OBSERVATIONS ON

FRACTURE OF THE NECK OF THE FEMUR IN CHILDHOOD

WITH ESPECIAL REFERENCE TO TREATMENT AND DIFFERENTIAL DIAGNOSIS FROM SEPARATION OF THE EPIPHYSIS

BY

ROYAL WHITMAN, M.D., M.R.C.S.

NEW YORK

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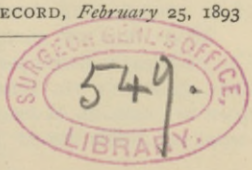

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OBSERVATIONS ON FRACTURE OF THE NECK OF THE FEMUR IN CHILDHOOD,[1]

With Especial Reference to Treatment and Differential Diagnosis from Separation of the Epiphysis.

It is sufficiently well established by recorded cases that the hip may be injured in childhood, and that shortening and disability may follow, which can only be explained by fracture or displacement in or about the hip-joint.

This injury may be classed, in most instances, as either fracture of the neck of the femur, or separation of the epiphysis. The latter is assumed by most writers to be the probable diagnosis, on the ground that an epiphysis existing, its displacement is more probable than fracture of bone. Indeed, it seems a very general impression that an epiphysis is a portion of bone adhering to another portion in such a manner that its disjunction may, and usually does take place from a much less amount of force than would be necessary to fracture the bone itself.

Thus a number of cases of supposed separation of the epiphysis of the head of the femur are recorded, and are copied from one work on fractures to another, in most of which the diagnosis was made, to my mind, on most inconclusive evidence.

Two years ago I reported a case of fracture of the neck of the femur in a child, and presented the patient at the meeting of the orthopedic section of the Academy; since then,

[1] Read before the Surgical Section of the New York Academy of Medicine, December 12, 1892.

several similar cases have come under observation, which have confirmed me in the belief that this fracture may occur in childhood, and that it is the more probable injury in these cases in which diagnosis is difficult; I propose, therefore, to present the question of fracture *versus* separation of the epiphysis, and to show several patients in whom the history and present appearances seem to bear out this conclusion, in the hope that members of the section may confirm the diagnosis, or point out the errors in reasoning by which it was made.

It may at once be stated that both accidents may occur, as proven by actual observation. A specimen of separation of the epiphysis was presented by Bousseau, at a meeting of the Anatomical Society of Paris, and is published with an illustration in the report of the society.[1]

The case is as follows: "A girl of fourteen was run over by a heavy carriage, was taken to the Hospital St. Louis in an unconscious condition. The left hip and thigh were much swollen and ecchymosed, the left leg everted and shortened, so that the heel was on a level with the opposite malleolus. Later, on regaining consciousness, voluntary movement of the limb was impossible. The girl died during the night, and examination showed the muscles about the hip reduced to a pulp, infiltrated with coagulated blood, a complete separation at the epiphyseal junction, rupture of the capsule, and upward displacement of the neck of the femur. In addition both spines of the ilium were separated, the subperitoneal tissue of the iliac fossa filled with blood, and the left humerus fractured."

A case of fracture of the neck of the femur is reported by Schultz,[2] from the practice of Dr. Hoffa, who removed the head of the femur in a girl of fourteen, for ununited fracture six weeks after the occurrence of the injury from a fall. A similar case is reported by Hamilton.[3]

[1] Bulletin de la Société Anatomique de Paris, April, 1867, p. 283.
[2] Zeitschrift für orthopädische Chirurgie, i., p. 49.
[3] Hamilton and Smith, Eighth edition, p. 369.

A girl of sixteen was caught between the wheels of two carriages, and sustained an injury to the hip. Autopsy three years later showed ununited intracapsular fracture of the neck of the femur.

Fractures of the neck of the femur produced by violence, in the attempt to replace dorsal dislocations of the hip in childhood, are reported by Cooper and Leisrink, and such an instance has come under my own observation, as I was present at an operation when, in the attempt to reduce, through open incision, an anterior dislocation of the femur, the result of an acute arthritis in a boy of six, the neck was broken at its junction with the shaft, although the previous disease, by which the cartilage was partially destroyed, should have made separation of the epiphysis the more probable accident, if it is true that this more readily occurs than fracture. Aside from proving that both injuries may occur, these observations are of little aid in diagnosis in a class of cases presenting quite other appearances and symptoms. Neither do the experimental studies on separation of the epiphyses on the bodies of infants or older children, or on living animals, aid to any extent in settling the question. In one respect, the experimenters agree: that separation is difficult, that it may be most easily produced in hinge-joints, by extreme over-extension, and in ball-and-socket joints, by abduction.

These experiments on infants are of no value in the question under consideration, because the epiphysis of the head of the femur does not exist, the entire upper extremity of the bone, including the neck and trochanter, are cartilaginous at birth, ossification beginning in the epiphysis of the head at about the first year.

Bruns[1] has collected from literature one hundred undoubted cases of separation of the epiphyses, selecting those only in which the diagnosis was proven by examination after death, by resection, or by penetrating wounds. Of these one hundred cases, but one is recorded of separation of the ephiphysis of the head of the fe-

[1] Deutsche Chir., xxvii, p. 118; Archiv für klin. Chir., xxvii., p. 241.

mur, that already mentioned. The cases were divided as follows:

Upper epiphysis of the humerus	11
Lower epiphysis of the humerus	4
Upper epiphysis of the ulnar	1
Lower epiphysis of the ulnar	2
Lower epiphysis of the radius	25
Ossa pelvis	3
Upper epiphysis of the femur	1
Great trochanter	1
Lower epiphysis of the femur	28
Upper epiphysis of the tibia	4
Lower epiphysis of the tibia	11
Upper epiphysis of the fibula	3
Lower epiphysis of the fibula	4
Metatarsus	2
Total	100

Of the eleven cases of separation of the upper epiphysis of the humerus, which offers some analogy to that of the femur, five were produced by intra-partem violence. With this exception, it is stated by Bruns that separation of the epiphyses is rare in the first ten years of childhood.

Although one may not attach great importance to statistics of this character, in deciding for or against the question under consideration, the fact that but one case of separation of the upper epiphysis of the femur is recorded in one hundred instances of separations in other localities, would seem to show that the accident is a rare one. It may be stated then, of separation of epiphyses, that it is rare, compared with fracture; that its cause is usually a sudden twisting wrench or strain; it is most frequent in those situations where the epiphysis forms the entire extremity of the bone, so that great leverage may be exerted by means of ligaments and muscles attached near the line of junction, as in the lower extremity of the femur. Even in these localities, experiments on the dead body, and on animals, have shown that fracture is more common, although the force is exerted in the direction most favorable to attain this object.

The weight of evidence is thus against the assumption

that separation of an epiphysis is more likely to occur as a result of violence than fracture. Of all the epiphyses in the body, that of the head of the femur, lying deep in the acetabulum, completely within the capsule, with a wide range of motion in all directions, seems least liable to this injury, and this is borne out by the statistics quoted.

Holmes,[1] in considering injuries to the hip in children, says: "Fractures of the neck of the femur are hardly known in childhood, and the upper epiphysis of the femur is so small and so completely within the hip-joint that its disjunction is unknown, except perhaps in the fœtus."

In the reported cases of separation of the epiphysis of the upper extremity of the humerus, the only joint analogous to the head of the femur, the deformity was well marked, easily reduced, but difficult to retain in position, slow to unite, or remained ununited, while subsequent impairment of motion was the rule.

Hutchinson considers the result of non-union more particularly in his article on separation of the upper epiphysis of the femur, in the *Archives of Surgery* for April, 1892, as follows:

"In the later stage of confirmed non-union, which, according to my experience, is that which most frequently comes under notice, the symptoms are those of unreduced dislocation on the dorsum, but with very free mobility, and inability to find the rounded head of the bone." In the child, the neck of the femur projecting from the shaft at an angle of 129° (*vide* Fig. 1) expands at the epiphyseal junction. This junction is further assured by a thick external sheath of cartilage, which persists for many years after birth, and by the periosteum, which is here, as in other situations, thicker than elsewhere, so that when separation takes place it is stripped from the bone for a considerable distance.

Admitting, then, as experiments prove, that fracture more readily occurs than separation even in the most fa-

[1] Diseases of Childhood, second edition, p. 258.

vorable localities, it is evident that this epiphyseal junction, which is broader and stronger than the neck, completely within the capsule, firmly held in place by muscles, the cotyloid, and other ligaments, and by atmospheric pressure, is likely to be separated only by great violence; that the separation is likely to be complete,

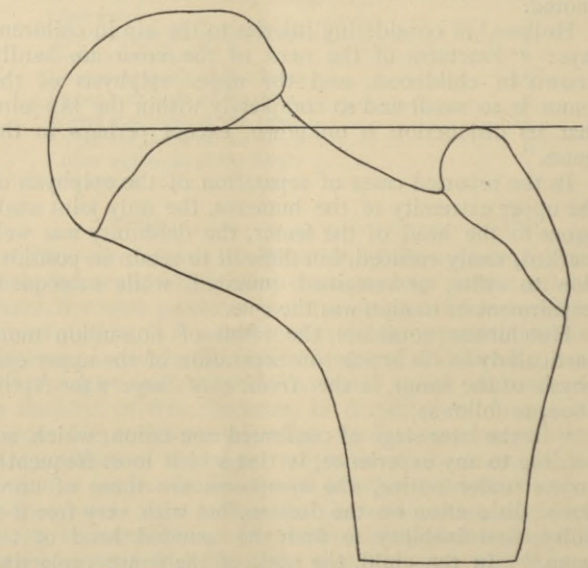

FIG. 1. (after Wolff)—Shows the epiphyses of the head and the trochanter; also the normal elevation of the head above the trochanter at the age of fourteen.

and accompanied by rupture of the capsule, and displacement. If separation has occurred, three terminations seem possible:

1. Complete upward displacement of the neck, nonunion of the fragments, with a final result, as in Hutchinson's cases, similar to those which are occasionally seen after acute epiphysitis, that is, a condition simulating congenital dislocation of the hip.

2. Irregular junction of fragments, with subsequent impairment of function of the joint, similar to the results reported after displacement of the upper epiphysis of the humerus.

3. Immediate replacement of fragments, with complete recovery without loss of function or shortening.

If, then, a patient be presented for examination, some weeks or months after an injury to the hip—in other words, before nature has, by developmental changes, accommodated herself to the changed conditions—and examination shows three-fourths of an inch shortening, and a corresponding elevation of the trochanter, with motion free in all directions, without deformity of the limb, one is justified in assuming that the head of the bone is in normal relation to the acetabulum, and that the shortening is caused by bending or united fracture, sufficiently far away from the articulating surfaces as to cause no interference with the function of the joint. This may be assumed on the following grounds: The length of the articulating junction between the epiphysis and the neck varies, according to the age and size of the child, from three-fourths to one and one-fourth inch or more. Upward displacement of three-fourths of an inch would either completely separate the fragments or allow but one-fourth or one-half an inch of apposing surfaces (*vide* Fig. 2). Under these circumstances, if union followed, it must be an irregular one, and it would seem, too, that the projecting neck must impinge on the rim of the acetabulum, and that in any case the function of the joint must be embarrassed by the misplacement. With these preliminary remarks, the histories of five patients treated and the patients themselves are now presented for your consideration.

Case I.—A boy aged eight, was brought to the hospital in the arms of his mother, on May 20, 1890. Six weeks before, he had fallen into an area, a distance of fourteen feet, injuring the right leg. He was put to bed and treated by a physician, who devoted his attention to the knee, which was said to have been swollen. Later,

another physician was called, who pronounced the condition hip disease, and said that it was incurable.

On examination, it was noted that the leg was rotated outward, that the trochanter was elevated three-fourths of an inch above Nélaton's line, and somewhat nearer the

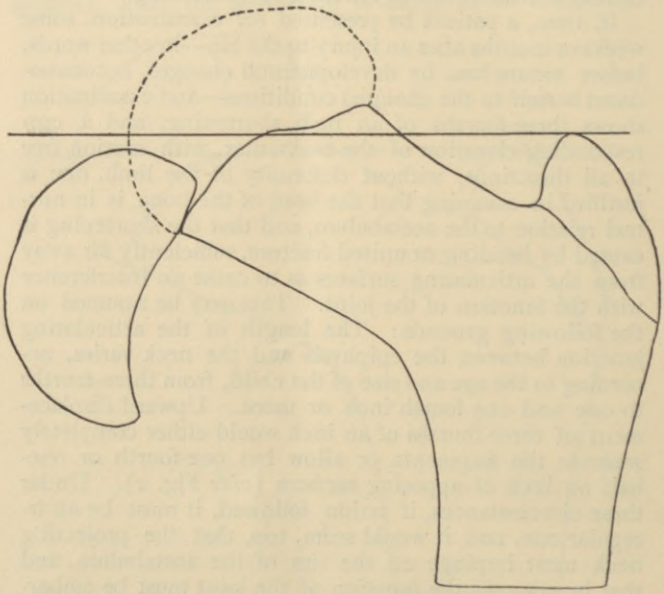

FIG. 2.—A scheme to represent disjunction of the epiphysis and to show the separation necessary to explain an elevation of the trochanter of three-fourths of an inch above Nélaton's line, as in the cases reported.

median line of the body than its fellow. Passive motion of the limb was slightly painful, but free, except in extreme flexion and inward rotation. The head of the bone was evidently firmly in its place. A hip-splint was applied, on which the child immediately began to walk. Six months later it was discarded. Examination two years later, October 20, 1892, showed practically free

motion in all directions. It was said that the child complained somewhat of stiffness after long sitting. This was explained by the marked projection of the trochanter, which distended the gluteal region when the leg was flexed. Otherwise the child suffered no discomfort. There was a slight limp and one inch shortening, an apparent increase of one-fourth of an inch since the first examination. The legs were three inches longer than in 1890.

Case II.—A boy, aged six, was brought on November 9, 1891, to the hospital, on account of a persistent limp. Four and a half months before, he had fallen from a fire-escape, a distance of fourteen feet, the accident being followed by swelling of the thigh, pain, and inability to stand. A plaster-of-Paris bandage was applied, and kept in position for eight weeks, on its removal he appeared well with the exception of the limp.

Examination showed, as in the preceding case, slight outward rotation of the limb, prominence of the trochanter, which was elevated three-fourths of an inch above Nélaton's line, with two-thirds of an inch displacement toward the median line. No limitation of motion, except to extreme flexion and inward rotation. A brace was worn for three months, and then removed. The child was examined on December 10, 1892, one year later. The shortening was then one and one-fourth inch, the other leg having increased one and one-half inch in length. The only symptoms remaining were the limp caused by shortening, and a slight limitation of motion. I am unable to say whether the increase of one-half inch in shortening is due to retarded growth or to further bending of the neck.

Case III.—A boy, aged five, was brought to the hospital December 28, 1891, and was said to have been knocked down or run over by a heavy carriage, nine weeks before. At this time there was pain and swelling of the thigh, for which a plaster bandage was applied; it was removed two weeks later. The patient had since walked with marked limp, and suffered more or less pain. Ex-

amination showed the leg, in full extension, somewhat rotated outward, three-fourths of an inch shorter than its fellow, with a corresponding elevation of the trochanter, which was, however, much less prominent than in the preceding cases; motion was much more limited, terminating at one hundred degrees of flexion, and the muscular resistance was more marked. In this case it was inferred that the upper extremity of the bone had sustained more damage than in the preceding cases; which was borne out by the after-history; the spasm and resistance to motion necessitating the use of a brace up to the present time, when it is being gradually discarded. There has been no change in the appearance; motion is now perfect in extension, somewhat limited in flexion. The relative shortening is as on the first examination.

Case IV.—A boy, aged eight, applied at the hospital October 8, 1892, with a history of a fall of about fifteen feet six months before, followed by pain and disability, for which he was treated at the Gouverneur Hospital. The appearance in this case was very similar to the preceding. The right trochanter was elevated one inch above Nélaton's line, there was marked thickening about the joint and muscular spasm on motion. The leg was fully extended, and rotated outward. Dr. Silver has kindly furnished me with the history of the case: On the child's admission to the hospital he was etherized, and a diagnosis of fracture of the neck of the femur, at its junction with the shaft, was made. There was distinct bony crepitus at this point, and the trochanter rotated on its own axis. At first Buck's extension was applied, but as the child was unruly, a plaster-of-Paris spica was substituted. On its removal the boy walked fairly well, but as the pain and limp had recurred since his removal from the hospital, some support was thought necessary. This, as in the preceding case, was applied and at once relieved the pain and night cry.

Case V.—A child, two and a half years of age, was brought for examination in October, 1892. One month before, it had fallen four stories, but did not appear to be

seriously injured. It had since limped, and complained of pain and fatigue in the left leg. Examination showed outward rotation, but absolutely free motion of the hip, three-fourths of an inch shortening, with the elevated and prominent trochanter as in the former cases. No pain or spasm. A modified hip-splint, with joints, was applied and has since been worn, with relief of all the symptoms.

It will be noted that these histories are very much alike, that the injuries were caused by falls, that the shortening was about three-fourths of an inch, that the movements of the hip were free and perfect until checked by muscular spasm, or pain ; which may be assumed to be the result of the thickening and infiltration caused by the fracture. Thus the accident was the result of violence, which might cause fracture ; the subsequent symptoms were those of fracture, and I find no evidence in the literature of the subject or in the appearance of the patients, which opposes a diagnosis of fracture.

There are no reported cases of fracture at this age available for comparison, and I have not thought it necessary to collect cases of supposed separation of the epiphysis of the femur to criticise the diagnosis. As a rule, the descriptions are defective and after-histories not given. I have therefore confined myself to a consideration of cases examined and treated by myself; three of them having been followed to final results. These five patients have been presented for observation and comment. The criticism may be justly made that these cases are inconclusive, and that diagnosis is impossible in parts so deeply seated. Granting this, one is obliged to accept a probable diagnosis, and my reasons have been presented in support of the belief that it is in these cases fracture, rather than separation of the epiphysis, and that fracture in similar cases is the more probable accident of the two.

From the rapidity with which recovery took place, in three of the patients it has seemed to me probable that the fracture of the neck might have been partial, a bending and fracture, or an impaction rather than complete sep-

aration (*vide* Fig. 3). The history of the patients would also seem to show that the immediate treatment of the injury had but little influence on the final result. In all, union promptly took place, and in all, the present disability depends upon the shortening. As it may be assumed that there is practically no danger of non-union in disjunction of the epiphysis, or fracture, unless the fragments are completely separated from one another, the first essential in immediate treatment should be to overcome the evident

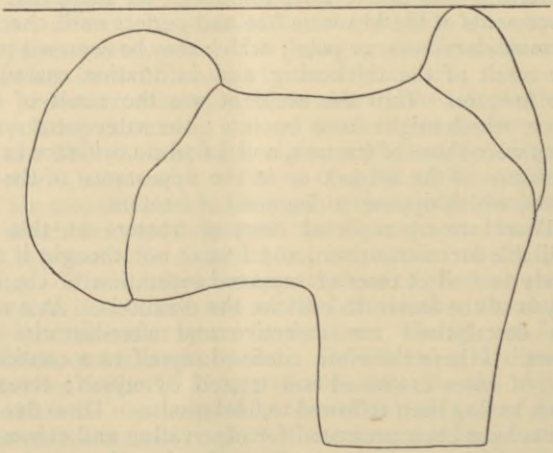

FIG. 3.—A scheme to represent the change in the angle of the neck after fracture, to explain an elevation of three-fourths of an inch above Nélaton's line.

shortening of the limb, even if this necessitates a breaking up of an impaction, in order that the parts may be placed in as nearly as possible a normal relation to one another. For it must be remembered that the neck is so short that the fracture must be in close relation to the epiphysis, and that cessation of growth is likely to follow great deformity or exuberant callus, and that non-union may result from complete separation of the fragments. To hold the parts in apposition, extension with direct

counter-extension on the perineum would seem necessary. For his purpose a modified Thomas hip-splint suggests itself. It should be double, provided with a pelvic band for perineal straps, and lengthened to project beyond the foot to provide for extension. If such an appliance were not available, a plaster bandage, including the body and foot, applied during etherization, under extension and counter-extension, the leg being slightly abducted, might prove equally efficacious.

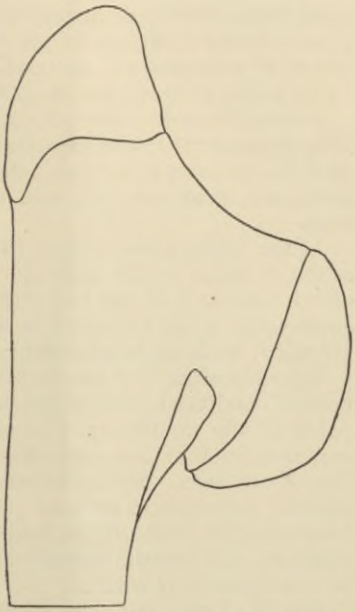

FIG. 4.—Rachitic Bending of the Neck of the Femur (after Schultz). In this case the trochanter was two inches above Nélaton's Line. The specimen was obtained by resection.

References.— Ueber die Verbiegung des Schenkelhalses im Wachsthumsalter; Ein neues Krankheitsbild. Dr. Ernst Müller, Beiträge zur klinischen Chirurgie, Bd. 4, S. 137. Bemerkungen zu dem Neigungswinkel des Schenkelhalses. C. Läuenstein, Archiv für klinische Chirurgie, Bd. 40, S. 244. Ein Fall von doppelseitiger rhachitischer Verbiegung des Schenkelhalses. Joseph Rotter, Münchener klinische Wochenschrift, August, 1890, No. 32, S. 547. Zur Casuistik der Verbiegungen des Schenkelhalses. Julius Schultz, Zeitschrift für Orthopädische Chirurgie, vol. i., S. 55.

The interesting feature in the after-treatment of these cases has been the immediate relief of pain and disability following the application of the ordinary hip-splint, by which the vulnerable joint was protected from traumatism. The question also arises whether an increased bending of the neck, at the seat of fracture, may not result from a too early use of the limb. This bending occasionally occurs from rachitis in adolescence, resulting in great deformity, and the

point seems worthy of attention (*vide* Fig. 4). This appliance would doubtless be serviceable in shortening the period of weakness and discomfort after similar injuries in the adult, as is illustrated by the following case:

A man, thirty-five years of age, was carried into the outdoor department of the Hospital for Ruptured and Crippled, in the arms of a friend, eight months after fracture at the hip, weakness and pain preventing the use of the limb.

As the patient was subject to a recurrent dislocation of the shoulder on the same side, which the pressure of a crutch displaced, he was bed-ridden. Two weeks after the application of the hip-splint he came from Brooklyn, unattended, walking without difficulty or pain.

In conclusion, I think it may be stated, that under normal conditions, the epiphyseal junction is not a weak point in the continuity of bone. That, as a result of violence, fracture may occur above, below, or through the line of cartilage. Such fractures or displacements are of especial importance, because of the vicinity of the joint, because of the difficulty in keeping the fragments in apposition, and because cessation or diminution of growth or non-union may result.

Finally, I may call your attention to the fact that the oldest of the patients presented is but eight years of age, that the first decennium is a period when either fracture or separation of the epiphysis is said to be extremely uncommon. If, then, five cases were seen at the Hospital for Ruptured and Crippled in a period of two years, it is probable that the accident is much more common than statistics would lead one to suppose.