AN UNDESCRIBED METHOD
BY WHICH THE
SUPERJACENT WEIGHT OF THE BODY IS TRANSMITTED
IN
UNITED OR UNUNITED FRACTURE OF
THE NECK OF THE FEMUR
THROUGH AN ACQUIRED ILIO-FEMORAL ARTICULATION;
AND THE BEARING OF THE PRINCIPLE INVOLVED UPON THE
SURGERY OF THE HIP-JOINT.

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IN 320 subjects which I have examined I found several instances of fracture of the neck of the femur. In all but three union was complete. I was much struck by the fact that in three out of the small number of these fractures of the neck of the femur which I observed, a very considerable proportion of the superjacent weight of the body was transmitted to the femur by means of a very strong and dense process of bone, which projected from the front of the upper end of the femur, and articulated above by a flattened upper extremity with a corres-

ponding quadrilateral depression situated immediately below the anterior inferior spinous process of the ilium, and encroaching to a varying extent upon this process.

The opposing surfaces of bone, as well as the portions of bone immediately adjacent, were intimately united to one another by dense ligamentous tissue. The amount of pressure which was transmitted through this newly-formed articulation varied considerably in the three cases. In that in which the fragments had not united by bone, almost, if not the whole of the superjacent weight was transmitted through the acquired joint. In the two cases in which the fragments had united by bone the amount of weight transmitted by the head of the femur was considerable, in one case equalling, and in the other possibly exceeding that borne by the accessory articulation.

I have not seen this condition described or mentioned in any surgical work, though its relatively frequent occurrence among the number of fractures observed in the 320 subjects dissected would tend to show that such a condition cannot be very uncommon.

That I have not been able to find an instance of it in the museums is, I think, no argument for or against its rarity.

I will now describe and figure the two most typical examples, commencing with the ununited fracture. This specimen, whose anterior aspect is presented in outline by Fig. 1, was taken from the body of a vigorous woman fifty years old. It was quite apparent from the condition of the muscles of the leg and from the density of the osseous system generally, as well as from that of the fractured femur, and from the eburnation of the opposing surfaces of the fragments, that the injury had taken place many years before the death of the individual; that it had not prevented her from continuing her very hard and laborious work up to the last, and that that heavy work was performed without her having suffered any extreme inconvenience from the presence of an ununited fracture of the neck of her right femur.

I mention this last fact, as it is usually supposed that such a condition altogether unfits the sufferer for leading a hard, laborious, and active life. (I am referring here

FIG. 1.—The dotted lines indicate the extremity of a projection from the front of the neck. This surface articulated with a depression in and beneath the anterior inferior spinous process of the ileum. The head of the femur is not represented in the diagram.

to ununited fractures of the neck of the femur, in which the opposing fragments move freely upon one another, and are not connected by intervening ligamentous tissue.)

As I have just stated, the fractured femur as well as the other bones had undergone no degenerative senile change of any sort, but they were, on the contrary, remarkably strong for a woman at any period of life. The compact layer of bone was particularly thick. In such a subject one would certainly not expect to find a well-marked example of intracapsular fracture of the neck of the femur, using the term *intracapsular* in its usual acceptation.

Sir Astley Cooper¹ observed only two cases of intracapsular fracture of the neck of the femur in people below the age of fifty out of a total of 225 instances of this fracture, and, as I have already shown, the liability to fracture of this portion of the neck of the femur in old

¹ 'On the Dislocations and Fractures of Joints,' 1842.

people is due to the fact that the considerable destruction of the cancellous tissue and the thinning of the compact tissue which ensues in feeble old age in both sexes, but more particularly in women, leaves that portion of the neck immediately beneath the head the weakest portion of the bone,¹ and that the supposed alteration in the direction of the neck, which is said to occur in old age and under other conditions, and which has been regarded by many as an important factor in the causation of intra-capsular fracture, is only apparent, and due to an alteration in the form of the head.

In this case the fracture extended through the neck of the femur in a direction from before backwards, and slightly inwards, so that a portion of the neck about three quarters of an inch long was attached to the head in front, while behind the fracture had reached the margin of the articular surface of the head.

The outer surface of the inner fragment was smooth, and was so shaped that its aspect was plane from above downwards, but somewhat concave from before backwards. The facet on the outer fragment was much longer than the corresponding articular surface on the inner, showing that the movements permitted between these portions of the femur were of an upward and downward character. Consequently when the weight of the body was sustained by the injured limb, the head of the femur must have been depressed very considerably below its normal level. This very great vertical displacement of the head was the only attribute common to the three examples of fractured neck which I am describing, and it would therefore seem that it is one of the chief determining factors in the development of the ilio-femoral joint by means of abundant callus.

The stump formed by the neck of the femur was of considerable length, in fact the neck was but slightly shortened by the injury. This fact alone shows that comparatively little strain was thrown upon the opposing surfaces.

¹ "The Causation and Pathology of the so-called Disease, Rheumatoid Arthritis, and of Senile Changes," 'Trans. Path. Soc.,' 1886.

The head of the femur was firmly fixed to the floor of the acetabulum by dense fibrous tissue, so that it required the exercise of very considerable force by means of an elevator to dislodge it. I have already described¹ the manner in which this ankylosis takes place by means of alteration in the character of the opposing lamellæ of articular cartilage, so I will only refer to it here.

An abundant and irregular mass of bone of very great density projected upwards and inwards from the spiral line and from the front of the neck of the femur, and it presented at its upper and inner extremity a slightly concave quadrilateral facet. Its extent and position are indicated by dotted lines and the numeral I in Fig. 1.

This facet fitted into, and was intimately connected by dense fibrous tissue to, a depression of a similar form in and beneath the anterior inferior spine of the ilium. Strong ligamentous bands also united the anterior inferior spine and the adjacent bone to the margin of the bony outgrowth from the femur.

The bone forming the floor of the articular cavity, which had developed in and beneath the anterior inferior spine, was very dense and strong, and it was obvious from a careful examination of the newly-formed joint that very much the greater part of the superjacent weight of the body was transmitted through it, and but a very small amount through the arthrodial joint which had developed in the neck of the femur.

The second specimen, whose anterior aspect is represented in Fig. 2, was obtained from the body of an old woman which was dissected in Guy's Hospital.

The density of her osseous system and the pressure changes it presented showed that she had for long been actively employed and that her occupation had been tolerably laborious.

She appeared to have sustained an impacted fracture of the neck of the left femur, which injury was probably accompanied by much splitting of the great trochanter.

¹ 'Trans. Path. Soc.,' 1886.

The head and neck had been displaced and driven downwards, so that the upper limit of the head lay an inch and an eighth below the upper extremity of the great trochanter, and instead of the neck being directed inwards, upwards, and forwards, it became directed backwards,

FIG. 2.—The dotted line indicates the surface which articulated with the depression beneath the anterior inferior spinous process.

downwards, and inwards. It is obvious that such an alteration in the direction of the neck would interfere very considerably with the security of the hip-joint and with its capacity for transmitting pressure, especially in certain attitudes.

A somewhat irregular but very dense process of bone projected upwards and slightly inwards from the anterior intertrochanteric line, and ended in two prominences. The outer one terminated in a broad transversely oval facet, whose extent and position are indicated by the dotted lines and the numeral I in Fig. 2. This surface articulated with a correspondingly excavated facet beneath the anterior inferior spine of the ilium, and the opposing bony surfaces were covered by soft fibrous tissue, their margins being firmly connected by a dense

capsule of ligamentous tissue. The internal prominence was pointed, and was connected by ligament to the innominate bone.

It was apparent from the examination of this specimen that a very large proportion of the weight of the body was transmitted through the ilio-femoral articulation, though the proportion was not so great as in the previous instance.

As I said before, I believe that the unusual very considerable downward displacement of the head of the femur, which was present in this as in the other two cases, was the factor which determined the formation of an ilio-femoral articulation in front of the normal hip-joint.

I have described in the 'Guy's Hospital Reports' for 1886 the skeletal changes which are consequent upon a shortening of one limb and upon an excessive compensation of that shortening. In the three cases I have described, the deformity of the trunk which followed on the injury was very slight as compared with that usually present in hardworking people.

In the majority of cases of fracture of the neck of the femur the amount of shortening is usually less than in the three cases which form the subject of this paper, so that in the vast majority of cases the displaced head and neck are still able to perform their normal functions, after they have in many instances been supported by the development of a dense mass of bone below the displaced neck at its junction with the shaft, so that there does not then exist the same necessity for the presence of any accessory joint.

I would now direct particularly the attention of the reader to the immense mechanical advantages which the ilio-femoral articulation affords in cases of fracture of the neck of the femur in which there is much downward displacement of the head of that bone, and these advantages are especially obvious when the fragments move freely upon one another. I would also ask him to consider the

manner in which this newly-developed articulation serves to diminish as much as possible the shortening of the limb both apparently and practically, to render it very much more useful than it would be without the presence of such a powerful joint, and to reduce to a very considerable extent the deformity of the trunk, and particularly the extreme lordosis and unsteady gait which would otherwise ensue on the injury. I believe that the application of the knowledge of this mechanism will enable us to make very considerable strides in the operative surgery of the hip-joint.

Let us take, for example, the operation of excision of the hip-joint. We are all only too familiar with the very unsatisfactory result of the most successful operation and with the comparatively useless condition of the excised limb. Apart from the shortening, what is the chief reason of the practically complete failure of this operation?

I think the cause is perfectly obvious. The divided upper extremity of the femur is left in apposition with the outer aspect of the ilium, to make for itself a most insecure and unsatisfactory connection with that bone in a position in or behind the original vertical plane of the acetabulum. A secure or firm joint is never or hardly ever formed, but there develops instead a new joint which is arthrodial or amphiarthrodial in character, and whose flat articulating surfaces are placed almost vertically. This new articulation, on the security of which the usefulness of the limb depends, allows of a gliding movement between the bones, the upper extremity of the femur rising vertically to a variable extent when the weight of the body is thrown upon the excised limb.

During locomotion the rotation of the pelvis around its antero-posterior and transverse axes is much in excess of that normally present, so that this joint is made to support a strain which is considerably greater than that borne by its healthy fellow. This strain is also thrown upon it at a great mechanical advantage, and in a ver-

tical plane which is anterior to that in which the acquired joint lies, so that everything combines to diminish its security and usefulness. The only obstacle to the upward displacement of the femur is a dense ligamentous capsule or strong intervening interosseous ligament.

It is quite obvious, from a careful examination of the mechanism of this ilio-femoral articulation which developed in the case of ununited fracture of the femoral neck, that if in the operation of excision of the hip-joint the upper extremity of the femur were displaced upwards, forwards, and inwards, and were attached or fixed in position to the anterior inferior spinous process and to the bone immediately beneath it, we would have formed an ilio-femoral articulation which would differ in no way from, and would serve its purpose quite as well, as did that which I described in the ununited fracture in the neck of the femur. That some difficulty might be experienced in uniting the upper extremity of the femur to the innominate bone and in retaining it in position is very possible. I am unfortunately unable to speak from a practical experience upon this point, as I have not recently had an opportunity of applying my suggestion, yet I have not the slightest doubt, with our present facilities of surgical treatment, these difficulties would be readily and effectually met. It is apparent that the mechanical advantages which would be gained by the formation of such an ilio-femoral joint in cases of excision are simply enormous. Instead of the usually very feeble joint which, when unsupported, cannot, except in very rare instances, support the weight of the body, we would have an articulation which would sustain nearly as much strain as the original, which would be accompanied by much less deformity of the trunk both in standing and in walking; and the deficiency in the length of the leg could be readily compensated without increasing the upward displacement of the femur and diminishing still further the usefulness of the joint in connection with that bone.

Other possible applications of this principle suggest

themselves, but the one I have described serves to illustrate it sufficiently well for my purpose.

I have illustrated in the following diagrams the appearances usually presented by united and the various forms of ununited fractures, as the outline indicates pretty plainly the mechanism of each.

FIG. 3.—Ununited fracture of the neck of the femur. The upper extremity of the femur was connected to the innominate bone by a dense fibrous capsule, but the head was not connected to the femur in any way.

Fig. 3 represents a vertical transverse section through an ununited fracture of the femoral neck. The neck had been completely removed by the friction of the fragments upon one another. The head was fixed in the acetabular cavity by the shortened ligamentum teres, and its articulating external aspect was flush with the margin of that cavity. The upper extremity of the femur was rounded and was connected to the innominate bone by a very dense ligamentous capsule, whose upper and back part was very much thicker than the remainder. The conditions present are exactly analogous with those seen in many cases of excision of the hip-joint, the upper and back part of the capsule being the only mechanism by which upward dis-

placement of the femur is obviated. The very unsatisfactory character of such an arrangement is only too apparent.

FIG. 4.—Vertical transverse section of an ununited fracture of neck of femur. The upper extremity of the femur and the outer surface of the head were united by a layer of dense ligamentous tissue. A process of bone projects inwards beneath the head and prevents its depression.

Fig. 4 represents a similar transverse section of an ununited fracture of the neck of the femur in which the fragments were connected by a layer of dense ligamentous tissue, and the downward displacement of the inner fragment was obviated by the presence of a supporting shelf of bone which projected inward from the lower fragment.

FIG. 5.—Transverse vertical section through a united fracture of the neck of the femur. As in the other diagrams the double outline indicates the thickness of the compact layer.

In Fig. 5, which represents a united fracture of the neck, the displaced head and neck are sustained by a mass of callus similar in position and function to that present in Fig. 4.

(For report of the discussion on this paper, see 'Proceedings of the Royal Medical and Chirurgical Society,' New Series, vol. ii, p. 302).