior lip of acetabulum. In a similar way the driving of the pelvis forward while hip joints are flexed occurs in cave-ins and when a roof or heavy object falls on the back of a stooping workman. This is well illustrated in case 8 of our series who was on his knees under a jacked-up binder at the time that the binder fell on his pelvis causing posterior dislocation and fracture of posterior superior lip of acetabulum of the left hip. Over 50 cases have been reported of bilateral dislocation of the hip caused by falls from roofs.<sup>41,15</sup> Also, case 7 illustrates this type of mechanism (driving pelvis forward) since he suffered a posterior dislocation of the right hip with fracture of the posterior superior lip of the acetabulum when he fell from a tree a distance of 30 feet, landing on the buttocks in a sitting position.

Occasionally the head of the femur is driven forward because at the time of impact the extremity is widely abducted, such as occurred in case 11 of our series.<sup>6,23</sup> In this forcible abduction the neck or trochanter impinges upon the rim of the acetabulum and the head of the femur is levered out of its socket and through the anterior capsule. Forcible external rotation facilitates this motion. The head of the femur then lies on the pubic crest if it occurs with the hip in extension or in the obturator foramen if it occurs with the hip in flexion. This was the more frequent accident of former years according to writers of those days. They write that it occurred in a man with one foot on a river bank and the other on a boat which gradually moved away causing wide abduction of the victim's hips until one gave way and dislocated forward. One case has been reported of dislocation where the femoral head was driven into the scrotum.<sup>17</sup>

With reference to the mechanism involved in fracture of the head and dislocation, Christopher<sup>11</sup> in a study of this injury adopts Tanton's<sup>36</sup> view that the chief factor in this injury is a force acting either in the long axis of the femur and toward its proximal end or directly on the greater trochanter. This force, they believe, is suddenly applied in the course of the luxation in such a way that it breaks the femoral head against the acetabular rim and the latter according to Tanton may also be fractured. "In all probability it (the fracturing force) is always applied when the femur is flexed and slightly abducted." (Christopher) He discounts Birkett's<sup>4</sup> theory that the pull of the ligament teres helps to break the head when the femur is driven upward and back. The ligamentum teres, according to Cotton<sup>13</sup>, is not strong and ruptures under a pull of 14 kilos. Karmerer<sup>33</sup> believes that every case of hip luxation with femoral fracture is the result of 2 distinct violences. Tunacliffe<sup>26</sup> and Lossen<sup>1</sup> each record the clear succession of 2 separate traumatic events. In Tunacliffe's case, where the injury was on the right side, a tree fell on the patient's left shoulder driving the feet through a sheet of ice. His body was inclined to the right and as he fell through the ice the right great trochanter struck hard on the edge of the hole. In Lossen's case a ladder crashed with a patient who landed on his feet and then fell sidewise striking the greater trochanter of the affected limb against the ladder. Cotton<sup>13</sup> has a picture of a man standing with a heavy load falling on his shoulder and states that the position of the right lower extremity in flexion, adduction, and rotation inward may luxate the right hip. A fall or impact may then break the right femur demonstrating combined mechanism of hip fracture dislocation.

Central dislocations result from a fall or blow on the trochanteric region of the hip as illustrated by case 12 of our series. The acetabulum may be fractured indirectly by a fall upon the feet in rare instances. As the neck of the femur is the point of least resistance in old people and children most of these cases occur in young or middle-aged adults.

In addition to the mechanisms mentioned, it should be pointed out that it is quite possible to pull the head of the femur out of the acetabulum by excessive traction on the limb. This can occur with skeletal traction and even with skin traction. In attempted reduction of a slipped proximal femoral epiphysis, elevating the foot of the bed greatly increases the power of traction, and it is therefore necessary to control the angle of tilting of the bed or this accident might occur. It is possible in using the method of Roger Anderson's well-leg traction for treatment of a pertrochanteric or subtrochanteric fracture to push the head of the femur out of the acetabulum. In this method the traction is applied to the injured limb in full abduction and counter pressure is transferred to the normal limb which is held in adduction and flexion and, as pointed out above, this position invites hip dislocation. If too much traction on the injured limb is applied and therefore too much pressure on the normal limb the hip joint can easily be dislocated.

#### Diagnosis

In the simple anterior or posterior dislocation, there is limitation of all hip movements. The diagnosis of posterior dislocation is made by the characteristic internal rotation and adduction deformity with shortening of the limb which is more apparent than real. This is because of the flexion and adduction position which makes the shortening appear to be 2 to 3 inches but actually is rarely more than 1 inch. The trochanter on the affected side is unusually prominent and the gluteal fold is elevated and less pronounced than on the sound side. The buttock on the affected side is unusually prominent because of the presence of the head of the femur and the approximations of insertions to the origins of the gluteal muscles. The patient prefers to lie on the back with the knee of the affected side resting upon the opposite thigh. In a recent case it is usual to find the patient unable to bear weight upon, or even to move, the affected thigh because of the intense pain. And, there is the history of a severe injury followed by intense pain. The tip of the trochanter will be found above Nelaton's line.

The opposite deformity is found in anterior dislocations, namely, external rotation, and abduction deformity with slight lengthening of the limb, and here the head of the femur is in front and slightly below the acetabulum. The thigh may be in slight flexion or extension, and the head of the femur can be palpated and is often visible in its abnormal position. The trochanter is displaced inward causing flattening of the lateral aspect of the hip.

In the obturator dislocations the abduction is marked and the limb appears to be lengthened. It is maintained in slight flexion and external rotation. There is about one inch actual lengthening although the abduction makes it appear to be more. The head is deeply buried in the tissues and is hard to palpate. The thigh can be moved into external rotation, abduction, and flexion, but adduction is definitely limited.

In pubic dislocations abduction may be minimal, but the external rotation is marked, the hip usually is in extension, and the limb is slightly shortened. The head is usually visible and easily palpable. The thigh can be moved into external rotation and abduction but adduction and internal rotation are definitely limited.

Radiographic changes from the normal are typical in a hip that is dislocated. The important clue in interpreting x-ray picture of a hip suspected of posterior dislocation is the disappearance of the lesser trochanter. As the hip is internally rotated, the shadow of the trochanter becomes smaller but it does not entirely disappear within the normal range of internal rotation movement. If on examining the x-ray the lesser trochanter cannot be visualized, the head of the femur is behind the acetabulum and is dislocated. Another important finding is that the line known as Shenton's is broken. Normally, the continuation of the curved line of the lower margin of the superior ramus of the pubis lies in the same curve as the lower margin of the neck of the femur, the two together making a continuous curved line. If this line is disturbed so that, for in-

stance, in a posterior dislocation of the hip the lower margin of the neck of the femur is found to be lying above the curved line of the lower margin of the superior ramus of the pubis, the hip is dislocated. Sometimes a mistake is made in interpreting x-ray pictures after attempted reduction of a dislocated hip in that examination gives the impression that the hip is reduced; yet by observing that the lesser trochanter cannot be seen and that Shenton's line is broken one knows that reduction has not taken place. If one were to judge by the outline of the head of the femur as it fitted into the acetabulum on casual inspection one might think that they coincided and would feel that a satisfactory reduction had been obtained. But, this error can be avoided by noting the two points mentioned. Lateral x-ray pictures will also be of great assistance in determining whether or not reduction has occurred, and if there is clinical evidence of internal rotation deformity and restriction of mobility in a posterior dislocated hip this is further proof that reduction has not been obtained.

Radiographic changes that occur in anterior dislocations of the hip joint show the femur to be in abduction, external rotation, the lesser trochanter is visible and more prominent than normally, and Shenton's line is broken. In this case, the lower margin of the neck of the femur is obviously below the lower margin of the superior ramus of the pubis.

### Reduction

When diagnosis of dislocation of the hip has been made, the hip should be manipulated as soon as possible. Bigelow is given credit for describing the first method of closed manipulative reduction. He first emphasized the fact (utilized also in the Stimson, Watson-Jones, and Allis methods) in 1869 that in order to reduce the posteriorly dislocated head of the femur the Y ligament, which is the chief obstacle to reduction, must be relaxed by increasing the deformity of flexion. Also, the position of flexion brings the head down posterior to the acetabulum and near the rent in the capsule. In his method the limb is circumducted from the position of deformity

through the opposite position into extension. For example, in a posterior dislocation where the deformity is internal rotation and adduction the hip is flexed, abducted, externally rotated, then extended and brought into neutral rotation. In anterior dislocation, the limb is circumducted in the opposite direction. Here the abducted externally rotated limb is flexed, adducted, internally rotated and finally extended. If this maneuver is analyzed, one can visualize, in case of posterior dislocation, that in attempting to turn the limb from the position of internal rotation to external rotation the femoral head might be rotated from its displaced position behind the joint right past the notch at the bottom of the acetabulum to the front of the joint and thus convert a posterior dislocation to an anterior dislocation, or, conversely, an anterior dislocation into a posterior dislocation. In some cases where reduction is difficult, however, and it is necessary to do an open reduction this maneuver is of decided benefit in changing an anterior dislocation to a posterior dislocation which is the better position for the head of the femur for open reduction.

In the Stimson method, the patient is laid prone with his limbs hanging vertically over the end of the table. The effect of gravity is then supplemented by pull of the femur obtained by traction at the knee and direct pressure over the head of the bone. The Stimson maneuver is the gentlest one in use and is the method of choice in feeble patients and where general anesthetic is contraindicated. The method is slower and less spectacular than the others, however, as frequently the reduction is gradual and the surgeon is robbed of the satisfied feeling one gets when the head of the femur "pops" into the acetabulum.

Probably the best methods of manipulative reduction in both posterior and anterior dislocations are those of Watson-Jones and Allis. The two methods are essentially the same except that Allis maintains the slight adduction and internal rotation while Watson-Jones rotates the thigh to the neutral position

after flexing the hip. Their methods cause less trauma and are less dangerous than that of Bigelow. In this maneuver the hip is flexed, rotated into the neutral position (Watson-Jones) so that the femoral head lies just below the acetabulum, and then the head is lifted into the acetabulum. The anesthetized patient is laid on blankets on the floor so that the surgeon stands over the hip, with an assistant leaning by the patient steadying the pelvis. The hip and knee joints are flexed to the right angle. With the patient's foot held between the operator's thighs, the knee is grasped with both hands. The limb is then slowly and gently rotated from the position of deformity into neutral rotation and then lifted with firm, steady traction. Reduction is usually accomplished by gentle maneuvering. Forcible manipulation and vigorous traction are unnecessary and dangerous. Immediately after the manipulation has taken place and it is felt that the hip has been reduced check x-rays should be taken.

#### Immobilization

If study of the x-rays shows that proper reduction has occurred, the patient's hip should be immobilized for a sufficient length of time. The practice of allowing early movement of the joint and of even encouraging weight-bearing within a week or two is wrong. One might feel that the hip joint is so stable that it will not redislocate, but redislocation is quite possible particularly if there is a fracture of the posterior superior margin of the acetabulum. In the latter injury failure to immobilize the joint completely, sometimes with continuous traction, is inevitably followed by redisplacement. Also, early mobilization might lead to aseptic necrosis, which is to be discussed later, in that early motion aggravates the capsular damage and increases the danger of thrombosis of capsular vessels. Further, it might cause myositis ossificans since the subperiosteal haematoma formation is increased. There are various methods of immobilizing a hip following its reduction, any one of which is satisfactory provided it gives complete immobilization. Some men merely tie the two lower extremities together and feel that this sufficiently immobilizes the lower extremities; however, Watson-Jones<sup>39</sup>

condemns this practice. An acceptable method is the application of a plaster spica with the hip in neutral rotation and the knee joint slightly flexed, if the dislocation is unassociated with fracture of the acetabulum; or, simple Buck's extension with about 8 to 10 pounds of weight will hold a dislocated hip in the socket quite satisfactorily. If there is a marginal fracture of the acetabulum the reduction is less stable. Here it is probably better to use an abduction frame so that continuous traction can be maintained for a month or 6 weeks.

Watson-Jones states that in over 30 per cent of traumatic hip dislocations aseptic necrosis occurs. When one is confronted with a case of dislocation of the hip one cannot be sure whether or not this particular case will go on to aseptic necrosis; therefore, when a patient is allowed up weight-bearing should not be allowed for a long period of time. Plotts and Oblatz<sup>30</sup> state that a case should not be considered uncomplicated until at least 5 years after injury. The practice at this hospital is that of fitting the patient with a Thomas ring caliper ischio weight-bearing brace which the patient wears as soon as he is allowed up and is advised to wear for at least 1 year. X-rays are taken periodically to study the condition of the head of the femur.

#### Treatment of Fracture Dislocations

Henry and Bayuni<sup>18</sup> have given a good review of the recorded cases of fracture of the femur with luxation of the ipsilateral hip and treatment of this condition. Up to the time of their report there were 13 recorded examples of dislocation with fracture of a marginal fragment from the head of the femur. In 2 of these cases the head was fractured in more than 1 place and in 1 of these the oblique fracture ran also into the neck. In 4 cases a piece of the head remained in the cavity of the acetabulum and in 1 it rested on the posterior lip. In 4 of the cases there was an associated fracture of the acetabulum. They state that the dislocation should be reduced in the usual way. Good results by closed methods have been obtained whether the fragments

of the head are displaced outside the acetabulum or remain within. Operative reduction is indicated where closed methods fail because of (1) patient's delay in coming for treatment, (2) an obstructing fragment interfering with joint movement or pressure on sciatic nerve, (3) difficulty of maintaining reduction either of the fracture or the dislocation.

They reviewed 16 dislocations of the hip associated with fracture of the neck of the femur. The problem for the surgeon is whether (1) to operate early, before union has occurred, while the dislocation is still recent, or (2) to wait for union of the fractured neck before attempting to reduce the dislocation. Where the proximal dislocated fragment is so widely divorced from the neck that it would be impossible to reduce it, where the proximal fragment is a danger to important vessels, and where manipulative reduction has failed the procedure of choice is excision of the loose head and any loose fragments. Then the distal part of the neck should be placed into the acetabulum and in case of need the neck should be elongated by Whitman's reconstructive method of detaching the greater trochanter and reaffixing it lower down on the shaft. After such an injury operative reduction must inevitably cause necrosis of the detached head which is further indication for the Whitman's procedure.

Case 1 of this series illustrates this type of injury where the Whitman procedure was carried out. This is the case of a white male thirty-three years of age who was hurt in an automobile accident on 2/1/31, at which time he sustained "fracture of the left femur near the hip joint" besides suffering numerous other injuries. He was in the hospital 7 weeks undergoing treatment for these injuries but apparently received no treatment for the dislocated hip. Then he was allowed up for a year with weight-bearing using a cane because of the pain in the "left hip, thigh, knee, leg, and ankle aggravated by changes in weather". There was not a great deal of pain on direct weight-bearing. Because of the continual pain a diagnosis of tuberculosis of the left hip was suspected and patient was placed in a spica cast for 8½ months followed by the use of a brace

which he obtained to "transmit the weight-bearing from the knee to the pelvis to save the hip". He wore this brace about 2 months. About 3 years following his injury he was seen by 2 orthopedic surgeons who informed him that he did not have tuberculosis of the left hip but that he had a dislocated hip. They advised surgery and that the brace be discarded. He used the cane for a while and then was admitted here for operative treatment 5 years after accident. There was atrophy of left lower extremity and it was 3 centimeters shorter than the right. There was a flexion deformity of 30 degrees, some adduction deformity, limitation of external and internal rotation, marked limitation of abduction, impairment of extension and tilting of the pelvis. X-ray examination on admission was reported as follows: "Marked deformity of the right ilium, which has marked exostoses and suggests an old fracture with marked secondary deformity. The left hip showed rather marked changes. The head of the femur is almost gone and is very markedly flattened. There is considerable sclerosis and cystic degeneration within it. One area of separation of a fragment of bone suggests a sequestrum. The neck of the femur shows no particular change. There is marked internal rotation. The hip joint itself appears to be fairly normal, and the acetabulum is undisturbed except for some secondary hypertrophic changes around the margin. The whole appearance would suggest an old trauma involving the right ilium. The condition of the left femur might be due to a trauma with a partial dislocation and a compression fracture of the head with secondary changes from vascular disturbances." A Whitman arthroplasty of the left hip was carried out and at operation the head of the femur was found lying posterior to the neck and completely separated from it but attached to the greater trochanter. The deformed head (aseptic necrosis) was removed, the neck of the femur reshaped and inserted into the acetabulum. The greater trochanter was displaced down the femur and fastened to the femur with an ivory peg, and spica cast was applied. Immediate postoperative x-rays showed good position of the greater trochanter but the ivory bone peg had fractured. X-rays taken 2 months after operation

showed that distinct separation of the greater trochanter from the shaft had occurred. X-rays taken 10 months after operation, however, showed that union had occurred between the detached fragments of the greater trochanter and the shaft. At this time the patient had a 30 degree flexion deformity and full range of flexion above this. There was limited adduction and abduction and external rotation. No internal rotation was possible. Patient stated that he was having some pain but that he had been using his hip a great deal, and at that time was advised to discard his crutches. He was not seen from then until January 1945 (9 years after operation) at which time he reported that he was able to carry on a full day's work. He rarely had pain in his hip except occasionally at the end of the day. The left lower extremity is  $3\frac{1}{2}$  centimeters shorter than the right and the left thigh and calf are each 1 centimeter smaller than the right. He gets along very well wearing a  $1\frac{1}{4}$ " build-up on heel.

Up to the time of Henry's and Bayumi's report 16 cases have been recorded of dislocation of the hip joint with fracture of the upper half of the femur. They concluded that manipulative reduction should be tried at the earliest possible moment by the method of Stinson in a posterior dislocation. When the dislocation is pubic, pressure on the dislocated head can be applied when the patient lies on his back. Manipulation of the proximal fragment may be facilitated by a spike introduced subcutaneously into the trochanteric region. If this fails, the dislocation should be reduced after operative exposure of the fractured femur but without dissection of the capsule or exposure of the hip joint. The operation is not to be regarded as an open reduction of the dislocation but as a procedure to enable instruments to be applied directly to the upper fragment by which manipulative reduction may be effective. Sir Ashley Cooper<sup>28</sup> recorded in 1823 the first successful treatment of the condition "Hip-Luxation with Ipsilateral Fracture of the Femur" in the case of a boy 16 years of age belonging to this group with shaft fracture: "The hip was dislocated on the dorsum and the same thigh

broken about the middle of the bone. As the reduction of the hip was of course impractical, the thigh was bound up in the usual manner and treated without any reference to the dislocation of the joint, with the hope that, when the thigh-bone was reunited, the hip might possibly be reduced. At the end of 5 weeks, the bone appearing tolerably firm, I had a careful and unremitting extension made by pulleys, and in less than half an hour had the satisfaction of feeling the head of the bone re-enter the socket....The patient became so upright as to show scarcely any sign of lameness afterwards."

Case 3 in our series is the type of injury that can be classed under this heading and will illustrate what is not the best type of treatment that should be carried out. In this case aseptic necrosis developed. This is the case of an Indian male 23 years of age who was in an automobile accident 11/2/39 at which time a diagnosis of fracture dislocation of the right hip was made, in addition to soft tissue injuries to left shoulder and a Colle's fracture of the right wrist. He was taken to the local Indian hospital where the shock was treated. The patient was unconscious for 15 hours. Five days later he was transferred here where skin traction was immediately applied and a new cast applied to the left wrist. Thirteen days following the injury open reduction was done and the following was found at operation. The greater trochanter was separated from the shaft of the femur at the intertrochanteric line. The head and most of the neck of the femur was separated from the greater trochanter except on the posterior aspect, and the head was dislocated upward and posteriorly. A 4 inch vitalium screw was inserted into the neck and head of femur and using this as a lever and with the aid of a skid the head was reduced. The screw was then removed and reinserted through the greater trochanter, through the neck and into the head, obtaining good approximation of the greater trochanter, neck, and head of the femur. Two additional smaller screws were inserted to help hold the fragments. A right hip spica cast was applied to the ankle and patient placed in bed with 8 pounds of skin traction, the leg part of

the cast being applied over the traction. Check-up x-rays 2 days following operation showed the dislocation had been reduced with 3 screws present uniting the various portions of fracture in good position. Seven weeks later the hip spica was removed but traction was continued. Two months after operation the patient developed thrombophlebitis of right femoral vein. A right lumbar sympathetic block was carried out with immediate complete relief of pain. He was allowed up 3 months after operation with crutches and a ring caliper brace. He had a small draining sinus at lower end of incision which necessitated removing the screws 1 year after operation to clear it up. X-rays taken periodically during the year showed gradual absorption of the head and neck. At the time of removal of the screws union had occurred but about  $\frac{1}{4}$  of the head remained and about  $\frac{1}{2}$  of the neck. Aseptic necrosis had intervened. In retrospect, it would have been better at the primary operation to have removed the head of the femur and performed a reconstructive operation. In general the type of reconstruction would have to be determined at the time of operation, depending on what one had to work with. In this case it was inevitable that aseptic necrosis would develop both because of capsular and blood supply damage previous to and during the operation.

Henry and Bayumi found only 3 cases belonging to the group fractures of the femur other than of the shaft, neck or head, with hip-dislocation. These were as follows: (1) Borchard's<sup>5</sup> case of a boy, aged 14, in whom suprapubic dislocation of the hip was accompanied by fracture of the greater trochanter, and a similar (2) case seen by Lauenstein, (3) Drehmann,<sup>14</sup> in 1896, reported a case of von Mikulicz, with a left dorsal hip dislocation and an epiphyseal separation of the left femoral head in a boy, aged 8, who fell to the ground while carrying another boy on his back. In addition, Funsten<sup>16</sup> et al reported a case of complete posterior dislocation of the head of the femur (epiphyseal) separation in a boy of 13 years where the neck had sprung back into the acetabulum, and similar cases in a woman 43 years of age and a man 46 years of age with poor results, aseptic necrosis occurring in all three.

These recorded cases of fracture of the femur associated with dislocation of the hip joint obviously are rare but they are of practical importance in that many of them may be produced by "surgical fracture" of the femur during attempted reduction of a simple dislocation. If this accident occurs, the same treatment should be pursued as for fracture dislocations indicated above.

#### Treatment of Central Dislocations

In the treatment of central dislocations the type of treatment is governed by the type of fracture. The 3 elements of the hip bone meet in the acetabulum at a tri-radiate synchondrosis. Of these the pubis contributes least to the acetabulum, the ilium next, and the ischium most, including the non-articular part. Usually the whole floor of the acetabulum is swung inwards; however, sometimes the acetabulum may be grossly comminuted with many loose fragments displaced into the pelvis. Occasionally, the main fracture line runs into the upper part of the acetabulum separating the pectineal portion of the ascending pubic ramus below from the ilium above, and it is the pectineal part of the bone which is displaced inwards away from the ilium. The head of the femur can be pulled back into its normal position by skeletal traction of the tibial tubercle or lower femoral pin type with the limb in suspended traction and slight abduction. This method usually does the trick. If not, it can be supplemented by placing a Kirschner wire through the region of the greater trochanter and then have traction directly over the side of the bed, thus obtaining a resultant parallelogram of forces pulling in the line of the neck of the femur. The floor of the acetabulum does not always follow the head of the femur, however. If the bone is severely comminuted, the best possible position should be obtained by traction for a period of about 2 months. Then, if after 6 months to 12 months pain and stiffness are present in the joint the procedure of choice is arthrodesis of the joint. If the displacement inward of the head of the femur is such that its widest part lies internal to the normal line of the floor of the acetabulum

manipulative reduction is indicated.

In central dislocations where 1 main fragment swings inward replacement of the femoral head by skeletal traction may be supplemented by operative reduction of the floor of the acetabulum. Watson-Jones<sup>39</sup> cites the case of Diggle who found it easy through a midline suprapubic incision to expose the inner wall of the acetabulum, press the pubic fragment into position, and fix it by 1 screw into the ilium. Levin<sup>22</sup> reports the case of a 21 year old woman with a central fracture dislocation of the acetabulum and marked displacement of the fragments that was treated by open reduction and internal fixation with a stainless steel plate. The plate was placed subperiosteally in the iliac fossa. When last seen the patient had a hip which was freely movable without pain. The Smith-Peterson incision was utilized in carrying out the procedure. Attempts to replace the floor of the acetabulum by direct pressure outward by placing the finger in the rectum should be avoided as perforation of the rectum with subsequent infection has occurred.

#### Treatment of Old Unreduced Dislocations

Treatment of old unreduced dislocations is a problem. If reduction has not been accomplished by several weeks or months the chance at manipulative reduction has disappeared and the only chance of reduction is by open operation and as mentioned previously this is a shocking procedure and almost inevitably leads to aseptic necrosis of the head of the femur.

If there is no pressure on the sciatic nerve and if a true shortening of the limb due to upward displacement of the femur is not more than 1 inch the safest and simplest procedure is osteotomy, preferably McMurray in type, to correct the internal rotation-adduction deformity. However, if the shortening is more than 1 inch or if the sciatic nerve is compressed a more radical operation is necessary. In case 9 of our series it was necessary 8 months after injury to explore the right sciatic nerve. We first saw him 7 months after his injury and immediately instituted physiotherapy and galvanism in

in an effort to improve the muscle tone. At operation the sciatic nerve was found to be wedged and compressed between callous about the acetabular lip, head of femur, ischium and scar tissue. Extensive myositis ossificans was also present. The head of the femur was removed to obtain adequate exposure, and neurolysis was performed. The sciatic nerve was found to be frayed and compressed but continuity was not disturbed. Physiotherapy and galvanism were continued postoperatively as soon as the patient's condition permitted. The patient must have further reconstructive surgery.

If the shortening is more than 1 inch, or if the sciatic nerve is compressed Watson-Jones<sup>39</sup> feels that open reduction, followed later by arthrodesis, must be undertaken. He further states that since it is known that capsular destruction will inevitably cause avascular necrosis it is tempting to go straight on to the necessary arthrodesis by denuding articular cartilage at the time of the open reduction and continuing plaster immobilization until the joint is soundly fused. The difficulty is that the blood supply of the femoral head has only recently been cut off and it will be at least 12 months or 2 years before the new blood supply has reached the surface of the femur and before new bone formation can begin to consolidate the arthrodesis. The problem is difficult. In some cases he has driven a 3 flanged nail into the pelvis 2 or 3 weeks after the open reduction. In other cases he has deferred arthrodesis until 2 or 3 years after the open reduction, by which time although a severe degree of deformity may have developed owing to degenerative arthritis, a sound arthrodesis is possible because the bone has revascularized. The deformity is corrected at the time of operation.

Platt<sup>29</sup> pointed out the danger of injury to the sciatic nerve and fracture of the neck of the femur when manual reduction is attempted more than a few weeks after dislocation. If uncontrollable bone fragments are present at the time of manual reduction, he felt that their removal at operation 6 to 8 weeks after reduction improves motion and lessens pain.

Campbell<sup>8</sup> feels that if the dislocation has been present for several years, even though the articular cartilage is apparently well preserved, open reduction alone is not sufficient. By this time the soft tissues will be so severely contracted that only by extensive dissection of the attachments to the head and neck and even to the lesser and greater trochanters can the head be reduced into the acetabulum. Such a procedure leads to impairment of circulation and subsequent degenerative changes. Instead the head of the femur may be trimmed to a smaller size and the acetabulum enlarged proximally with a chisel. The head of the femur may even then be under such tension that pressure necrosis will ensue. The degenerative and proliferative changes may become so extensive that motion will be limited and painful. In young individuals a complete arthroplasty may be advisable, and in the middle aged the joint should be fused provided arthritic changes in the spine are not excessive. Where open reduction is attempted and the head is replaced into the acetabulum, the motion preserved is always doubtful until the elapse of at least 1 year. Secondary degenerative changes of the head may occur necessitating an arthroplasty or arthrodesis for relief of symptoms.

A common sequelae of open reduction is external rotation and flexion of the hip. To restore alignment and permit flexion of the knee in the normal plane a supracondylar osteotomy is performed and the distal portion rotated internally.

Usually, after long-continued posterior dislocation an accessory or compensatory socket is formed upon the dorsum of the ilium by functional adaptation. If this occurs the patient walks with a peculiar limp as the new articulation is on a plane posterior to the acetabulum, the relations of the muscular attachments are altered, and the actual length of the limb is decreased. Some men feel that these should be treated by the Lorenz bifurcation operation; however, most orthopedic surgeons feel that the high or low Schanz or McMurray osteotomy, depending upon the case, is the operation of choice in these cases utilizing the Moore or Blount blade plate, molded stainless steel

(or Moe) plate, for fixation.

Case 4 of our series aptly illustrates this type of case in which a high Schanz osteotomy and wedge osteotomy were carried out and a good functional result was obtained. The patient is a white male 37 years of age who on 8/31/40 in an airplane accident received crushing injuries to left foot, fractured the left tibia and fibula, and dislocated the left hip besides suffering other minor injuries. He was immediately taken to a local hospital where splints were applied for 5 days. Then a double spica was applied and patient was transferred to another hospital in this state. There the cast was removed and traction applied to the left lower extremity for 8 weeks, at which time a long leg cast was applied to the left lower extremity for 3 months. The fractured tibia and fibula healed, but the patient developed an equinus deformity of the foot. The left hip was manipulated twice (9 and 14 months after the accident) previous to admission to the University Hospitals. On admission here 25 months after the injury, he walked with a limp and the right leg measured 91 centimeters and the left 85 centimeters from anterior superior spine to internal malleolus. The left foot was in slight equinus position, there was limitation of motion of the left ankle and subastragular joints. The left knee had 15 degrees of motion, and the left hip could be flexed to 85 degrees. There was marked limitation of rotation of the left hip, and the head of the femur could be felt posteriorly. The typical flexion-adduction deformity was present. X-rays showed posterior dislocation of the left hip with secondary arthritic changes. Open reduction of the dislocation was attempted 10/17/42, 26 months after injury, without success. It was felt at the time of operation that osteotomy was indicated, but because of the condition of the patient it was decided to allow him to recover from the shock of the operation and then perform the osteotomy at a later date. This was carried out at another hospital (preceded first by 15 days of skeletal traction with 35-40 pounds followed by another attempt at closed reduction without success), on 2/20/43, the osteotomy being in 2 planes, a high Schanz to correct the flexion, and

a wedge osteotomy to correct the adduction. Fixation was by means of a stainless steel plate molded to fit the osteotomies. The patient recovered very nicely from this procedure and up to the present time has a good functional weight-bearing hip and is able to carry on his work as a bus driver.

### Complications

As stated in the first paragraph of this paper, traumatic dislocation of the hip joint is a serious injury. Not only is the injury itself shocking and painful and deforming, but the complications that develop are oftentimes severe even though the dislocated hip is reduced promptly. An attempt will be made to point out and discuss the more frequent and severe complications of this shocking injury. These are as follows: (1) Fracture of the acetabulum, (2) Sciatic nerve paralysis, (3) Myositis ossificans, and (4) Avascular necrosis or aseptic necrosis of the head of the femur, (5) Osteoarthritis. Fracture of the acetabulum has been listed in this report as a 5th type of fracture dislocation associated with subluxation of the hip, and it is included under the complications because of the frequency of its occurrence in this type of trauma. It is associated with dorsal dislocation of the hip joint with fracture of the superior posterior margin of the acetabulum. Fortunately, the fragment is usually accurately replaced when the hip is reduced because the fragment is held to the neck of the femur by fibres of the joint capsule; however, when the marginal fragment is rotated operative replacement becomes necessary. Platt<sup>29</sup> reported a case of traumatic dislocation of the right hip with fracture of the acetabular margin. The detachment of a fragment from the acetabular rim produced an obstacle to the concentric reposition of the femoral head. Owing to the position of the fragment in the depth of the socket, removal by open operation was essential and reduction was obtained. If the fragment is large, it is often necessary after reduction of the hip to have continuous traction because of the instability of the hip.

In an uncomplicated dislocation of the hip joint the restoration of perfect

function can often be hoped for; however, in certain circumstances the prognosis may be profoundly modified by the occurrence of complications which usually date from the time of the accident but on occasion may arise during the early stages of treatment. Platt<sup>29</sup> reported a case of a woman 30 years of age with posterior dislocation of the right hip. Fracture of the acetabular rim occurred and extrusion of a loose bony fragment per vaginum occurred 8 weeks after the accident. The semi-circular fragment of bone was passed during a menstrual period by way of the vagina. (For various reasons a radiographic examination could not be conveniently carried out.) The patient stated that her menstrual periods since the accident had been accompanied by severe pain -- an unusual occurrence -- but that after the extrusion of the bony fragment the pain had disappeared completely. The author concluded that fracture of the acetabular lip which at first formed an obstacle to concentric reposition of the head rendered the reduction temporarily unstable, as the hip had to be reduced several times. Some days later the fragment penetrated the vaginal wall and by a gradual process of ulceration was finally extruded into the vaginal cavity.

### Sciatic Nerve Paralysis

Sometimes in a posterior dislocation sciatic nerve paralysis occurs owing to stretching of the nerve trunk over the head of the femur or compression of the nerve in the sciatic notch. In a complete lesion there is paralysis of all muscles below the knee and anesthesia below the knee except in the area supplied by the long saphenous nerve on the inner side of the leg. In addition, the sciatic gives off muscular branches in the upper part of the thigh to the semitendinosus to the long head of the biceps femoris, to the semimembranosus, and to the adductor magnus, and about the middle of the thigh a branch is furnished to the short head of the biceps but fortunately the hamstrings are seldom affected. Trophic lesions and traumatic ulceration of the foot may occur. The prognosis after complete sciatic palsy is grave but incomplete lesions usually recover. Fortunately the lesion is usually

incomplete. The peroneal nerve fibres are chiefly involved. During attempted manipulative reduction of hip dislocation traction injuries may be sustained. The importance of early reduction is again brought out by the fact that incomplete lesions usually recover if the pressure is relieved by immediate reduction of the dislocation but if there has been several weeks in reducing the displacement and the nerve lesion is complete the prognosis is grave.

In case 9 of this series (mentioned previously but in more detail here) the patient had an old unreduced posterior dislocation of the right hip with practically complete right sciatic nerve paresis. This patient is a white male 38 years of age who suffered in addition to the dislocated right hip bilateral fractures of the tibia and fibula and brain hemorrhage in an automobile accident 1/22/44. He was unconscious for 9 days and the patient stated that for about 10 days he didn't know what was going on about him. He was taken to the local hospital and x-rays taken of the legs revealed the fractures of both tibia and fibula, and traction was applied. Some days later it was discovered that the right hip was bruised and x-rays revealed the dislocated hip. Manipulations failed and more traction was applied to the right hip. By this time casts had been applied to both legs. The patient stated that he was able to move the toes of his right foot before the cast and traction were applied but after the traction was started he lost movement of the toes on the right and sensation below the right ankle, this being about 6 weeks after the injury. He was transferred to another hospital about this time where several attempts of closed reduction were resorted to and then on 4/28/44, three months after injury, open reduction was attempted without success. The patient received no further treatment until he came to this hospital. On 9/27/44, 8 months after injury, the right sciatic nerve was explored, and head of the right femur removed to obtain adequate exposure and relieve the pressure on the nerve. The sciatic nerve was found to be wedged in and compressed between callous about the acetabular lip, head of femur, ischium, and scar tissue. There was myositis ossi-

ficans present. After the head of the femur was removed and the nerve freed from callous and scar tissue it was found to be compressed but continuity not disturbed. At the time of this report he is still receiving physiotherapy and galvanism and is patiently awaiting the regeneration of the nerve and further reconstructive surgery.

In Platt's case<sup>29</sup> he reports a case of sciatic nerve involvement following posterior dislocation of the right hip. He states that whether there was a primary contusion or not the nerve sustained additional injury by its late involvement in fibroosseous scar. The appearance of irritation signs in the stage of recovery is, of course, a typical phenomenon in severe but incomplete sciatic lesions. The intramuscular and capsular ossification points to the dangers of attempting reduction by manipulation in a dislocation of some weeks' standing. Three weeks after the dislocation there was noted some sciatic nerve involvement and 3 attempts were made to reduce the hip. The 3rd was successful. The sciatic nerve involvement increased.

Platt's case and our case bring out the importance of early reduction and the danger of late attempted closed reductions.

Case 7 of our series illustrates the late appearance of peroneal nerve involvement. This patient is a white male 41 years of age who on 3/31/42 fell from a tree a distance of 30 feet landing on the buttocks in a sitting position and suffered dislocation of the right hip with fracture of posterior superior lip of acetabulum, compression fracture of the first lumbar vertebra, and fracture of the left 12th rib. The hip was reduced about 12 to 15 hours after the accident by the Watson-Jones method and spica plaster jacket applied with physiotherapy in hyperextension. Two months later the cast was removed, patient was fitted with a Thomas ring ischial weight-bearing brace and was discharged wearing the brace and a plaster jacket. He was instructed to return in 4 months for removal of the cast but the latter was removed 2 months

later. Four months after the accident it was noted that the patient was unable to extend his toes and diagnosis of right peroneal nerve lesion was made. Patient offered the information 1 week later that he wore his right shoe to bed to prevent his foot from falling. Seven months later the diagnosis of right hallux rigidus was made. The right foot gradually became more and more inverted and plantar-flexed. All of the toes were markedly flexed making it difficult and nearly impossible to get his shoe on. Seventeen months after injury a subastragular arthrodesis was carried out which markedly improved the foot but the flexion deformity of the toes was still present. The latter was corrected 29 months after the accident by incision of the flexor hallucis longus and flexor digitorum longus in addition to correction of the hallux rigidus of the right great toe. The patient now has a good functioning foot following these procedures and correction of the deformity which was secondary to the peroneal nerve lesion.

#### Myositis Ossificans

In any dislocation the periosteal attachment of muscles and of the capsule are avulsed so that a subperiosteal haematoma develops and undergoes ossification. If the dislocation is reduced immediately and the joint is adequately immobilized the periosteum is replaced and the haematoma is absorbed. That is why it is important in avulsion of the quadriceps which tears the periosteum from the upper border of the patella that the muscle be immediately stitched back so as to accurately replace the periosteum. Then if immobilization is complete the avulsion cures without any subperiosteal ossification. Similarly, if a dislocation is immediately reduced and immobilized the periosteum is replaced and the haematoma absorbed and the periarticular bone formation due to subperiosteal ossification is then of minimal degree. But if there is delay in reduction, repeated attempts at reduction, unduly rough manipulation, or if passive stretching is employed the haematoma is increased. There is fresh bleeding and traumatic myositis ossificans develops. Under such circumstances

considerable new masses of bone formation are laid down as illustrated in case 9 of this series where several attempts at closed reduction followed by attempted open reduction were unsuccessful. Watson-Jones<sup>39</sup> stresses the importance of primary immobilization of a dislocated joint and states that myositis ossificans does not arise if the joint is immobilized. He cites the case of a young man 28 years of age who 2 weeks after reduction of a dislocation of the hip joint was up and walking. During the next 2 weeks the hip gave way and he fell to the ground on 6 occasions. Recurrent dislocation had developed. Every time the limb was internally rotated, the femur slipped onto the dorsum ilii. Every time the limb was externally rotated, the dislocation was reduced. There was a marginal fragment from the acetabulum which moved in and out of position with the femoral head, thus allowing the hip to be redislocated. Myositis ossificans was developing in the haematoma at the site of capsular avulsion. The disability was relieved by 10 weeks' immobilization in plaster. The marginal fracture united, and the dislocation did not recur. He condemns the customary after-treatment of traumatic dislocation of the hip joint, such as "use sandbags for 10 days", "tie the lower limbs together for 2 weeks", "avoid overtreatment", "begin exercise within a few days". He states that when the violence of injury to the soft tissues is recognized, those suggestions are astonishing. Further-more, no surgeon would treat a dislocated knee with ruptured cruciate ligaments in this way. The torn ligaments and capsule are not healed within a few days. The subperiosteal haematoma is not absorbed. The blood supply of the femoral head is not restored. One author speaks of patients returning to work in 1 or 2 weeks and then adds: "There often occurs some bony formation in the short rotators which limits mobility of the hip joint." The bony formation is myositis ossificans. Then Watson-Jones concludes, "Every dislocation of the hip joint should be immobilized for at least 6 weeks, and if there is a marginal fracture of the acetabulum for at least ten weeks."

## Aseptic Necrosis (Avascular Necrosis)

Too often the patient who has suffered traumatic dislocation of the hip is allowed to feel, after the hip has been reduced, that his recovery will be uneventful. Often the patient is permitted to bear full weight on the limb and return to his occupation with the impression that he is cured. Most likely the discharge examination has revealed full motion of the hip and freedom of pain after a short period of immobilization and rest. This is unfortunate because when one is presented with a case of a dislocated hip one does not know whether this patient will go on to aseptic necrosis as many of them do. Many of these patients experience recurrence of pain and progressive disability of the hip after months or, exceptionally, years of normal activity. It is now known that this reappearance of symptoms after an early period of apparent recovery is due to aseptic necrosis of the head of the femur which has resulted from a disruption of a major portion of its blood supply at the time of the dislocation. This complication of hip dislocation was probably first noticed by Sir Aspley Cooper<sup>12</sup>: "Sometimes after the reduction of dislocation, suppuration ensues and the patient falls a victim to excessive discharge and irritation." Also Konig, in 1888, described the pathology of osteochondritis dissecans as "quiet necrosis". This was probably the first recognition of what is now known as aseptic or avascular necrosis. The blood supply of the bone may be cut off by a fracture or through embolism or thrombosis of its vessels.

### Incidence

The incidence of this complication cannot be definitely stated because statistics of end results have not generally been made available on a large series of cases. However, Watson-Jones states that over 30 per cent of traumatic dislocations of the hip result in avascular necrosis. Pfab found 2 cases in a follow-up study of 24 cases, or 8.3%. In 6 of 20 cases reported by Funsten<sup>16</sup> Kinser and Frankel absorption of the head of the femur occurred. Reference to the table will show that in the 14 cases here

presented 4 cases have resulted in aseptic necrosis. When one considers, however, that 4 of these 14 cases have occurred within several months of this report and it is not definitely known whether or not aseptic necrosis is going to develop the incidence of aseptic necrosis rises from 4 in 14 to 4 in 10.

### Etiology

Normally, the head and medial 3/5ths of the neck of the femur lie within the cavity of the hip joint. The ligamentum teres connects the head with the acetabulum. The intra-articular portion of the neck is covered by a capsulo which, during the major period of longitudinal growth functions as periosteum, but which in adult life is almost completely devoid of its osteogenic properties. It is generally agreed that the head and neck considered as a unit receive nutrient branches from the anterior and posterior circumflex femoral artery and from the arteries of the round ligament. Fahey<sup>21</sup> has shown the low position of the anterior portion of the circumflex artery with a large branch at the inferior portion of the neck and large branches entering the bone below the base of the greater trochanter. He also has demonstrated that the posterior branch is the more important and that it supplies a liberal blood supply to the posterior lower half of the neck. Both the anterior and posterior branches send branches over the superior lower portion of the neck close to the greater trochanter. These arteries enter the bone through foramina at the site of capsular attachment completing their course within the bone, or they run on the surface of the neck in retinaculæ reflected from the deep aspect of the capsule finally entering the bone in the subcapital region. The capsular vessels are generally regarded as the more important since these vessels supply the upper part of the neck of the femur and the greater part of the head.

The vessels entering the head by way of the ligamentum teres are well defined in children and usually remain patent throughout adult life, as shown by Chandler and Kreuzer,<sup>9</sup> Wolcott,<sup>40</sup> Nordenson, and Kleinberg and Friedman<sup>20</sup>.

The arteries of the ligamentum teres supply an area of bone and articular cartilage in the region of the fovea centralis. Chandler and Kreuzer studied 114 ligamentum teres from cadavers of persons ranging in age from 25 to 75 years. Arteries were found in all of them. Fifty ligamentum teres showed vessels with lumina ranging from .04 to 1.05 millimeters in diameter. Microscopic sections of the fovea were made in some cases and the vessels were seen to enter the bone. They were of sufficient size to be of importance in supplying blood to the head. All ligaments contained vessels and in 4 cases the vessels were of pre-capillary size. All of the other ligamentum teres contained a significant blood supply, and they concluded from this anatomical study supplemented by clinical experience that the ligamentum teres and its circulation should not be disturbed in any operative procedure.

It is generally agreed that the blood supply mentioned is the only blood supply of the femoral head and medial 3/5ths of the neck and that they do not receive any blood supply from the nutrient and periosteal vessels of the femoral shaft which extend as high as the trochanteric region and lower part of the neck. Watson-Jones states that there is no anastomosis between these 2 sets of end arteries, that is, the capsular vessels and the vessels of the ligamentum teres, and if either group of vessels is obliterated by injury, thrombosis, or embolism the corresponding part of the head of the femur loses its blood supply.<sup>38</sup> Banks<sup>2</sup> states that there is some lack of evidence as to which of the above vessels are injured when the head becomes necrotic. The round ligament is always torn when the head of the femur is forcibly displaced outside of the acetabulum and probably in fracture of the floor with central displacement of the head. This may or may not give rise to necrosis depending upon the extent of the vessels from the round ligament to the head and the collateral circulation of the arteries entering by way of the neck. It is also possible, he states, that the tear of the capsule may injure the vessels of the neck to a greater or lesser degree. In favor of the theory that the tear of the

round ligament vessels causes necrosis is the known fact that the head may survive in case of complete fracture of the neck of the femur, proving that in such instances there is important blood supply by way of the ligamentum teres. On the other hand, when recognizable necrosis develops after dislocation it is usually the entire head and some of the adjacent neck which is affected and this favors the view that vessels of the neck may also have been injured. In addition to the fact that rupture of the ligamentum teres necessarily occurs in traumatic dislocations of the hip, it may be further damaged by forcible rotation movement or manipulation of the joint causing stretching of the ligament over the margin of the acetabular fossa, causing loss of blood supply to that part of the head in the region of the fovea. Individuals vary as to the area around the fovea supplied by the ligamentum teres and it follows that the greater the area supplied the more grave is the complication. Further, the capsular sulcus is torn to a greater or lesser extent, and the more the capsule is damaged the greater is the loss of blood supply. The danger of avascular necrosis is great, and the incidence is increased if surviving capsular vessels are injured by forcible manipulation or early passive movements. If operative interference is necessary for late unreduced dislocated hips or if open operation is necessary in a recent dislocation, further damage to the blood supply must inevitably occur and the chance for aseptic necrosis developing is definitely greater.

#### Pathology

Axhausen,<sup>1</sup> Pfenister,<sup>26</sup> Schmorl, Hesse, Nussbaum, and Santos<sup>32</sup> have described the histological alterations in the head when it undergoes avascular necrosis and replacement. Aseptic necrosis, following dislocation of the hip, appears to undergo the same changes that take place in necrotic heads after fracture of the neck of the femur followed by bony union. According to Pfenister<sup>28</sup> these alterations are as follows: "The early changes which occur in the necrotic area consist of disappearance of the

cells of both the bone and the marrow. If a portion of the head remains alive it is likely to be near the fovea or in the inferior part where the blood supply is derived from the round ligament or untorum capsule. Atrophy of disuse gradually develops in the distal fragment, in acetabulum, and in case of partial necrosis in the surviving portions of the head. The necrotic bone does not atrophy but retains its original density; consequently, after 2 to 4 months of disuse it casts a heavier shadow in roentgenograms than the surrounding atrophied living bone. The neck fragments are gradually eroded. The dead bone is gradually invaded by connective tissue which replaces the dead marrow. If the entire head is dead the invasion is by way of the round ligament and untorum portion of the capsule in the earlier stages. Later it may be by adhesions. If a portion of the head remains alive, connective tissue grows out from its margin and invades the dead bone. Behind the zone of invasion comes a zone of transformation of the dead bone. The invading connective tissue of the marrow spaces is embryonal and differentiates into bone and bone marrow. Some of the old bone is absorbed while some of it has new bone laid down on its surface and is gradually replaced by it through the process of creeping substitution. Wherever new bone is laid down new bone marrow containing both haemopoietic and fatty cells is also formed. The new bone is usually much more spongy than the old bone which it has replaced and defects are sometimes left filled with marrow which in the x-ray give a cystic appearance. The rate of connective tissue invasion and creeping substitution of the dead bone is slow, requiring several months to years for completion, depending largely on the extent of the necrotic area. Articular cartilage dies when its underlying bone is necrotic as the great bulk of its nutrition comes from the bone; however, some nutrition comes from the synovial fluid as shown by Bussbaum, and cartilage cells are sometimes kept alive by it for long periods. If the underlying dead bone is rapidly absorbed and replaced by new bone the cartilage may be revived and persist. This was observed in animal experiments and in a human case two months after fracture. Pieces of cartilage chipped off by the fracture may

remain free in the joint. Their surviving superficial cells may proliferate and after years form oval loose bodies nourished by the synovial fluid. The nuclei of the cartilage on the head break down very slowly and those near the bony attachment sometimes may not completely disappear for two or three years. The dead cartilage is usually absorbed in the course of three or four years and replaced by a thin layer of fibrocartilage or fibrous tissue. Sometimes the apposing articular cartilages become adherent and are simultaneously absorbed narrowing the cartilage space of the joint. Articular cartilage overlying living portions of the head remains alive. It is almost impossible to distinguish between atrophied, old, living bone and the new bone which has replaced the old dead bone except along the border where active creeping replacement is going on. For this reason it is impossible to know how much of the live bone is old, atrophied, living bone and how much is new bone that has replaced the dead portions."

These changes can be divided into 3 stages: (1) Onset of necrosis, at which time the general architecture of the bone remains undisturbed, although there is immediate cellular death of the avascular tissues. The bone cells disintegrate, the marrow elements change to a formless oily debris, and the lacuni become empty tombs. If a joint surface is involved patches of necrosis appear, separated by areas where articular cartilage has survived by direct nutrition from the synovial fluid as mentioned above. In a short period of time neighboring bone reacts with an active hyperaemia which is manifested in osteoporosis of the living bone which takes place because of the presence of free blood supply and calcium is carried away by the blood stream. However, in necrotic bone where the blood supply is deficient it retains its original calcium content and therefore does not decalcify. The same occurrence is seen in osteomyelitis where dead bone becomes sequestered and because the blood supply is cut off the same differentiation between dead and living bone becomes possible. In fact,

at times because of the dead bone retaining its original density it may by contrast appear to have increased in density.

(2) Stage of regeneration. When active hyperaemia of the neighboring bone occurs the growth of granulation tissue is initiated. The process of creeping substitution described above gets started which preserves both the form and architecture of the bone, and as the revascularization takes place the decalcification can be traced by serial x-rays. The same process occurs that occurs in a bone graft which, cut off from its circulation, is invaded and replaced by living bone. X-ray pictures taken in the earlier stages often give the suggestion of fragmentation of dead bone because of the tongue-like inroads of vascular decalcified granulation tissue surrounding the avascular islets of dead bone.

(3) Stage of healing. The regeneration of new bone may take months or even years.

Shortly after its formation bone is soft and easily distorted but eventually gains the full strength of original bone. Unfortunately, on the other hand, the articular cartilage is more apt to suffer more permanent damage. It is largely replaced by fibrous tissue and fibrocartilage and irregularity of the joint contours occur if early weight-bearing is allowed because of collapse of the subchondral bone. Even if early weight-bearing is avoided degenerative arthritis often develops because of the imperfection of the new fibrocartilage. Generally the formation of good healthy bone is to be expected; however, the fate of bone which undergoes aseptic necrosis because of disturbance of blood supply varies considerably according to the environment of the necrotic area. If the necrotic bone is attached to and directly continuous with living bone there is ingrowth of vessels and of fibrous and osteogenic tissues from the living into the necrotic area. There is usually survival of unossified osteogenic elements about the periphery and ends of the area that have had their circulation interrupted. By the process of creeping substitution the old bone is gradually absorbed and replaced by new bone, so that in the case of months or occasionally years the necrotic area is more or less completely transformed into a living one.

Whether the amount of new bone formed is as great as the amount of bone which died depends largely upon the extent of living bone with which it is in contact and the amount of osteogenic elements surviving about its periphery. When these are extensive there may be complete replacement of the dead bone by new bone but, when limited, bone absorption may be greatly in excess of bone formation so that incomplete replacement results with the formation of bone that is less dense than the original and that shows varying degrees of cavitation. Functional stimulation also plays an important role in the rate and degree of transformation. In general the greater the degree of function the greater the rate and degree of transformation into new bone. If the necrotic bone is largely or wholly intra-articular and extensively bordered by articular cartilage the attachment to the surrounding soft parts will be markedly limited and chances for revascularization and transformation will be greatly reduced.

It should be pointed out that aseptic necrosis of the head of the femur may occur in cases where spontaneous reduction of a subluxation of a hip occurs following the acute trauma, or as the patient is being transported to the hospital. X-rays taken after the injury may therefore appear normal. However, if displacement of the head was of sufficient magnitude capsular vessels as well as vessels of the round ligament may be so injured as to be followed by aseptic necrosis of the head. The patient may be well for a period of time and then begin to experience late pain and progressive disability. This is very aptly illustrated in the case reported by Banks<sup>2</sup> in which x-rays taken the day of the automobile accident in a 30 year male showed a linear fracture of the posterior margin of the acetabulum but no changes in the femoral head. Full use of the extremity followed a short period of bed rest. Thirty months later pain in the hip returned and grew progressively worse as walking was continued. Examination showed limitation of flexion and pain on rotation of the leg. X-rays revealed a flattened head of mottled density with irregular absorption of the articular cortex while the cartilage

space was markedly diminished in width. Sclerosis of the acetabular margin and new bone formation about the acetabulum and head indicated a far advanced secondary arthritis. A diagnosis of aseptic necrosis of the femoral head following a traumatic dislocation of the hip was made and the patient was advised to use crutches. Pain and disability persisted, and a vitallium cup arthroplasty was performed.

Some writers on this subject<sup>2,15,34,32,35,37,54</sup> feel that aseptic necrosis following hip dislocations, under proper management, have better end results in children than adults. The roentgenographic changes during replacement of the head appear somewhat similar to those observed in Legg-Perthes disease. The osseous center undergoes necrosis with subsequent invasion and transformation; however, when the femoral head in older children becomes necrotic<sup>3,9,19,28</sup> the pathologic alterations simulate those seen in adults and the results are equally poor. This appears to be true whether the primary pathological condition was a traumatic dislocation, a fracture of the neck of the femur, or a slipping of the upper femoral epiphysis.

That limitation of the aseptic necrosis may be only in that portion of the head supplied by the vessels of the ligamentum teres is shown in the case of Chandler and Kreuzsch. This case was one of traumatic dislocation of the hip with flattening of the head, occurring in a girl, aged 14, who sustained a central dislocation of the femoral head. Immediate replacement of the head was done by the closed method. There was no fragmentation of the head nor was there fracture of the neck. Six months later the patient complained of slight pain in the hip with some muscular fixation. The x-ray film showed a definite necrosis in the region of the fovea. The appearance was not unlike that of Perthe's disease except that the aseptic necrosis was confined so definitely to the region where the ligamentum teres attaches. The process of necrosis seemed to extend from the fovea directly into the head and only slightly laterally. Films made at frequent intervals showed that the destruc-

tion had ceased after invading that portion which it is felt is supplied by the arteries of the round ligament, as shown in the most recent examination ten years after the accident. Watson-Jones<sup>39</sup> shows a case of dislocation of the hip joint in a child with avascular necrosis. This patient suffered traumatic dislocation with fracture of the pelvis which was reduced by manipulation. X-ray pictures taken four months later show relative density of the area supplied by the vessels of the ligamentum teres. The changes were typical of Legg-Perthe's disease but coxa plana was minimized by prolonged recumbency and traction.

If the patient suffers aseptic necrosis, one of the procedures that can be carried out is that of vitallium cup arthroplasty which was done in cases 2 and 5 of this series.

Case 2 is that of a white male 16 years of age who on 7/15/34 was hit from the rear by an automobile while he was walking. He stated he was immediately knocked unconscious for a period of 12 hours and has no recollection of exactly what happened. However, he believes that the front and rear wheels ran over him. He suffered a posterior dislocation of the left hip besides fractured clavicle and green stick fractures of both tibiae. The dislocation was reduced 24 hours later. He was immediately allowed to move his hip freely in bed and was kept in bed with splints for 5 weeks because of the fractured tibiae. He was then allowed up using crutches with weight-bearing on the left lower extremity. Crutches were used for 4 weeks. The patient had no trouble until May 1935, 8 months after the injury, when he began to have pain in the hip. This became increasingly severe, and x-rays at that time showed beginning aseptic necrosis of the head of the femur; however, it was not recognized. One year after the accident he went to bed for 6 weeks because of the severe pain, at which time an orthopedic surgeon was consulted. Diagnosis of aseptic necrosis was made and a ring caliper brace was prescribed which he wore for two years. Then he

had no marked difficulty until July 1939, 5 years after the accident, when the pain in the left hip became more severe and the hip gradually stiffened. The x-rays at that time showed aseptic necrosis of the head of the femur with partial ankylosis developing. On 10/18/39 a vitallium cup arthroplasty was carried out. His convalescence was uneventful. The motion in the left hip gradually increased, and 6 weeks following operation he had the following motion in the left hip: flexion 90°, extension 5°, rotation 60°, abduction 30°, and 5° adduction. There was 1½ inch shortening of the left lower extremity. Following his discharge from the hospital he had no pain and was progressing very satisfactorily when on 5/1/40, 5½ months after the cup arthroplasty, while getting out of a car, he felt a sudden sharp pain in the left hip which continued and did not relent. X-rays taken at that time showed that the vitallium cup had fractured. This pain became worse and so on 5/29/40 the fractured cup was removed and a new one inserted. At operation it was found that the synovial capsule about the hip joint had regenerated. The head of the femur appeared to have developed cartilage; however, microscopic sections showed this to be fibrous tissue and not cartilage. Motion in the left hip on 6/19/40 was as follows: flexion 90°, abduction 30°, and there was limited internal and external rotation. Patient progressed quite satisfactorily following this procedure; however, the pain returned 1 year later, and for a period of 2 months he was practically incapacitated, and although in school he attended few classes. Deep x-ray treatment relieved the pain. This patient is now a physician and is specializing in radiology. He had ambitions to be a surgeon but found that standing or even sitting at the operating table in one position for a period of an hour was more than he could bear because of the pain in the left hip. He stated that if he can change positions he gets along satisfactorily, but he cannot remain in either a standing or sitting position for more than 10 or 15 minutes at a time. The hip is never exactly free of pain although most of the time he feels quite comfortable. In the morning the hip is

stiff, but after he has been up a little while it loosens up. He was examined by the Army and was given 50 per cent disability; however, he himself feels that the disability is about 30 per cent. There is ¾ths of an inch shortening of the left lower extremity at the present time.

Case 5 is that of a white male 53 years of age who in 1941 suffered posterior superior fracture dislocation of left hip when a 600 pound hay stroker broke and fell across the left hip. He was taken to the local hospital where 2 to 3 hours later the hip was reduced by closed reduction and patient was kept in bed for 6 weeks following which he was allowed up walking without a brace. He immediately began to experience pain in the left hip which gradually increased in severity. He walked with a marked limp. Patient stated that his leg was numb over the lateral aspect of foot and leg immediately after the accident but this gradually improved. On admission to this hospital on 11/17/43 the patient walked with a marked limp. The left hip flexed to 90°, there was 20° to 25° of external rotation, and 0° to 5° of internal rotation. He could extend the hip 10°. There was decreased sensation over lateral aspect left leg and dorsum of the left foot (peroneal nerve lesion). X-rays showed aseptic necrosis head of the left femur. A vitallium cup arthroplasty was carried out on 11/20/43. The patient got along very satisfactorily, his convalescence was uneventful, and on discharge he could walk without pain in the hip. When last seen the patient had good motion of the left hip and he could walk well with the aid of crutches.

#### Osteo-arthritis

Oftentimes there is superimposed upon the necrotic head an osteo-arthritis. This condition usually develops after several years and is characterized pathologically by a villous synovitis, acetabular sclerosis, marginal osteophytes and occasionally the formation of loose bodies in the joint.

## Radiologic Diagnosis of Aseptic Necrosis

Brailsford states that the trauma associated with the production and reduction of dislocations of the hip joint is usually the cause of serious damage to the vascularity of the proximal end of the femur. This is a factor which is only too commonly overlooked, and the roentgenographic appearances of the bone and joint are in some measure responsible. This is because there is so little alteration in the characteristic outlines and details in roentgenograms taken several months after the reduction and the changes are undetected. He further states that he has seen such roentgenograms taken several months after the reduction and the changes are undetected. He further states that he has seen such roentgenograms exhibited in court by expert witnesses as evidence that the patient had sustained no damage to the joint and that the disability of which he complains was "functional". In the early stages one should look for a slight degree of osteoporosis with or without a faint, hazy opacity within the capsule, due to a deposit of amorphous calcium. If these apparently insignificant signs are missed and the limb allowed to bear weight this neglect presages disintegration of the joint. On the other hand, if these signs are noted and the joint is not allowed weight-bearing, or is immobilized until x-ray appearance indicates return of the joint to normal, it would in a large measure be preserved. A significant finding in the early diagnosis of aseptic necrosis is the apparent density of avascular bone. Inasmuch as bone that is going on to aseptic necrosis has no blood supply, its calcium content cannot change appreciably, whereas neighboring vascular bone undergoes disuse decalcification, and the avascular bone appears dense by contrast. If this is seen it must be realized that the density is only relative inasmuch as it is not a true hypercalcification and will not show up unless disuse atrophy or decalcification of the neighboring bone occurs. This will not show up until after a few weeks when disuse atrophy can have time to occur or begin. Later, if functional activity is allowed it may be difficult for a while to make the diag-

nosis because then the decalcification and disuse atrophy will disappear; however, at this time other radiographic signs of avascular necrosis may appear in the head of the femur by the tendency to disintegration and flattening under the pressure of weight-bearing. But the point is that the diagnosis should be made long before this so that early weight-bearing can be avoided. It should be understood that bone disintegration and degenerative arthritis do not always develop rapidly and may take months to years to develop and if the passing shadow of relative density has been overlooked a completely erroneous prognosis may be given. For this reason it is important that all cases of hip dislocation should have x-ray pictures taken during the second, third, and fourth months at intervals of about 2 to 3 weeks. If in these x-rays the shadow of relative density appears in any portion of the head of the femur the warning should be observed and proper measures taken.

### Summary

Fourteen cases of traumatic dislocation and fracture dislocation of the hip have been presented. The classification, mechanism of injury, diagnosis, treatment, complications, and a review of the literature in this condition has been given. The injury is a serious one and should be so treated.

### Conclusions

1. All cases of traumatic dislocation should be adequately immobilized for a period of at least 6 weeks in a simple dislocation and 10 weeks in dislocations with fracture of a large marginal fragment of the acetabulum.
2. When allowed up the patient should be supplied with a Thomas ring ischio-weight-bearing caliper brace which should be worn ideally for a period of 5 years; however, this is a practical impossibility but insistence should be made that the brace be worn for at least 1 year. It will be noted from the table that those patients in these 14 cases whose hips were protected from weight-bearing did not develop aseptic necrosis except

in case 3. In this case development of aseptic necrosis was inevitable because of the severe injury, capsular damage, and extensive dissection necessary at operation.

3. X-ray pictures should be taken during the second, third, and fourth months after injury at intervals of about 2 to 3 weeks and then every 3 months up to 1 year, followed by x-rays taken twice yearly for 5 years.

4. In these 14 cases there were 4 cases of aseptic necrosis. If the recent cases are deducted, the incidence is 4 cases in 10.

5. The reduction should be accomplished as soon after injury as possible in order to try to obviate the frequent occurrence of complications. These are: fracture of the posterior superior lip of the acetabulum, myositis ossificans, aseptic necrosis, sciatic nerve paralysis, and osteo-arthritis.

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## TRAUMATIC DISLOCATION AND FRACTURE DISLOCATION OF HIPS

Case	Sex	Age (Yrs)	Type of Dislocation		Side Dis- loca- ted	Cause	Secondary Complication	
			Sim- ple	Complication			Immediate	Delayed
1	M	33		Posterior with fracture of femoral neck	L.	Automobile accident		Aseptic necrosis femoral head
2	M	16			L.	Automobile accident. Hit in rear while walking. Unconscious 12 hrs. Front & rear wheels ran over him.		Aseptic necrosis femoral head
3	M	23		Posterior with subtrochanteric and intertrochanteric fracture with greater trochanter separated from shaft of femur at intertrochanteric line.	R.	Automobile accident.		1) Thrombo-phlebitis. 2) Draining sinus and vitalium screws removed 1 yr. later and sinus healed 17 mos. after open reduction. 3) Aseptic necrosis.
4	M	35	Pos- ter- ior		L.	Airplane accident.		1) 6 cms. shorten- ing. 2) Arthritic changes left hip.

Method of Reduction		Time between injury and treatment	Periods of Immobilization after Reduction	Result	Period of Observation
Closed	Open				
	Whitman procedure 5 yrs. after accident	5 yrs., was treated as possible TB for 8½ mos.		Aseptic necrosis. Has no pain in hip. Is able to do a full day's work.	9 years.
Closed		Reduces 24 hours after injury	None. In bed 5 wks. then up with crutches for 4 wks.	1) Vitallium cup arthroplasty 5½ yrs. after injury. 2) No pain in hip, then 5½ mos. later had sudden severe pain left hip. Cup had fractured, and new cup inserted 6½ cup arthroplasty. Now able to do work of radiologist. Cannot sit or stand in 1 position for any period of time. Has 50% disability according to army. He thinks 30%.	10½ years.
	Vitallium screws thru trochanter and neck up into head.	13 days	2 mos. Then allowed up with crutches and Thomas ring caliper brace.	Fractures united. Increased absorption head and neck. Aseptic necrosis of head and neck, developed. 1.5 cm. shortening of right lower extremity when last seen.	1 year. Has not been seen since year after injury.
1) Attempted twice before attempted open reduction & again before osteotomy.	1) Attempted 26 mos. after injury without success. 2) Osteotomy, utilizing steel plate 29 mos. after injury with good functional result.			Good functional result. Now is able to carry on work of a bus driver without pain.	4½ years.

Case	Sex	Age (Yrs)	Type of Dislocation		Side Dis- Loca- ted	Cause	Secondary Complication	
			Sim- ple	Complication			Immediate	Delayed
5	M	51		Posterior with fracture of superior posterior lip of acetabulum	L.	600 lb. hay stoker fell across left hip with patient in "stooped position"	Peroneal N. lesion which improved. Had impaired sensation over this area	Aseptic necrosis.
6	M	49		Posterior with fracture of superior posterior lip of acetabulum.	R.	Automobile accident (inebriated)		
7	M	41		Posterior with fracture superior posterior tip of acetabulum	R.	Fell from tree a distance of 30 ft. landing on buttocks in sitting position.	Inability to avoid, but no trauma to bladder or urethra noted.	1) 3 mos. after injury peroneal N. lesion noted. 2) Cystitis, incontinence of bladder and feces. 3) Impotence.
8	M	52		Posterior with fracture of posterior superior lip of acetabulum	L.	Jacked up binder fell on patient as he was crawling out. Brunt of weight fell on left hip.	1) Following reduction had episode of psychosis probably alcoholic after few days of restraint improved markedly.	1) some degree of myositic ossificans.

Method of Reduction		Time between Injury and Treatment	Periods of Immobilization after Reduction	Result	Period of Observation
Closed	Open				
Closed		2-3 hours	Bed rest for 6 weeks. Then up walking.	Vitallium cup arthroplasty 30 mos. after injury with good result. Walks without pain.	4 years.
Closed. Bigelow's maneuver		6-9 hours	12 (3mos) weeks, then crutches for 7 weeks. Fitted with Thomas ring caliper brace 5 mos. after accident.	X-rays were negative for aseptic necrosis. No pain in hip 4 yrs. and 2 mos. after injury. Has been working 2 yrs., 9 hrs. a day at a job requiring standing.	4 years, 2 months.
Closed. Watson-Jones method.		12-15 hours	2 mos. in cast, then fitted with Thomas ring caliper brace which he wore 1 yr.	1) Scobastrogalar arthrocast 17 mos. after injury. 2) Incision of flexor hallucis longus and flexor digitarum longus rt., 30 mos. after injury to correct plantar flexion of toes.	3 yrs. Has good functioning foot and no pain in hip.
Closed Watson-Jones		4 days	3 mos. in spica cast, then fitted with Thomas ring brace	Patient seen 1 yr. after injury and had some pain in left hip beginning 10 mos. after injury. 32 mos. after injury had no pain and could work a full day without difficulty.	32 mos.

Case	Sex	Age (Yrs)	Type of Dislocation		Side Dislocated	Cause	Secondary Complication	
			Simple	Complication			Immediate	Delayed
9	M	38	Posterior dislocation		R.	Automobile accident		1) About 6 wks. after injury noted rt. sciatic hemiparesis. Complete except for fair power in medial hamstrings and questionable flicker of biceps on admission here. 2) Left peroneal hemiparesis. 3) Myositis ossificans, rt. hip.
10	F	45		Posterior with fracture of posterior superior hip of acetabulum and mid-acetabulum extending thru sciatic spine.	L.	Caught left heel in fence while climbing over it and fell on left knee with knee & left hip flexed.		
11	M	17	Anterior (Obturator).		R.	Large truck with trailer. Patient fell asleep at wheel and ran into a ditch with trailer jackknifing up over the tractor.		

Method of Reduction		Time between Injury and Treatment	Periods of Immobilization after Reduction	Result	Period of Observation
Closed	Open				
1) Attempted first time about 2 weeks after injury then 6-8 wks. after injury several (23) attempts made.	3 mos. after injury with success. Never was reduced.			8 mos. after injury rt. sciatic N. was explored. Head of rt. femur removed to obtain adequate exposure. Sciatic N. found to be compressed between callous about the acetabular hip and head of femur, ischium and scar tissue plus myositis ossificans. After head of femur removed and necrolysis performed the sciatic N. was found to be frayed and compressed but continuity not disturbed.	15 Mos. Is receiving P.T. at present. Will be having further reconstructive surgery.
Closed Watson-Jones		15½ hours	Puck's extension for 6 wks. and then up with Thomas ring Caliper brace.	Good thus far. Recent case. No evidence of aseptic necrosis as yet. No pain in hip.	5 mos.
1) Attempted with success first time 15 days after injury. 2) A second attempt 18 days after injury was unsuccessful, the obturator dislocation being easily converted to a posterior, vice versa. Was left posterior.	2) The dislocation was left as posterior and open reduction carried out 21 days after injury with success.	15 days successful reduction by open method 21 days after injury.	Hip spica applied at open reduction still in cast. Will be fitted with Thomas ring caliper brace when cast is removed.	Good thus far. Recent case. No evidence of aseptic necrosis as yet.	4 mos.

Case	Sex	Age (Yrs)	Type of Dislocation		Side Dislocated	Cause	Secondary Complication	
			Simple	Complication			Immediate	Delayed
12	M	77		Central with one fragment of acetabulum displaced into pelvis and possibly several small fragments as well.	L.	Incoherent history but apparently fell on left hip while working.		
13	M	35		Central dislocation with fractured acetabulum, fracture rt. ilium with dislocation rt. sacro iliac joint; fracture superior and inferior ramus left pubic.	R.	Together with 30 other men was riding on truck with legs hanging over the side when truck was sideswiped by another truck, killing 2 men on his immediate right and causing fractures of 3 men to his left and the pt's own injuries.	Traumatic section or obstruction of urethra necessitating suprapubic cystostomy. Pt. unable to void immediately following injury and suprapubic cystostomy was done 6-8 hrs. after injury.	1) Perineal abscess which ruptured spontaneously thru left perineal adductor space. Healed with difficulty. Low grade infection. 2) Fecal incontinence starting 2 mos. after injury lasting 5-6 wks. Neurological neg. and proctoscopic neg. sphincter control present.
14	M	14	Simple posterior.		R.	Horses ran away and patient was thrown from wagon and front & rear wheels ran over anterior aspect of right upper thigh.	Right peroneal nerve lesion. Pt. noted this as soon as anesthetic wore off after reduction (drop foot)	

Method of Reduction		Time between Injury and treatment	Periods of Immobilization after Reduction	Result	Period of Observation
Closed	Open				
Buck's extension 15 lbs.		24 hours.	3½ wks.	No change. Allowed up to get about as best he could because of age, extreme senility, generalized arteriosclerosis, and Parkinsonism.	4½ mos.
Kirschner wire, lower femur with 18 lbs. traction started 21 days after injury, & 5 lbs. added 4 days later. Pt. put in pelvic sling 1 mo. after injury. This & traction discontinued 2 mos. after injury.		21 days	8 weeks	Satisfactory reduction of central dislocation. Because of severity of other injuries patient still has suprapubic cystostomy tube in place (6 mos. after injury) as it has been impossible to get him into the lithotomy position. Patient was manipulated under anesthesia 6 mos. after injury in effort to improve motion in back, hips, and knees. Is receiving P.T. directed toward this goal.	8 months
Closed.		3-4 hours		14 months after injury patient still had drop-foot but this had improved. Muscles, anterior, tibial, peroneals, and extensors (dorsiflexors), classed as weak. 2 years after injury pt. still had drop-foot but muscle power has increased showing nerve regeneration. No evidence of aseptic necrosis 2 yrs. after injury. Patient was allowed to go home from hospital as soon as anesthetic wore off. Pt. was fitted with ring caliper brace and stopjoint at ankle one month after injury, but was uncooperative and failed to wear brace consistently.	2 years.

### III. GOSSIP

To the Nicollet Hotel to speak before the Needlecraft Section of the Occupation Safety Conference on the relationship between "Personal Health and Accidents". Some people are accident prone while others have occasional accidents. Accidents are due to carelessness, inattention and fatigue. One of the greatest problems in industry is headaches. A surprising number of people are absent from work because of headaches. Industrial medical offices have learned that it does not pay to give pills for headaches. If no medicine is available at the first aid station, the worker goes home and the plant physician and industrial nurse implant the seed of interest as to the cause of headache. Some are due to eyestrain, others to hangovers, and many other causes. At the Course for Industrial Nurses at the Center for Continuation Study this week, Robert Tracht is discussing "Methods of Measurement of Visual Acuity". Machines are now available for doing this. It has been learned that when fine work is done, accidents and inefficiency soon develop unless the visual factor is taken into consideration. Erling Hansen is discussing External Eye Diseases this afternoon, and Eye Injuries is also being considered. At the dinner meeting this evening, Haven Emerson is the principal speaker. Tomorrow morning there will be an Industrial Surgery Symposium. Speakers are John H. Moe, Bernard Lannin, Miland E. Knapp, and John B. Erich. The panel discussion in the afternoon will be on Industrial Nursing Problems, lead by Ruth B. Freeman. Recognition dinner on Saturday night will be addressed by J. J. Bloomfield, Senior Sanitary Engineer, United States Public Health Service on "New Horizons on Industrial Health". In 1895 Mr. Proctor, President of the Vermont Marble Company, placed a graduate registered nurse on the payroll of his company in a professional capacity. Today there are over 12,000 nurses in industrial health services, and many visiting nurse associations are providing additional personnel on a part time basis. The first industrial nurse, Ada Mayo Stewart is still living in Vermont not far from the place which she originated industrial nursing service. We celebrate that event this week....I took a trip over the spring vacation period to Battle Creek and Detroit, Michigan. Travel is not so heavy although the Stations seem to be as crowded with people as ever. In Battle Creek to visit the Kellogg Foundation with Dean H. S. Diehl and there is much interest in University of Minnesota post-war plans. Kellogg Foundation offices occupy the entire second floor of Kellogg Inn, just across the street from Percy Jones Hospital for disabled soldiers, which comprises more than 10,000 beds. Hundreds of soldiers are practicing with their aids on the streets. Our time is so short that we do not have a chance to visit the institution. In Detroit there is much interest in the drive to register hospitals. It seems anyone can start a hospital in Michigan and many are not used for legitimate purposes. Kellogg Foundation, National Foundation for Infantile Paralysis and Commonwealth Fund have made a joint gift of 1 million dollars to study our hospitals. The hospital has become an important social institution as well as educational agency. Better standards and uniform methods of operation are the order of the day. It is good to get away from home and learn of the interest in things we are doing at Minnesota. A glance at any map reveals we are off the beaten path, but still what we say and what we think make a difference. Our graduates are loyal to us, and carry the conviction that they are proud of their institution. Everyone will be given a chance to display real affection for this place when the drive for funds to erect the Mayo Memorial Building is made. Thousands of men and women have received great returns on their education obtained here. There is a great interest in coming back here at the Center for Continuation Study after leaving school. The course in Surgery next week was barely announced before the registrations began to roll in. We could only take 90 men because of limitation of amphitheater space. To date we have had to say "No" to nearly 80 more - we are sorry, we would like to have you come, but there isn't any room. When the Mayo Memorial is built, this answer will not have to be given for present indications are that "weeks" in Medicine, Surgery, Pediatrics, Radiology, Ophthalmology, Obstetrics and Gynecology and all other specialties will be great future attractions.