THE TREATMENT OF FRACTURES OF THE NECK OF THE FEMUR BY IMMEDIATE REDUCTION AND PERMANENT FIXATION.

BY
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Read before the Wisconsin State Medical Society, June 4, 1889.

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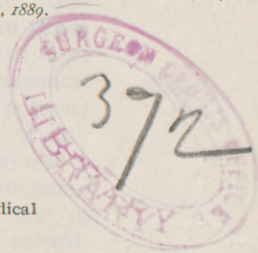

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THE TREATMENT OF FRACTURES OF THE NECK OF THE FEMUR BY IMMEDIATE REDUCTION AND PERMANENT FIXATION.

The treatment of a fracture of the neck of the femur is always a source of anxiety to the surgeon. In many instances the diagnosis is attended by unusual difficulties and not infrequently a fracture of this kind is overlooked, even after what appears to have been a thorough examination, while at other times, for want of a correct diagnosis, patients have been submitted to a long and debilitating treatment when no fracture existed. Patients suffering from this injury are with few exceptions advanced in years and liable to succumb to complications incident to prolonged confinement in bed. The marantic changes in the tissues of the aged and in persons rendered prematurely old by hereditary or acquired causes are known to be antagonistic to a rapid repair of such an injury, while at the same time the anatomical conditions at the seat of fracture are such as are well calculated to retard, if not to prevent, the production of callus. With few exceptions our surgical text books and special work on fractures continue to advance the same ideas that have been prevalent for centuries concerning the process of repair in fractures of the neck of the femur, and assert that bony union is only possible if the line of fracture is completely, or at least, partially outside of the limits of the capsular ligament. Teachers and authors

are so positive in their assertions that if the fracture is entirely intra-capsular a pseudo-arthrosis is inevitable, that many cases of partly extra-capsular fractures have been treated on the expectant plan the same as intra-capsular fracture, and only too often with the same unsatisfactory result. The time has come when it is no longer admissible to make such a distinction in the lecture room, the text books or at the bedside. Experience and experimental research have demonstrated that the proximal fragment, in case the line of fracture is entirely intra-capsular, does not only retain its vitality, but if placed in accurate contact with the opposite fragment, either by impaction or by mechanical fixation it takes an active part in the production of callus.

In a paper read at the meeting of the American Surgical Association, in 1883, ("Fractures of the Neck of the Femur, with Special Reference to Bony Union after Intra-capsular Fracture," Transactions of the American Surgical Association, vol. 1), I gave an account of fifty-four cases collected from different sources of bony union after intra-capsular fracture and in most of them the proofs in support of the assertion were so convincing that even skeptics on this subject would find it difficult to give to them a different interpretation. In the same paper I recorded the results of my own experimental work undertaken for the special object of demonstrating, if possible, that bony union after intra-capsular fracture is so seldom obtained, not so much on account of the anatomical peculiarities of the parts involved in the fracture as the inefficient treatment which is usually resorted to in its treatment. In the animals subjected to experiment the fracture was produced by making multiple punctures with a small drill through the neck of the femur entire-

ly within the limits of the capsular ligament and fracturing the balance of the bone by forcibly rotating the femur inwards. Twenty-three fractures in so many different animals thus produced were treated on the expectant plan, or by simple fixation with a plaster-of-Paris dressing. The animals were killed from four weeks to three months after fracturing the bone, and the seat of fracture was carefully examined in every instance, but in none of them was I able to find any evidences of bony union. The best result obtained by this method of treatment was pseudo-arthrosis by the interposition of a short ligament between the fractured ends. Discouraged by the many failures I finally resolved to secure accurate coaptation of the fragments by drilling a hole from the trochanter major through the entire length of the neck and well into the head and fastening the fragments together with an aseptic iron, bone or ivory nail. Eight such experiments were made on cats. In two suppuration followed the operation. In the rest bony union or union by an exceedingly short ligament without any displacement of the fragments was obtained. I will quote only two of the experiments for the purpose of illustrating the method of procedure and of showing the condition and appearance of the bone after permanent union by callus.

Experiment 27.—Adult Maltese cat; subcutaneous fracture of left femoral neck; fixation of fragments by means of bone nail made from compacta of tibia of an ox. Animal killed fourteen weeks after operation. Neck of femur only slightly shortened; capsular ligament nearly normal; ligamentum teres intact; vertical section shows a slight curve in the upper portion of the neck; the head being slightly depressed. Perfect and complete bony union, the spongiosa

being restored nearly to its normal condition. No traces of bone nail or perforation.

Experiment 32.—Young cat; subcutaneous fracture of neck of right femur, direct fixation of fragments with bone nail. Animal killed four months after operation. During life function of the joint was perfect; vertical section through the head; neck and upper portion of shaft, shows that the line of fracture must have been entirely within the capsule, as the capsular ligament and bone outside of it presented a perfectly normal contour and appearance. Accurate measurements show only a very slight shortening of the neck; the osseous tissue composing the interior of the neck more dense than in the opposite bone. Spongiosa restored to nearly its natural perfection. No traces of track of perforation or bone nail.

In no case did I feel crepitation after the fracture more distinctly than in this instance, and the sudden giving way of the bone the moment it was fractured was well marked, and was heard by all of the assistants, and as the post-mortem examination shows a perfect restoration of the continuity of the bone, I am firmly convinced that this specimen represents a typical and perfect recovery of union by bone after intra-capsular fracture of the neck of the femur. The results obtained by immediate transfixion of the fragments stand in direct contrast to those treated by external fixation. Bony union, or union by short ligament, was the rule, non-union the exception. In the treatment of all fractures the two cardinal indications are: *Firstly*, to bring the fractured surfaces into accurate coaptation as soon as possible after the accident, and, *secondly*, to maintain uninterrupted approximation by permanent immobilization. In these respects the treatment of fractures is governed by the same rules as the

treatment of wounds of the soft parts. In the repair of all injuries the severed tissues should be brought as nearly as possible in the same relative position they occupied in their normal condition and to retain them in such position by temporary mechanical measures until the completion of the reparative process. By following this rule the normal regenerative resources inherent in the tissues are taxed only to a minimum extent and definitive healing is obtained in the shortest possible space of time. As union between the divided or severed parts can only take place by the interposition of new material, the product of a regenerative process in the tissues at and in the immedate vicinity of seat of trauma, and as this process presupposes the existence of a connecting bridge of new blood vessels, it is evident that the length of time required to secure union will be greatly modified by the width of the intervening space. It is somewhat strange that the customary treatment of fractures of the neck of the femur which has governed the practice of surgeons from time immemorial, still commands the confidence of the profession. For centuries these fractures have been treated by some kind of extension and imperfect immobilization. The favorite treatment of to-day consists of extension by means of the weight and pulley as devised by Gordon Buck, and fixation of the limb by a long splint or two sand bags. The extension is applied for the purpose of counteracting muscular contraction, the cause of the shortening of the limb. If we consider the number and strength of the muscles which are inserted in the lower fragment, and which are the direct cause of the shortening, we can imagine the force requisite to overcome the longitudinal displacement. At best permanent extension by weight and pully cor-

rects the shortening only gradually and always imperfectly and never secures immediate reduction, the first and most important indication in the treatment of any fracture. As the upper fragment is short, sometimes not reaching beyond the niveau of the cotyloid cavity, is deeply located and not parallel to the long axis of the lower fragment, but nearly at a right angle to it, all means of fixation short of complete immobilization of the pelvis and the lower fragment upon it must fail in securing uninterrupted coaptation and perfect immobilization. The result obtained by the customary treatment have been such that no better proof need be advanced to demonstrate its inadequacy. The long confinement in bed which it necessitates has often proved a direct cause of death. Bony union of fractures within the capsule has only occurred in cases where impaction had taken place and where this means of fixation was allowed to remain undisturbed until union was completed, in all other cases a pseudo-arthrosis proved to be the unavoidable result. In fractures outside of the capsule healing with shortening of an inch has always been considered an excellent result, and more frequently the shortening was in the neighborhood of two inches. The treatment by weight and pully extension and splint fixations requires constant watchfulness on the part of the surgeon and those who are in direct charge of the patient. Extension continued for two or more months not infrequently is followed by serious, if not permanent, damage to the structures of the knee joint.

It is my purpose on this occasion to call your attention to the advantages to be derived from the treatment of fractures of the neck of the femur by immediate reduction and permanent fixation as compared with the treatment by the usual

methods. The treatment I shall describe is equally well adapted for intra- and extra-capsular, impacted and non-impacted fractures. As it is no longer necessary, from a practical standpoint, to make a distinction between an intra- and extra-capsular fracture, I will only allude to a few diagnostic signs which indicate the existence of a fracture through the neck of the femur which should be sought for, and carefully considered before a positive diagnosis is made.

SYMPTOMS AND DIAGNOSIS OF FRACTURE OF THE NECK OF THE FEMUR.

Displacement after fracture through the femoral neck is due either to the fracturing force, muscular contraction or simple gravitation. In incomplete and impacted fractures it is caused entirely by the fracturing force. A number of incomplete fractures have been reported by König, King, Jackson, and Billroth. These fractures are produced by crushing, not overbending. If the force is transmitted through the long axis of the femur the lower portion of the neck gives way and Adam's arch penetrates the cancellated tissue of the neck to a certain distance, thus shortening the lower border of the femoral neck, a condition which would give rise to slight adduction, but no shortening of the limb, and the upper border of the trochanter major will be found in normal position in reference to Roser-Nélaton's line. If incomplete fracture take place at the expense of the posterior portion of the neck the limb will retain its normal length, but the posterior margin of the trochanter major would be displaced slightly in a posterior direction and would be somewhat less prominent than on the opposite side. If in an exceptional case the fracturing force should be transmitted through the

trochanter major in an opposite direction and would crush a portion of the bone on the anterior surface of the neck, the slight deformity produced would be the same, only that the trochanter would be found rotated in an opposite direction. In all incomplete fractures then, no shortening exists and the upper margin of the trochanter major corresponds to the Roser-Nélaton line. In complete but impacted fractures the displacement is caused entirely by the fracturing force and is commensurate with the amount of bone tissue crushed at the seat of fracture. As the fracture in these cases is complete, more or less shortening is always present. A fall upon the foot or knee, as a rule, will fracture the neck at its narrowest portion, and, if the fracture is complete, no impaction will take place, unless it follows as a secondary occurrence from transmission of force through the trochanter major. In such cases the impacting force acts at a right angle to the fracturing force. Experiments and clinical observations have shown that the majority of fractures of the femoral neck are produced by force applied in the direction of the axis of the neck by falls upon the trochanter major. It is also well established that in most instances the neck gives way at its trochanteric portion, and that the posterior wall is crushed or fractured first, impaction of the posterior wall is therefore the rule. Besides shortening, an impacted fracture of the neck is always attended by slight rotation of the limb in the direction of the impaction. For instance, if the force is applied laterally through the trochanter, and, as is usually the case, from before backwards the posterior wall fractures first and impaction takes place here, the degree of rotation of the limb in an outward direction will be an indication of the extent to which impaction

has taken place. In very exceptional cases, if, as has happened in a few instances, the fracturing force is applied against the posterior border of the trochanter major, the anterior wall of the neck is fractured first and impaction takes place at this point, an occurrence which is always indicated by the limb being rotated in an inward direction. In impacted fractures the upper margin of the trochanter major will always be found above the level of Roser-Nélaton's line, the outer surface of the trochanter is less prominent than on the opposite side and its posterior border is displaced backwards in the most common form of impaction with outward rotation of the limb. In complete fractures without impaction the displacements are due to active and passive causes. The shortening results from muscular contraction and increases with the restoration of muscular action, while the rotation outwards of the limb is due to the tendency of the limb to fall in this direction when in a condition of complete repose.

Method of Examination.—Injuries about the hip-joint of sufficient intensity to fracture the femoral neck in persons advanced in years should always be examined with the utmost care for evidences of fracture. Whenever possible a positive diagnosis should be made at the first examination. In some cases the symptoms are so characteristic that a correct diagnosis can be made almost on first sight, while in other instances all diagnostic resourses must be exhausted before a correct idea of the nature of the injury can be obtained. To make a thorough examination all clothing as far as the chest must be removed and the patient placed upon an even, smooth, unyielding surface, either upon a table or the floor. Inspection will reveal the presence or absence of a bruise over the trochanter major. If present

the location of the superficial contusion will indicate the direction of the fracturing force. Suggillations about the hip are suggestive of a deep-seated injury, and not infrequently they make their appearance over the groin and along the inner side of the thigh in a few days after a fracture of the neck of the femur. If the limb is strongly rotated outwards, and by its position dislocation of the hip-joint can be excluded, it is more than probable that the femoral neck is fractured. In all cases of fracture of the neck, there is an appreciable fulness in the fold of the groin corresponding to the seat of the fracture. This swelling is caused by the hinge-like projection of the anterior portion of the neck, effusions of blood or inflammatory products, and, lastly, by the overriding or impaction of the fragments. When impaction has taken place at the base of neck, the trochanteric portion of the femur is enlarged from implantation of the upper fragment. More swelling is present in extra than intra-capsular fractures, as in the former there is more hæmorrhage and the bone injury is more extensive. Another witness which can be elicited by inspection in cases of fracture through the femoral neck, is a slight depression between the great trochanter and the crest of the ilium, a change in contour caused by relaxation of the fascia lata, as was first pointed out by Dr. Allis. This sign is most marked when the patient is placed in the erect position. The symptoms which have been elicited by inspection and gentle palpitation must be verified by careful measurements. The information furnished by measurements carefully made can be relied upon in arriving at positive conclusions concerning the nature of the injury. It is not only superfluous but positively harmful to search for positive symptoms of fracture, crepitus,

preternatural mobility of fragments, and new point of motion, in these cases ; all manipulations during the examination of a supposed fracture in this locality should be made with the utmost care and gentleness. The search for crepitus and other positive symptoms of fracture has been the cause of incalculable harm. In many instances careless handling of the limb has resulted in disjunction of impacted fractures, or in tearing of periosteal or ligamentous bands, thus removing the conditions upon which rested the possibility of obtaining osseous union by the interposition of a short ligamentous band. In every case care is to be taken not to disturb the parts at the seat of injury for the purpose of making a diagnosis ; it can never become necessary to administer an anæsthetic for the purpose of making a so-called *thorough examination*. Our diagnosis should depend on the presence or absence of the three most important symptoms—position of the trochanter major, shortening and eversion. A line drawn from the tuberosity of the ischium to the anterior superior spinous process of the ilium is called the Roser-Nélaton line, and with the trochanter major in its normal position and relations marks its upper edge. If the measurements show shortening, and the femoral neck is fractured, the upper border of the trochanter major will be found displaced beyond the Roser-Nélaton line to the extent of the actual shortening. It has recently been shown by Wight, Hamilton, Gurson, and others that inequality in the length of the lower limbs is a rather common occurrence, consequently in order to eliminate sources of error, it becomes necessary to ascertain the presence of asymmetry, should such exist, in applying measurements in the diagnosis of a fracture of the neck of the femur. For the purpose of avoiding

errors, which might accrue from asymmetry of the lower extremities, Wight directs that the following measurements should be taken: (1.) Inside measurements from the superior anterior spines of the ilium to the lower ends of the internal malleoli. (2.) Outside measurements from the superior anterior spines of the ilium to the lower ends of the external malleoli. (3.) Measurements from the tops of the great trochanters to the lower ends of the external malleoli. (4.) Measurements from the bases of the tibiæ to the lower ends of the internal malleoli. (5.) Measurements from the superior anterior spines of the ilium to a line drawn transversely in front between the top of the great trochanters. These measurements give the length of the femur and tibia on each side as well as the entire length of both limbs, and if asymmetry of any of the bones exists this fact is easily determined. If actual shortening is found the existence of a fracture of the femur below the hip-joint is excluded by ascertaining the exact relation of the great trochanter to the Roser-Nélaton line, if the trochanter is found displaced upwards to the extent of the shortening and other symptoms point to fracture, the diagnosis of a fracture through the femoral neck may be considered as established. In very fleshy persons the landmarks which serve as points from which the measurements are made are not well-defined and not easily located, and it is on this account advisable to fix the location of each as accurately as possible and indicate it on the surface by a pencil mark before any of the measurements are made. The best instrument for making the measurements is a steel tape-line, with feet and inches marked on one side, and centimetres and millimetres on the other. Eversion is readily detected by inspection. In im-

pacted fractures it may be very slight and a sudden or gradual increase of these displacements, days, week, or months after the accident, signifies that disengagement of the fragments has taken place, an accident probably caused by inflammatory osteoporosis and imperfect immobilization. If the surgeon has demonstrated by his examination that a fracture exists, the presence of impaction can be readily ascertained by gently rotating the limb upon its axis and by making slight traction; if these manipulations affect the head of the bone, impaction has occurred, and every care should be exercised to preserve the mutual fixation of the fragments. Unimpacted fractures of the neck of the femur seldom give rise to any difficulty in diagnosis. The symptoms attending them are so well marked that a correct conclusion can be reached without causing needless suffering or inflicting additional injuries in searching for any of the positive signs.

Treatment.—The treatment I shall advocate in fractures through any portion of the femoral neck consists in the fulfillment of two principal indications: (1.) Immediate reduction. (2.) Permanent fixation. The first part of the treatment, the adjustment of the fragments, is of course only necessary in non-impacted fractures. In impacted fractures no attempt should be made to correct any of the displacements, as the interlocking of the fragments secures the most favorable conditions for bony union to take place. It is not too much to assert that if the impaction in such cases can be maintained until the reparative process is completed, union by callus would be the rule, and non-union the exception. In all intra-capsular fractures, union is effected exclusively by the production of an intermediate callus, from the broken surfaces; nature's splint,

the external or provisional callus, for well-known anatomical reasons, is always wanting, hence the mechanical support which is requisite to maintain uninterrupted coaptation has a more important and prolonged application than in the treatment of fractures in other localities. The time required for bony union to take place in fractures of the femoral neck is an unusually long one. Gurlt fixes the time at from 56 to 207 days, and the average duration at 84 days. Dupuytren estimates the time from 100 to 120 days, and states that it has been customary at the Hôtel-Dieu to keep these patients in bed for 80 to 100 days. There can be no doubt that many cases, which promised well from the beginning, terminated unfavorably from failure on the part of the surgeon to secure efficient means of fixation or by abandoning the treatment too early. An impaction may become disengaged after a few weeks spontaneously or by a slight movement of the patient if the fragments are not immovably fixed by some efficient external mechanical support. To guard against such an occurrence, the retentive measures should not be removed for at least 80 to 100 days. In impacted fractures the fragments have been placed in the best possible condition for bony consolidation, and the object of treatment consists simply in preserving the mutual penetration for a sufficiently long time to obtain restoration of the continuity of the bone. Permanent fixation of an impacted fracture in the position in which it has been placed by the accident is necessary for the following reasons :

1. It prevents disengagement of the fragments.

2. It obviates secondary shortening and eversion during the stage of interstitial absorption which attends inflammatory osteoporosis.

3. By keeping the injured parts at rest, it serves as a prophylactic measure against the accession of arthritis and para-arthritis.

4. It enables the patient to leave the bed any time after the dressing has been applied, and thus guards against decubitus, hypostatic pneumonia, and other affections incident to prolonged confinement in bed.

The advantages arising from immediate reduction and permanent fixation in fractures of the neck of the femur are the following:

(a.) The untorn portions of the joint structures are replaced at once into their normal relations; a procedure which cannot fail to influence favorably the circulation in vessels which may have escaped injury.

(b.) The sharp and irregular margins of the broken surfaces act as irritants to the surrounding soft tissues; immediate reduction, by placing the fractured surfaces at once into mutual coaptation, acts as a preventive agent against the supervention of undue inflammation in and around the hip-joint.

(c.) With coaptation the process of repair is initiated at once, the blood and exudation material between the fragments act as a temporary cement substance, and at the same time serve a useful purpose in re-establishing the interrupted circulation.

(d). Perfect reduction and permanent fixation prevent muscular spasm and diminish pain.

My experimental work convinced me so strongly of the not only possibility, but the probability, of obtaining bony union in cases of intra-capsular fractures, provided the fractured surfaces are kept in uninterrupted contact for a sufficiently long time, that I was led to suggest what justly appeared at the time as heroic measures in securing

this end. It appeared to me impossible in cases where no impaction had taken place to insure sufficient immobilization of the fragments without some direct means of fixation. I suggested at that time the advisability of immobilizing the lower fragment by means of a sharp steel pin, regulated by a set screw passing through the centre of a curved steel bar, incorporated in the plaster-of-Paris splint over the fenestrum, in such a way that the sharp point of the pin would perforate the soft parts over the centre of the great trochanter, and by penetrating a small distance into the bone, could make the necessary lateral pressure and secure perfect immobility of both fragments. As still a more direct means of fixation of both fragments, I advocated that in some cases it would be justifiable to secure transfixtion of both fragments by an ivory or bone nail which was to be driven through a perforation made with a drill, from the outer surface of the great trochanter through the centre of the neck and well into the head of the bone. The result of my experiments convinced me that this means of fixation answered an admirable purpose in placing the fragments in a position where union by callus could take place. The specimens illustrating this treatment demonstrated that such nails, if aseptic, and in aseptic tissues, are completely removed by absorption during the time required for bony union to take place. These suggestions were dictated by an honest conviction that any less direct measures would fail in accomplishing the desired result. It is only natural that this plan of treatment was objected to as being utterly inapplicable in most cases, and too heroic in all. Clinical experience has since satisfied me that these direct measures are unnecessary, and that the same object can be obtained by well regulated

lateral pressure in the direction of the axis of the femoral neck combined with perfect fixation of the lower fragment upon the pelvis. The influence exercised by impaction in determining the ultimate result in fractures within the capsule of the hip-joint, has been repeatedly alluded to. Many fractures of the femoral neck are kept from becoming displaced for a variable period of time, by interlocking of the denticulated broken surfaces, a condition which has been termed by Bigelow "rabbeting." Believing that the surgeon should imitate the reparative resources of nature wherever it is possible to do so, it occurred to me that artificial rabbeting could be produced in all cases by uninterrupted lateral pressure. It is not difficult to conceive that if the fractured surfaces are placed as accurately as possible in apposition, lateral pressure would effect perfect approximation and a mutual interlocking of the fragments. Lateral pressure thus applied is one of the most efficient means in preventing secondary, lateral and longitudinal displacements. Pressure, to be effective, must be applied in the direction of the broken neck, that is, directly over the trochanter major, and in such a manner as not to interfere with the superficial circulation. Pressure with belts and strips of adhesive plaster encircling the whole pelvis, can exert but little, if any, influence on the fractured bone, at the same time it impedes the superficial circulation. In the more recent cases of fracture of the neck of the femur that have come under my observation, I have pursued the following plan of treatment.

The patient is dressed in well-fitting knit drawers and a thin pair of stockings. For strengthening the plaster-of-Paris dressing over the joints, and at other points where greater strength is required oaken shavings are placed

between the layers of plaster, these small thin splints greatly increase the durability of the dressing without adding much to its weight. The bony prominences are protected with cotton before the plaster-of-Paris dressing is applied. The drawers and stockings furnish a more complete and better protection to the skin than roller bandages. Usually about twenty-four plaster-of-Paris bandages are required for a dressing. The fractured limb is first encased in the dressing as far as the middle of the thigh, when the patient is lifted out of bed by two strong persons, the physician supporting the limb so as to prevent disengagement of the fragments if the fracture is impacted, and to guard against additional injuries in non-impacted fractures. The patient is placed in the erect position, standing with his sound leg upon a stool or box about two feet in height; in this position he is supported by a person on each side until the dressing has been applied and the plaster has set. A third person takes care of the fractured limb which is gently supported and immovably held in impacted fractures until permanent fixation has been secured by the dressing. In non-impacted fractures the weight of the fractured limb makes auto-extension which is often quite sufficient to restore the normal length of the limb; if this is not the case, the person who has charge of the limb makes traction until all shortening has been overcome, as far as possible, at the same time holding the limb in a position so that the great toe is on a straight line with the inner margin of the patella and the anterior superior spinous process of the ilium. In applying the plaster-of-Paris bandages over the seat of fracture, a fenestrum, corresponding in size to the dimensions of the compress with which the lateral pressure is to be made, is left open over the great

trochanter. To secure perfect immobility at the seat of fracture, it is not only necessary to include in the dressing the fractured limb and the entire pelvis, but it is absolutely necessary to include the opposite limb as far as the knee, and to extend the dressing as far as the cartilage of the eighth rib. The splint, which is represented by figure 1, is incorporated in the plaster-of-Paris

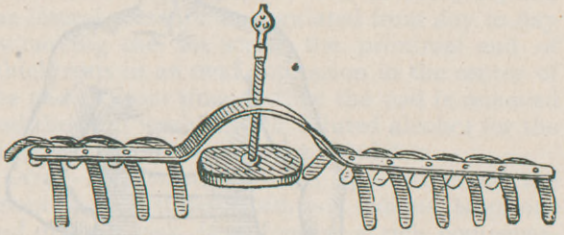

FIGURE 1.

dressing, and must be carefully applied so that the compress composed of a well-cushioned pad, with a stiff unyielding back rests directly upon the trochanter major, and the pressure which is made by a set screw is directed in the axis of the femoral neck. The set screw is projected by a key which is used in regulating the pressure. Lateral pressure is not applied until the plaster has completely set. If the patient is well supported and the fractured limb is held immovably in proper position, but little pain is experienced during the application of the dressing. Syncope should be guarded against by the administration of stimulants. As soon as the plaster has sufficiently hardened to retain the limb in proper position, the patient should be laid upon a smooth, even mattress, without pillows under the head, and in non-impacted fractures the foot is held in a straight position, and extension is kept up until

lateral pressure can be applied. The lateral pressure prevents all possibility of disengagement of the fragments in impacted fractures, and in

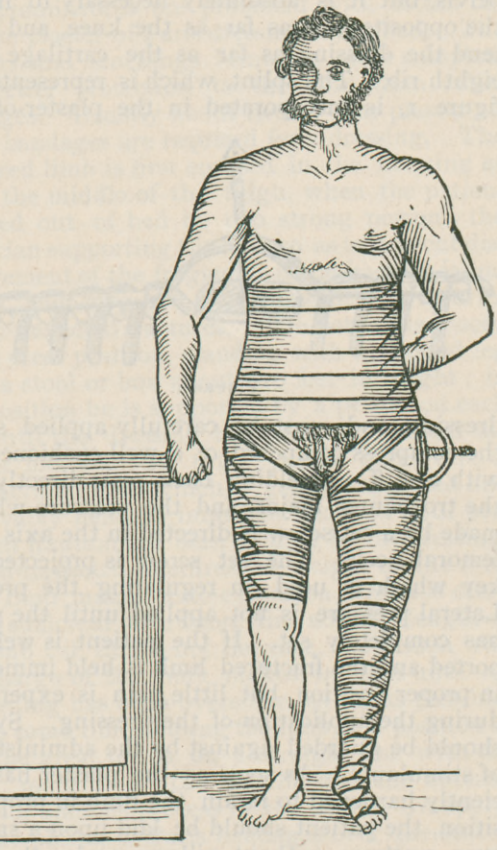

FIGURE 2.

non-impacted fragments it creates a condition resembling impaction by securing accurate appo-

sition and mutual interlocking of the uneven fractured surfaces. No matter how snugly a plaster-of-Paris dressing is applied, as the result of shrinkage in a few days it becomes loose, and without some means of making lateral pressure it would become necessary to change it from time to time in order to render it efficient. But by incorporating a splint, as shown in figure 1, in the plaster dressing (figure 2) this is obviated, and the lateral pressure is regulated from day to day by moving the set screw, the proximal end of which rests in an oval depression in the center of the pad. From time to time the pad is removed and the skin washed with diluted alcohol for the purpose of guarding against decubitus.

After-Treatment. — If the application of the dressing, as just described, is a tedious, laborious and difficult task, it will prove a rich compensation for physician and patient during the after-treatment. I have never found it necessary to apply more than one dressing. If the fracture is properly reduced and the limb fixed in normal position in the dressing, then the only thing that requires watchful attention is the regulation of the lateral pressure. The patient can move himself in bed and can lie on the back, face, and on either side, and can be taken out of bed and, if the weather is favorable, outdoors daily if desirable, without pain or risk of displacement of the fragments. If necessary, a patient in such a dressing could be transported great distances without any immediate or remote risks. The impunity by which the patient can change his position, the benefits to be derived from outdoor fresh air, are advantages which cannot be obtained by any other treatment, and to them must be attributed an important influence in the prevention of a number of the fatal complications which have so often figured as causes of death in patients suffering

from fracture of the femoral neck. If the dressing has been well applied, and more especially if the precaution has been followed to protect the bony prominences with a layer of salicylated cotton, there is little or no danger of the formation of excoriations. At the expiration of eighty to one hundred days, the time required for bony union to take place, the dressing is removed, but the patient should be cautioned not to step on the limb until the end of the fourth or sixth month, when union will be sufficiently firm to sustain the weight of the body. As soon as the dressing is removed passive motion should be made, and the nutrition and function of the limb promoted by massage and, if considerable muscular atrophy is present, the use of the faradic current.

During the last six years the following cases of fracture of the neck of the femur have come under my observation, and were treated by immediate reduction and permanent fixation as detailed in this paper. A number of the cases occurred in the practice of other physicians, and I was only called in to apply the dressing. I desire in this place to express to them my sense of obligation for their permission to use the material in the preparation of this paper.

CASES OF FRACTURE OF THE NECK OF THE FEMUR TREATED BY IMMEDIATE REDUCTION AND PERMANENT FIXATION.

Case 1.—Female, æt. 68, in fair general health, slipped on the sidewalk and fell upon the right hip. The examination made a few hours after the accident revealed a contusion over the trochanter major, some swelling about the region of the hip-joint, limb everted, shortening of 1¼ inch. The displacement of the great trochanter above Roser-Nelaton's line corresponded with the extent of the shortening. No impaction. Crepitus elicited by

the slightest movement of the limb. Anatomical diagnosis: Fracture of the neck of the femur partially within and partially without the capsular ligament. In this case reduction was made by placing the patient upon a pelvic rest and making extension. The limb could be brought down to within ¼ inch of its normal length, and in this position, with the foot in proper line, it was fixed in the plaster-of-Paris dressing, and as soon as the plaster had become firm lateral pressure by means of the pad and set-screw was applied. The patient suffered but little pain at any time, and could roll herself in bed from one side to the other with ease. The dressing was removed after three months, when it was ascertained that bony union had been obtained with ½ inch of shortening and the limb in good position. Passive motion and massage were now made daily and the patient was allowed to walk on crutches. Four months after the accident she was able to walk with the aid of a cane, and three months later she required no further mechanical support. At the end of a year recovery was complete and she could walk nearly as well as before the accident.

Case 2.—Male, æt. 65 years. Patient is somewhat anæmic and presents evidences of senile marasmus. Fell from a ladder a distance of about 6 feet directly upon his left side. No external contusion, and swelling over anterior aspect of hip-joint slight. A number of careful measurements revealed ¾ of an inch of shortening. Foot moderately everted. No impaction. Gentle traction upon the limb and slight rotation produces crepitus. After fractured limb was encased in plaster as far as the knee patient was made to stand with the sound limb upon a stool and was supported on each side by an assistant, while a third person made traction until the shortening was nearly corrected, and with the foot in proper

position the fixation dressing was applied. Lateral pressure was applied the next day and was kept up carefully for eighty-five days, when the dressing was removed. A careful examination showed that bony union had taken place, and that the shortening did not exceed ⅓ of an inch. The patient used crutches for six weeks, later a cane for a few months longer, and at the end of a year he walked well without any support and with only a slight limp.

In this case the symptoms after the accident pointed to a fracture of the neck of the femur involving more of the bone within than without the capsular ligament. Only a slight amount of callus could be found behind the posterior margin of the great trochanter.

Case 3.—Female, 58 years old. Senile marasmus well marked. Patient stumbled and then fell on right side. A few hours after accident the right foot was found everted and the limb shortened ⅔ of an inch. No impaction. Right groin considerably swollen. Trochanter major displaced backwards and upwards. Probable seat of fracture partly within and partly without the capsule. Reduction was effected by auto-extension and traction upon the limb. After the limb was immobilized in the dressing the foot was in normal position and apparently little or no shortening. Fixation and lateral pressure were continued for three months. On removal of the dressing the union was found firm with ½ inch of shortening. Patient used crutches for three months. Stiffness in the hip-joint was only overcome by regular active and passive exercise and massage continued for a long time. At the end of eight months the patient was able to take care of her household, and the function of the limb was nearly restored. Measurements made at this time showed that the shortening had not increased.

Case 4.—Male, 50 years old, prematurely old, the result of intemperate habits. Patient slipped and fell on the doorsteps, fracturing the left femoral neck. Considerable swelling at the seat of fracture. Foot strongly everted, shortening 1¼ inches. No impaction. Trochanter major less prominent than on the opposite side and displaced upwards above Roser-Nélaton's line 1¼ inches. No impaction. On making extension and gently rotating the limb crepitus can be distinctly felt. Reduction and immobilization in the usual manner. The second day the patient had an attack of delirium tremens. During the maniacal excitement he tossed himself in every direction and the nurses were kept busy in preventing him from demolishing the dressing. It was during this attack that the fixation dressing and the lateral pressure gave evidence of their efficiency in maintaining uninterrupted coaptation under the most unfavorable circumstances. Under the use of narcotics the patient became rational and quiet on the third day. The dressing had to be repaired in several places. Subsequently the progress of the case was favorable. The dressing was removed after ninety days, when the fracture was found firmly united with nearly an inch of shortening; considerable callus in front of and behind the trochanter. The patient was soon able to walk around on crutches, but I have been unable to obtain any reliable information as to his condition since.

Case 5.—A female, weighing nearly 200 lbs., was thrown out of a buggy and fell upon her left side. After she recovered from the immediate effects of shock she found that she could not use her left leg. Two physicians who examined the patient soon after the injury suspected a dislocation of the hip, but made no attempts at reduction. When I examined her the next day I found

marked eversion of the foot, and a number of measurements made showed ½ inch of shortening. The great trochanter had been displaced beyond Roser-Nélaton's line to the same extent, and appeared to be less prominent than on the opposite side. No swelling in the groin or posterior aspect of the hip-joint. On gently rotating the limb the great trochanter described a smaller circle than on the opposite side, and the movements affected the head of the femur. Slight traction had no effect in diminishing the shortening. The diagnosis of intracapsular impacted fracture was based upon these symptoms, and every precaution was exercised not to cause disjunction of the fragments during the examination and the application of the dressing. As I was anxious to maintain the impaction during the required time for bony union to take place, the patient was treated in the same manner as in the preceding cases, only that no attempts were made to overcome the shortening or to correct the other displacements. Lateral pressure was applied in a line with the axis of the outer portion of the femoral neck for the purpose of maintaining the impaction during the stage of inflammatory osteoporosis. The dressing was not disturbed for three months, when it was removed and the limb was found in the same position as when it was applied. The shortening had not increased. The patient was cautioned not to use the limb for another three months and to depend in walking entirely on crutches. For a long time the movements in the hip-joint were impaired, undoubtedly the result of a traumatic plastic inflammation of the structures of the joint. Passive motion and massage succeeded in restoring the normal functions of the joint. At no time could any callus be felt, which must be considered as another proof that the fracture was intracapsular. At the end

of a year the patient walked nearly as well as before the accident.

Case 6.—A man, 65 years of age, slipped on an icy sidewalk and fell in such a manner that the right femoral neck was fractured. A few hours after the accident a considerable swelling had formed in the groin. Contusion over the great trochanter; eversion so marked that the outer margin of the foot rested on the mattress. Shortening 1½ inch. No impaction. Crepitus on slightest motion of limb. Diagnosis non-impacted extracapsular fracture of the neck of the femur. Reduction was accomplished by auto-extension and traction on the limb. Fixation by means of plaster-of-Paris dressing and lateral pressure. Patient was relieved of pain as soon as the dressing had been applied and remained in good health during the entire treatment, which was continued for seventy-five days, when the dressing was removed. Bony union with ¾ of an inch of shortening. A large mass of callus on each side of the great trochanter could be distinctly felt. Crutches were used for four months. At the end of a year walked without any support and with only a slight limp.

Case 7.—A strong, healthy blacksmith was thrown from a buggy which was upset by an unruly horse. He fell in such a manner that his full weight came upon the right hip. Immediately after the fall he found that he was unable to use the right leg. He was conveyed in a carriage to his home some three miles distant, and examination two hours later revealed the following: superficial abrasion of skin over the great trochanter; marked eversion of foot. Shortening 1½ inches; tip of trochanter some distance above Roser-Nélaton's line; right femur 17¼, and left femur 17⅛ inches in length. Crepitus on extension and rotation of the limb inwards. New

point of motion at seat of fracture very evident. Pain is referred to point immediately behind the great trochanter. Considerable swelling in the groin and behind the great trochanter. The injury was diagnosticated as an extracapsular non-impacted fracture. Reduction by auto-extension was made on the third day and the fracture immobilized by plaster-of-Paris dressing in which the splint was incorporated for making lateral pressure. Patient suffered but little pain after the dressing was applied. The dressing was not removed for twelve weeks, when a large mass of callus was found behind and in front of the great trochanter, which for quite a long time seemed to impair the movements of the joint. With the disappearance of the callus the functional result improved. The fracture healed by bony consolidation with an inch of shortening. In six months he dispensed entirely with the use of crutches, and with a high sole on right boot to make up for the shortening of the limb he walks with only a very slight limp. In twelve months he was able to attend to his business, even to horse-shoeing, and has since, aside from the slight lameness, suffered no inconvenience from the accident.

Case 8.—An invalid lady, 61 years old, while descending three low steps caught the left heel in the skirt of her dress and fell, striking on the left hip. Examination soon after revealed the following *status præsens:* Dark blue discoloration of skin over the outer and posterior aspect of the great trochanter and from 2 to 3 inches below the hip-joint indicates the point where the fracturing force was applied. Slight eversion of foot. No swelling in groin or posterior aspect of hip-joint. Tip of great trochanter ½ inch above Roser-Nélaton's line. On making measurements from anterior superior spine of the ilium to the internal malleolus no shortening could be detected, but

the apparent discrepancy between the result obtained by these measurements and the Roser-Nélaton's test-line was subsequently explained by the other measurements, which showed asymmetry of the femora, the femur on the injured side being ½ inch longer than its fellow on the opposite side. Left trochanter rotates on a shorter radius of a circle than the right. Pain in the hip increased by pressure over the great trochanter. Patient is able to elevate the limb about 2 feet from the bed, but all such efforts aggravate the pain. The symptoms in this case, as well as the manner in which the injury occurred, pointed directly to an impacted intracapsular fracture of the neck of the femur. In order to secure the benefits of long continued impaction during the process of repair immobilization of the fracture was secured by a plaster-of-Paris dressing and splint for lateral pressure. The general condition of the patient was not impaired by this kind of treatment of the fracture, and when the dressing was removed eight weeks after its application the limb was found in the same position as after the accident. The patient was directed to rely on crutches for a number of weeks and then to use the limb cautiously. At the end of five months she could walk without a cane and with an almost imperceptible limp.

The treatment I have described I recommend for adoption in all cases where there is a reasonable hope that by it a bony union of the fracture will be obtained. It is superfluous to remark that it is not applicable in all cases of fracture of the femoral neck, and is positively contraindicated in cases of extreme obesity and debility, and in patients suffering from concomitant diseases which in themselves would lead to a fatal termination.

CONCLUSIONS.

1. From a scientific, prognostic and practical standpoint it is not necessary to make a distinction between intra- and extra-capsular fractures of the neck of the femur.

2. An impacted fracture of the neck of the femur will unite by bony union, provided the impaction is not disturbed and is maintained by appropriate treatment for a sufficient length of time for the fragments to become united by callus.

3. Impacted fractures of the neck of the femur should be treated by a fixation dressing consisting of a plaster-of-Paris case, including the fractured limb, the pelvis and the opposite limb as far as the knee, in which a splint should be incorporated by which lateral pressure can be secured in the direction of the axis of the broken femoral neck.

4. Unimpacted fractures of the neck of the femur, both intra- and extra-capsular, should be treated by immediate reduction and permanent fixation, so as to place the fragments in the same favorable condition during the process of repair as in impacted fractures.

5. Reduction is effected most readily by auto-extension and traction upon the fractured limb with the patient in the erect position, resting his weight upon the sound limb.

6. The fixation dressing should not be removed and the lateral pressure should not be discontinued for from ten to twelve weeks, the shortest space of time required for bony union to take place.

7. Patients who have sustained a fracture of the neck of the femur should not be allowed to use the fractured limb earlier than four to six months after the accident, for fear of establishing a pseudo-arthrosis at the seat of fracture.

8. The functional result is greatly improved by passive motion, massage, and the use of the faradic current.