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Contributors

Smith, George K.
Royal College of Surgeons of England

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THE INSERTION

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CAPSULAR LIGAMENT

OF THE

HIP-JOINT,

AND ITS

RELATION TO INTRA-CAPSULAR FRACTURE.



BY

GEO. K. SMITH, M.D.,

DEMONSTRATOR OF ANATOMY IN THE LONG ISLAND COLLEGE HOSPITAL.

*Brooklyn City
New York*

In primis hominis est propria veri inquisitio atque investigatio.

CICERO.

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THE INSERTION

OF THE

APRIL 1871

OF THE

HIP-JOINT



SAMUEL R. KRAVITZ, M.D.

RELATION TO EXTRA-CAPSULAR FRACTURE

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TO

VALENTINE MOTT FRANCIS, M.D.,

AND HIS NOBLE BROTHER,

SAMUEL W. FRANCIS, A.M., M.D.,

WORTHY SONS OF THE LATE

JOHN W. FRANCIS, M.D., LL.D., ETC. ETC.,

This Paper is respectfully Dedicated,

AS A SLIGHT

TRIBUTE TO THEIR STERLING QUALITIES,

AND AN HUMBLE

ACKNOWLEDGMENT OF THEIR GENEROUS KINDNESS TO

THE AUTHOR.

CASE REPORT

AND THE HISTORY OF THE DISEASE

BY

VALENTINE MOTT FRANCIS, M.D.

AND HIS BROTHER

SAMUEL W. FRANCIS, A.M., M.D.

FOURTH EDITION OF THE LATE

JOHN W. FRANCIS, M.D., F.R.C. P.

This Paper is respectfully dedicated

AS A Memento

TO THOSE WHOSE KINDNESS

AND PATRONAGE

MADE IT POSSIBLE FOR US TO PUBLISH THIS

THE AUTHOR

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THE INSERTION OF THE CAPSULAR LIGAMENT OF THE HIP-JOINT,

And its Relation to Intra-Capsular Fracture of the Neck of the Femur.

BY GEO. K. SMITH, M.D.,

Demonstrator of Anatomy in the Long Island College Hospital, Brooklyn, New York.

While listening to the lectures of Professor Hamilton on Fractures and Dislocations, delivered at the Long Island College Hospital, in the spring and summer of 1860, I became very much interested in the study of fracture of the neck of the femur within the capsular ligament; and, after reading considerable on that subject, I was led to wonder why it was that a given specimen, presented as an illustration of bony union after fracture of the neck, should, when viewed by different surgeons of equal merit, give rise to such widely different and conflicting opinions: some regarding it as an example of bony union of intra-capsular fracture; some of union partly without the capsule; while others denied that the bone was ever fractured, and declared that its morbid appearances were characteristic of interstitial absorption. An illustration of this singular fact is seen in a case reported by Professor Mussey, of Cincinnati, in the April number of the *American Journal of Medical Sciences* for the year 1857. Of this specimen, Professor Mussey writes as follows:—

“In the year 1830 I showed this to MM. Roux and Amussat, and some other professional gentlemen, in Paris. They regarded it as a fair specimen of bony union of intra-capsular fracture. In London I also showed it to Mr. Lawrence, Mr. Travers, Mr. Stanley, and Dr. Hodgkin, who was then Curator of the Museum at Guy's Hospital. These gentlemen were interested with the specimen, and considered it as a satisfactory example of bony union within the capsular ligament. On my presenting it for inspection to Sir Astley Cooper, he remarked: ‘This bone was never broken.’ I said, Sir Astley, please to look at the interior of the bone. He separated the two halves, and said: ‘This does look a little more like it, to be sure; but I do not think it is wholly within the capsular ligament.’ At Edinburgh, I showed it to that distinguished surgeon, John Thompson, whose work on inflammation had given him extensive notoriety. On carefully inspecting it, he declared, ‘upon his truth and honor,’ that it had never been broken. An opinion had prevailed for some time among surgeons, that in old persons the head of the thigh-bone is liable to sink below its ordinary level, with more or less shortening of the neck, which occurs in certain morbid conditions without the aid of mechanical violence.

Mr. Thompson regarded this as an instance of that kind of change.”

Dr. Mussey further states that—

“The professional gentlemen of our own country who have examined these specimens, unhesitatingly pronounce this to be a case of union by bone of intra-capsular fracture.”

Some specimens have been presented as proofs of bony union, concerning which the diagnosis of fracture was never clearly made out; and, in these instances, we were not surprised that some should deny that the bone was ever fractured, and that they should regard the morbid appearances of the bone as being characteristic of interstitial absorption of the neck.

I could see no satisfactory reason, however, for the difference of opinion among those who regarded the specimen as an example of bony union; for, if the capsular attachment to the neck be definite and invariable in its location, as described by Wilson and Gray, then it seemed easy to ascertain, by actual measurement, whether the line of union in any specimen be entirely within or partly without the capsule. Here it occurred to me that there might possibly be a variation in the locality of capsular attachment to the neck; and, if so, this fact would account, in a great measure, for the endless contention of surgeons over the possibility of bony union within the capsule. This supposition was materially strengthened by the fact that, in numerous instances, the surgeon, who made the autopsy after union of fracture of the neck, and examined the specimen before the removal of the capsular ligament, was convinced that the fracture was entirely within the capsule; while other surgeons, equally competent to judge of the point at issue, who saw the specimen after the removal of the capsular ligament, were positive that the fracture was partly without the capsule.

Entertaining this suspicion concerning the location of capsular attachment, I determined to ascertain, by actual observation and accurate measurement of numerous specimens of the normal capsule, whether it ever varied in its insertion from the descriptions given by Wilson and

Gray. I had examined but a few specimens before I learned that the line of capsular attachment to the neck was by no means invariable; and so great were its variations, that it seemed almost impossible that the dried bone should, in any instance, furnish positive proof that the fracture had been entirely within the capsule. I reasoned from this fact that, if, in the investigation of the question of bony union, the capsular ligament had been distended and dried with each specimen, the vexed question of osseous union within the capsule would long since have been settled; for, after being dried, and a section made of the bone and its capsule, leaving on one part enough of the capsule to indicate its attachment to the other, the latter might be macerated or boiled, to test the solidity of the union, while the former would ever afterward indicate the locality of the fracture in respect to the attachment of the capsule to the neck of the bone. But even this process leads to error; for, as we shall see hereafter, the capsule of the fractured bone is not only thickened by the inflammatory action which follows the injury, but also lengthened, being in some instances inserted posteriorly into the shaft of the bone, instead of its normal insertion into the neck, which has been removed by absorption.

After finding that scarcely any two capsules, taken from different subjects, were identical in point of attachment to the neck, I consulted other works on anatomy, to see if they agreed with Wilson and Gray in locating the attachment of the capsule.

From these several authors I quote the following:—

“The capsular ligament arises from the dorsum of the acetabulum, incloses the cotyloid ligament as it ascends, but does not adhere to it except at the notch; it is also connected to the inferior spine of the ilium and to the obturator ligament; it is inserted into the base of the neck of the femur, being longer behind and below than in any other situation.”*

To this is added the following note by Prof. Watts, the American editor:—

“This ligament includes the neck of the femur to such an extent that a fracture of the neck within the capsular ligament can and does take place, usually, however, in old subjects. The ligament includes the neck more completely anteriorly, where it extends as far as to the anterior inter-trochanteric line, whereas posteriorly the ligament is lost upon the periosteum, several lines within the posterior inter-trochanteric line.”

“This ligament incloses all the bones from the

edges of the socket to the roots of the trochanters, embracing not only the head, but the neck of the thigh-bone.”*

“It embraces that part of the head of the os femoris which projects above the margin of the acetabulum and descends along the neck to its root. It is longer in front; is fixed there to the oblique line which runs between the two trochanters, and behind into the root of the neck, a little in advance of the posterior oblique ridge.

“Above it is fixed to the neck just below the rough fossa in the trochanter major; and on the under surface of the neck it adheres just above the trochanter minor.”†

“The capsular ligament which contains these articulating parts is the strongest in the body. It arises around the acetabulum near the basis of the cartilaginous brim, but it does not adhere to the cartilaginous edge, and it is inserted into the os femoris near the roots of the trochanters, so that it includes a large portion of the neck of the bone.”‡

“Its inferior circumference is inserted in front into the oblique line leading from one trochanter to the other; but superiorly and behind its fibers are implanted into the neck of the bone within a quarter of an inch of the trochanteric fossa, and about the same distance from the posterior inter-trochanteric line.”§

“The capsular ligament of the hip-joint is the strongest one of the body. It is attached by its upper extremity around the border of the acetabulum inclosing the cotyloid ligament; and by its lower extremity is attached to the anterior inter-trochanteric ridge of the femur, and less strongly to the neck of the latter, just above the posterior inter-trochanteric ridge.”||

“It is inserted superiorly and externally into the root of the neck, internal to the digital fossa of the great trochanter; anteriorly into the anterior inter-trochanteric ridge and into the fore part of the neck above this line; internally and inferiorly it descends near to the root of the lesser trochanter, and is inserted into the neck about a quarter of an inch above the posterior inter-trochanteric ridge.”¶

“Its inferior circumference is inserted in front into the oblique line leading from one trochanter to the other; but superiorly and behind, its fibers are implanted into the neck of the bone within a quarter of an inch of the trochanteric fossa, and about the same distance from the posterior inter-trochanteric line.”**

“The femoral insertion of the capsular ligament requires to be carefully studied, for the purpose of explaining the difference between fractures within, and fractures beyond, the capsule. This insertion is so arranged, that at the upper part

* Bell's Anatomy, vol. i. p. 301.

† Horner's Anatomy, vol. i. p. 295.

‡ Pancoast's Wistar, vol. i. p. 258.

§ Elements of Anatomy, by Jones Quain, p. 273.

¶ Leidy's Anatomy, p. 159.

¶ Harrison's Anatomy, p. 668.

** Sharpey and Quain's Anatomy, p. 278.

and in front of the joint, it corresponds with the base of the neck of the femur, while beneath and behind it is situated at the junction of the external with the two internal thirds of the neck. The insertion of the capsule in front takes place not only at the base of the neck of the femur, but also internally to this base, to the extent of several lines, as may be ascertained by an incision being made along this insertion in the direction of the axis of the neck."*

"It arises round the outside of the brim of the acetabulum, embraces the head of the thigh-bone, and incloses the whole of its cervix as far as the root or outer extremity, round which it is firmly connected."†

"Its lower circumference surrounds the neck of the femur, being attached, in front, to the spiral or anterior inter-trochanteric line; above, to the base of the neck; behind, to the middle of the neck of the bone, about three-quarters of an inch from the posterior inter-trochanteric line."‡

"The capsular ligament arises from the whole circumference of the acetabulum, and passing outwards is inserted into the neck of the femur. In front it is inserted into that line which extends from the greater to the lesser trochanter; posteriorly, it does not extend so far outwards, but is inserted into the neck of the bone about midway between its head and the trochanter major; at its insertion it is incorporated with the periosteum."§

Prof. Alden March, of Albany, in a paper entitled "Osseous Union of Intra-capsular Fracture of the Neck of the Femur," published in the Transactions of the Medical Society of the State of New York for the year 1858, has questioned the authority of Wilson's Anatomy in locating the insertion of the capsule, and gives his opinion as follows:—

"It is a matter of some importance to define accurately the attachments and extent of the capsule. For the question of deciding whether a given fracture be altogether within, or partly within and partly without, the capsular ligament, will often depend upon the *precise point* of location of its attachments.

"The ligamentous capsule embraces, or is attached to the margin of the *acetabulum* superiorly, and inferiorly and anteriorly to the inter-trochanteric line, superiorly and posteriorly to the neck of the bone just within the *trochanteric* or *digital fossa*, and within the posterior *inter-trochanteric line*, or lip of bone extending from the *trochanter major* to the *trochanter minor*.

"Wilson says the capsule 'extends further upon the neck of the femur on the *anterior* and *superior*, than on the *posterior* and *inferior* side, being attached to the inter-trochanteric line in front, to the base of the great trochanter above, and to the middle of the neck of the femur behind.'

"Judging from a number of specimens I have examined, and from those herewith submitted for inspection, it would appear that the capsule is not attached 'to the middle of the neck of the femur behind,' as above quoted from Wilson's System of Anatomy. If the capsule were attached to the *middle of the neck*, then, indeed, we apprehend it would seldom happen that we should meet with fracture altogether within it.

"The capsular ligament is firmly attached to the os innominatum. Passing in various directions, according to their several situations, the fibers run to be inserted into the base of the neck of the femur, anteriorly into the anterior inter-trochanteric line, superiorly and externally into the surface of the bone close to the digital fossa at the root of the great trochanter, inferiorly and internally to the line leading from the lesser trochanter to the anterior inter-trochanteric line, and posteriorly it is partly reflected upwards, so as to become continuous with the periosteum of the posterior part of the neck of the bone; this reflection taking place along the posterior inter-trochanteric line, and partly inserted into that line, especially at its internal and external extremities."*

"The capsular ligament represents a kind of shut sac, which is attached, on the one hand, to the periphery of the cotyloid cavity, and on the other, to the prominent lines which extend, in front and behind, from one trochanter to the other, thus including both the head and neck of the bone. It descends further down on the anterior than on the posterior surface of the neck, and is thicker and stronger above and behind than in any other portion of its extent."†

It will be observed, in this connection, that, notwithstanding the extreme diversity among our authors in describing the *precise location* of the insertion of the capsule, not a single one, even, intimates that it ever varies from the position which he has assigned to it. All agree in locating the insertion of the capsule in front, at the anterior inter-trochanteric line, with the exception of Cruveilhier and Harrison, who state that it is also inserted into the anterior surface of the neck to the extent of several lines internal to the anterior inter-trochanteric line. Concerning its insertion into the posterior surface of the neck, great differences of opinion exist. Some locate it at the middle of the posterior surface of the neck; some at the posterior inter-trochanteric line; and others at all points intermediate between these two extremes. From this we see that he who has a specimen representing union at any point between the head of the bone and the inter-trochanteric lines, can find authority among anatomists for believing it to be union of intra-capsular

* Cruveilhier's Anatomy, American edition, p. 160.

† Fyfe's Anatomy, vol. i. p. 359.

‡ Gray's Anatomy, p. 170.

§ Cooper on Dislocations and Fractures, American ed., p. 73.

* Cyclopædia of Anatomy and Physiology, by Robert B. Todd, M.D., F.R.S., vol. ii. p. 778.

† Gross's System of Surgery, vol. ii. page 230.

fracture. Sir Astley Cooper located its insertion at the middle of the posterior surface of the neck, and regarded, as examples of union partly without the capsule, all those specimens in which the line of union on the posterior surface of the neck was found to be nearer the shaft of the bone than the middle of the neck; hence we see the reason why those who located the insertion of the capsule at the posterior inter-trochanteric line should deny the authority of Sir Astley, and regard all such specimens as genuine examples of union within the capsule.

The following is a table showing the insertion of the normal capsule in sixty-one specimens, accurate measurements of which have been taken. Different methods have been adopted in order to arrive at a definite knowledge of the insertion of the capsule. The entire hip-joint has, in many instances, been removed, and its capsule either distended with air, by the blow-pipe, or injected with plaster of Paris, and then allowed to dry before measurements were taken. Other specimens have, in the recent state, been measured after the disarticulation of the joint. For the opportunity of measuring many of these specimens, I am indebted to the kindness of my friend Charles J. Seymour, a student of the New York "University Medical College," who obtained the specimens and kept them for me till I could measure them.

The results obtained by the injection of the capsule with plaster were more satisfactory than those in which it was distended with air; for, after the plaster had hardened, I was enabled to dissect up the external fibers of the capsule, which have their insertion into the anterior inter-tro-

chanteric line, and leave that portion of the capsule which is reflected upward on the neck, forming its periosteum; thus showing the extent of the cavity lined by the synovial membrane, and illustrating the fact that a fracture of the neck may, in some instances, be extra-capsular and yet be situated some distance within the anterior inter-trochanteric line. (See figure 1.) The capsule being much thinner on the posterior surface of the neck than on the anterior, requires no dissection to show the extent of its cavity after it is filled with the plaster injection.

I have in my possession a large collection of specimens showing the insertion of the normal capsule, but few of which are represented by the engravings. Many more might be given, if it were necessary. Those of which delineations are given illustrate very well the facts which all unite to prove. The drawings from which the engravings were copied are accurate representations of the specimens, taken by my friend Constantin Herzberg, a distinguished artist now teaching at the Cooper Union in the City of New York, also at the Polytechnic Institute of this city. The points from which measurements were taken in making out the following table may be seen in figures 3 and 4. The length of the neck was obtained by measuring from the points given in the inter-trochanteric lines to those situated on the corona or cartilaginous edge of the head. The insertion of the capsule was ascertained by measuring: first, from the points in the inter-trochanteric lines to the insertion of the capsule in the direction of the axis of the neck; and second, from the points on the corona to capsular insertion.

No.		Length of the neck, showing on its anterior surface the distance from A to B, and C to D, respectively; also showing in like manner on the posterior and inferior surfaces of the neck, the distances from A to B, C to D, and E to F. (See figs. 3 and 4.)		Distances from the inter-trochanteric lines to the insertion of the capsule. The measurements on the anterior surface of the neck were taken from the points A and C, respectively; and those on the posterior surface were taken in the same order from the points A, C, and E. (See figs. 3 and 4.)		Distances from the corona or cartilaginous edge of the head, to the insertion of the capsule. The measurements on the anterior surface of the neck were taken from the points B and D, respectively; and those on the posterior surface were taken from the points B, D, and F, in the same order. (See figs. 3 and 4.)	
		Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
1	{	Anterior.....	1 $\frac{1}{4}$	1 $\frac{1}{2}$	1 $\frac{1}{4}$	1 $\frac{1}{2}$	1
		Posterior.....	2.....	2 $\frac{1}{4}$	2 $\frac{1}{2}$	1 $\frac{3}{4}$	2 $\frac{1}{4}$
2	{	Anterior.....	1 $\frac{1}{4}$	1 $\frac{3}{4}$	1 $\frac{1}{4}$	1 $\frac{1}{2}$	1 $\frac{1}{4}$
		Posterior.....	1 $\frac{1}{2}$	1 $\frac{3}{8}$	1 $\frac{7}{8}$	1 $\frac{1}{4}$	1 $\frac{1}{8}$
3 & 4	{	Anterior.....	1.....	1 $\frac{1}{4}$	1.....	1 $\frac{1}{2}$	1
		Posterior.....	1 $\frac{1}{2}$	1 $\frac{3}{4}$	1 $\frac{7}{8}$	1.....	1 $\frac{1}{8}$
5 & 6	{	Anterior.....	1.....	1 $\frac{1}{2}$	1.....	1 $\frac{1}{2}$	1
		Posterior.....	1 $\frac{1}{2}$	1.....	1 $\frac{7}{8}$	1.....	1 $\frac{1}{2}$
	{	Anterior.....	1.....	1	1.....	1 $\frac{1}{2}$	1
		Posterior.....	1 $\frac{1}{2}$	1.....	1 $\frac{7}{8}$	1.....	1 $\frac{1}{2}$

Length of the neck, showing on its anterior surface the distances from A to B, and C to D, respectively; also showing in like manner on the posterior and inferior surfaces of the neck, the distances from A to B, C to D, and E to F. (See figs. 3 and 4.)

Distances from the inter-trochanteric lines to the insertion of the capsule. The measurements on the anterior surface of the neck were taken from the points A and C, respectively; and those on the posterior surface were taken in the same order from the points A, C, and E. (See figs. 3 and 4.)

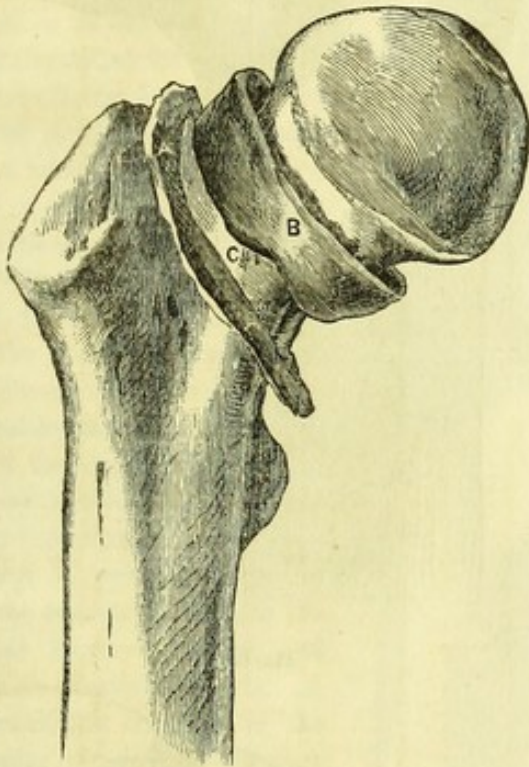
Distances from the corona or cartilaginous edge of the head, to the insertion of the capsule. The measurements on the anterior surface of the neck were taken from the points B and D, respectively; and those on the posterior surface were taken from the points B, D, and F, in the same order. (See figs. 3 and 4.)

No. 7 & 8	Anterior.....	1.....13	1.....1	1.....1
	Posterior.....	1.....2.....21	1.....1.....1 $\frac{1}{2}$	1.....1
" 9 & 10	Anterior.....	1.....1	1.....1.....1 $\frac{1}{2}$	1.....1
	Posterior.....	1.....2.....21	1.....1.....1 $\frac{1}{2}$	1.....1
" 11 & 12	Anterior.....	1.....1.....1 $\frac{1}{2}$	1.....1.....1	1.....1
	Posterior.....	1.....1.....1 $\frac{1}{2}$	1.....1.....1	1.....1
" 13 & 14	Anterior.....	1.....1.....1	1.....1.....1	1.....1
	Posterior.....	1.....2.....2	1.....1.....1 $\frac{1}{4}$	1.....1.....1
" 15 & 16	Anterior.....	1.....1.....1	1.....1.....1	1.....1
	Posterior.....	1.....2.....2	1.....1.....1 $\frac{1}{4}$	1.....1.....1
" 17 & 18	Anterior.....	1.....1.....1	1.....1.....1	1.....1
	Posterior.....	1.....1.....1 $\frac{1}{2}$	1.....1.....1	1.....1
" 19 & 20	Anterior.....	1.....1.....1	1.....1.....1	1.....1
	Posterior.....	1.....2.....2	1.....1.....1	1.....1
" 21	Anterior.....	1.....1.....1	1.....1.....1	1.....1
	Posterior.....	1.....2.....21	1.....1.....1 $\frac{1}{4}$	1.....1.....1
" 22	Anterior.....	1.....1.....1	1.....1.....1	1.....1
	Posterior.....	1.....2.....21	1.....1.....1 $\frac{1}{4}$	1.....1.....1
" 23 & 24	Anterior.....	1.....1.....1	1.....1.....1	1.....1
	Posterior.....	2.....2.....2 $\frac{1}{2}$	1.....1.....1 $\frac{1}{2}$	1.....1.....1
" 25	Anterior.....	1.....1.....1	1.....1.....1	1.....1
	Posterior.....	1.....1.....1 $\frac{1}{2}$	1.....1.....1	1.....1
" 26	Anterior.....	1.....1.....1	1.....1.....1	1.....1
	Posterior.....	1.....1.....1 $\frac{1}{2}$	1.....1.....1	1.....1
" 27	Anterior.....	1.....1.....1	1.....1.....1	1.....1
	Posterior.....	1.....1.....21	1.....1.....1 $\frac{1}{2}$	1.....1.....1
" 28 & 29	Anterior.....	1.....1.....1	1.....1.....1	1.....1
	Posterior.....	1.....2.....2	1.....1.....1 $\frac{1}{4}$	1.....1.....1
" 30 & 31	Anterior.....	1.....1.....1	1.....1.....1	1.....1
	Posterior.....	1.....2.....2	1.....1.....1 $\frac{1}{2}$	1.....1.....1
" 32 & 33	Anterior.....	1.....1.....1 $\frac{1}{2}$	1.....1.....1	1.....1
	Posterior.....	1.....1.....1 $\frac{1}{2}$	1.....1.....1	1.....1
" 34 & 35	Anterior.....	1.....1.....1 $\frac{1}{2}$	1.....1.....1	1.....1
	Posterior.....	1.....1.....1 $\frac{1}{2}$	1.....1.....1	1.....1

verse section of the capsule was made near the edge of the cotyloid cavity, leaving the capsule attached to the neck of the bone to show its insertion. The exact location of capsular insertion, in each of the following specimens, may be found by referring to the table.

Figure 1 represents the anterior view of specimen number 1. A A exhibit the superficial

FIG. 1.



fibers of the capsule dissected loose from the deeper fibers, and reflected outward to show their insertion into the anterior inter-trochanteric line. B represents the deeper fibers of the capsule which are reflected upward on the neck, limiting the extent of the cavity lined by the synovial membrane. C is a space internal to the inter-trochanteric line, through which a fracture may occur, and yet be extra-capsular according to the following definition of an intra-capsular fracture given by Malgaigne.

"This name is given to fractures dividing the cervix within the limits of the synovial membrane, so that if this membrane were divided at the same level, the fracture would communicate at once with the joint."*

Figure 2 is a view of the posterior surface of specimen number 1, showing the insertion of its capsular ligaments.

Figure 3, anterior view of specimen number 2. The dark ridge represents the anterior inter-trochanteric line. The external fibers of the capsule which have their insertion into the inter-trochanteric line have been removed by dissection, leaving that portion of the capsule which, by its reflection upward on the neck, limits the extent of the cavity of the joint.

FIG. 2.



The points indicated by the letters A B C and D, figure 3, are those from which the measurements on the anterior surface of the neck were taken in making out the preceding table. A is situated in the center of the inter-trochanteric line, at the base of the great trochanter. B is on the cartilaginous edge of the head. C is in the center of the inter-trochanteric line at the point at which the line crosses the internal angle of the shaft of the bone; and D is on the cartilaginous edge of the head. The length of the neck, on its anterior surface, was obtained by measuring—1st, from A to B; and 2d, from C to D, figure 3. The location of capsular insertion was determined by measuring—1st, from the points A and C, to insertion of capsule; and 2d, from B and D to capsular insertion.

Figure 4 exhibits the points from which measurements were taken on the posterior surface of the bone. A is situated in the center of the posterior inter-trochanteric line, at the base of the

* Malgaigne on Fractures. American edition, p. 530.

FIG. 3.

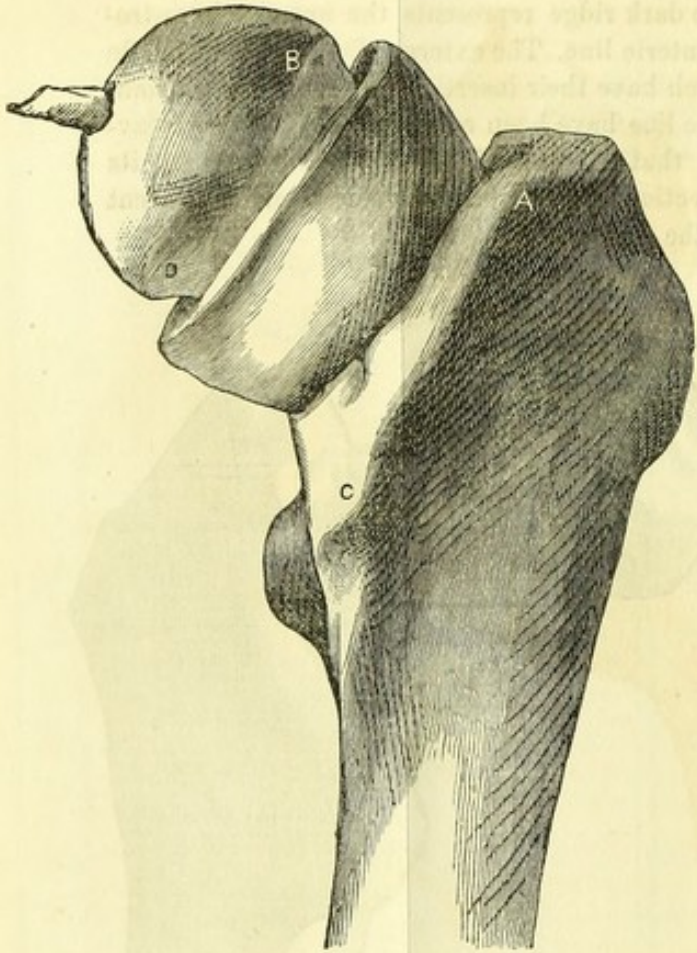


FIG. 5.

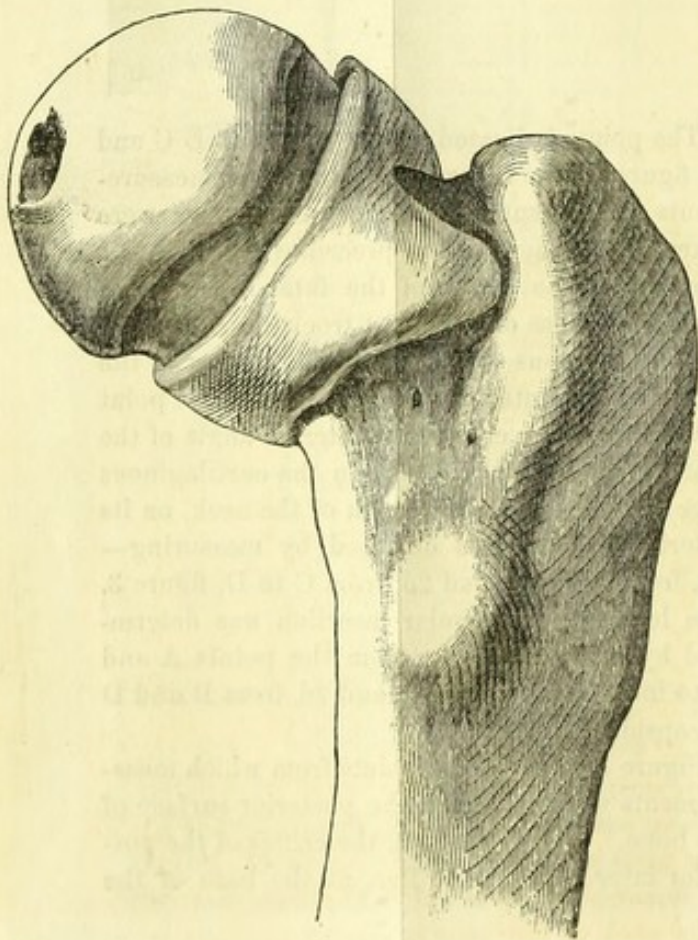


FIG. 4.

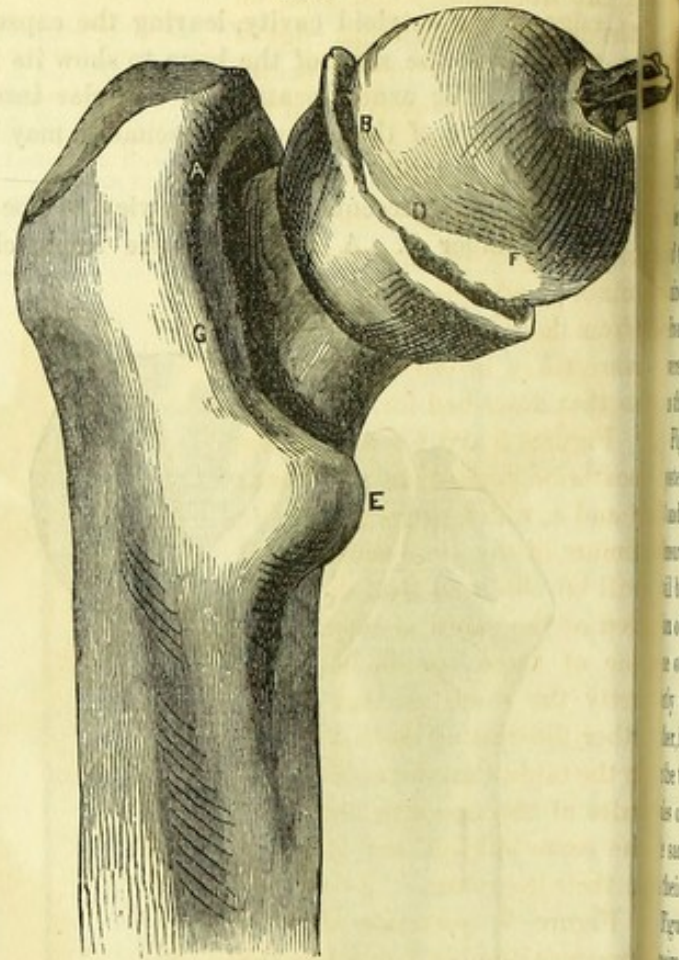
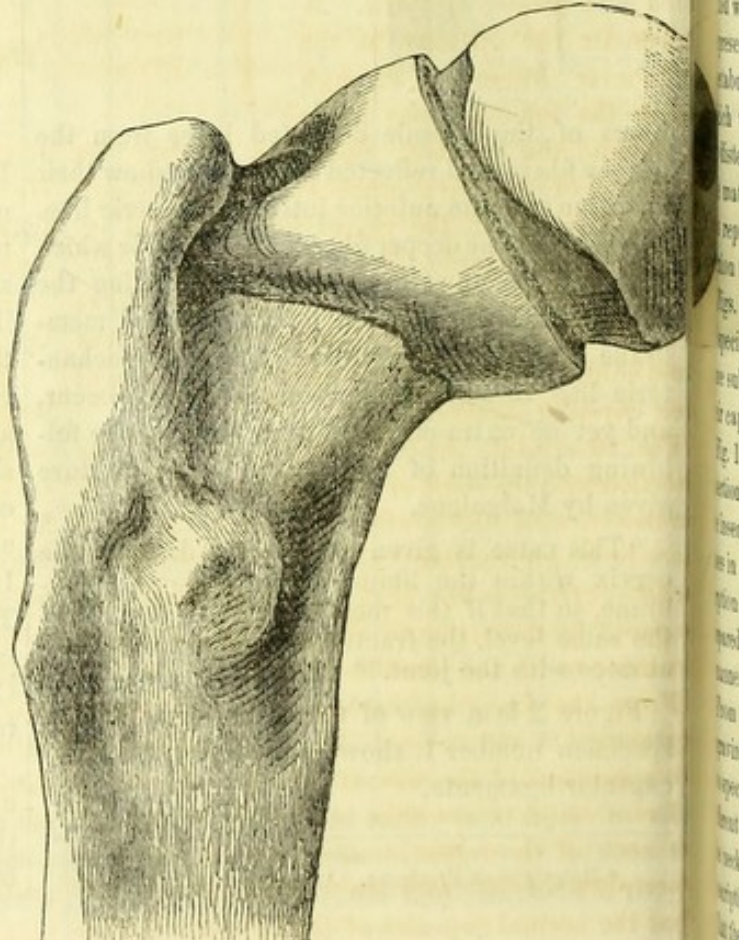


FIG. 6.



great trochanter; and B is on the corona cartilaginous edge of the head. C is in the center of the line midway between the point A and the apex of the trochanter minor; and D is on the corona. E is at the center of the apex of the trochanter minor; and F is on the corona. From these points measurements were taken in the same manner as that described for figure 3.

Figures 5 and 6 represent the posterior surfaces of specimens 3 and 4, which are the opposite femurs of the same subject. It will be observed that the insertion of the capsular ligament of one of these specimens is exactly the same as that of the other, illustrating the fact shown in the table, that the normal capsules of the opposite femurs of the same subject are identical in their insertion.

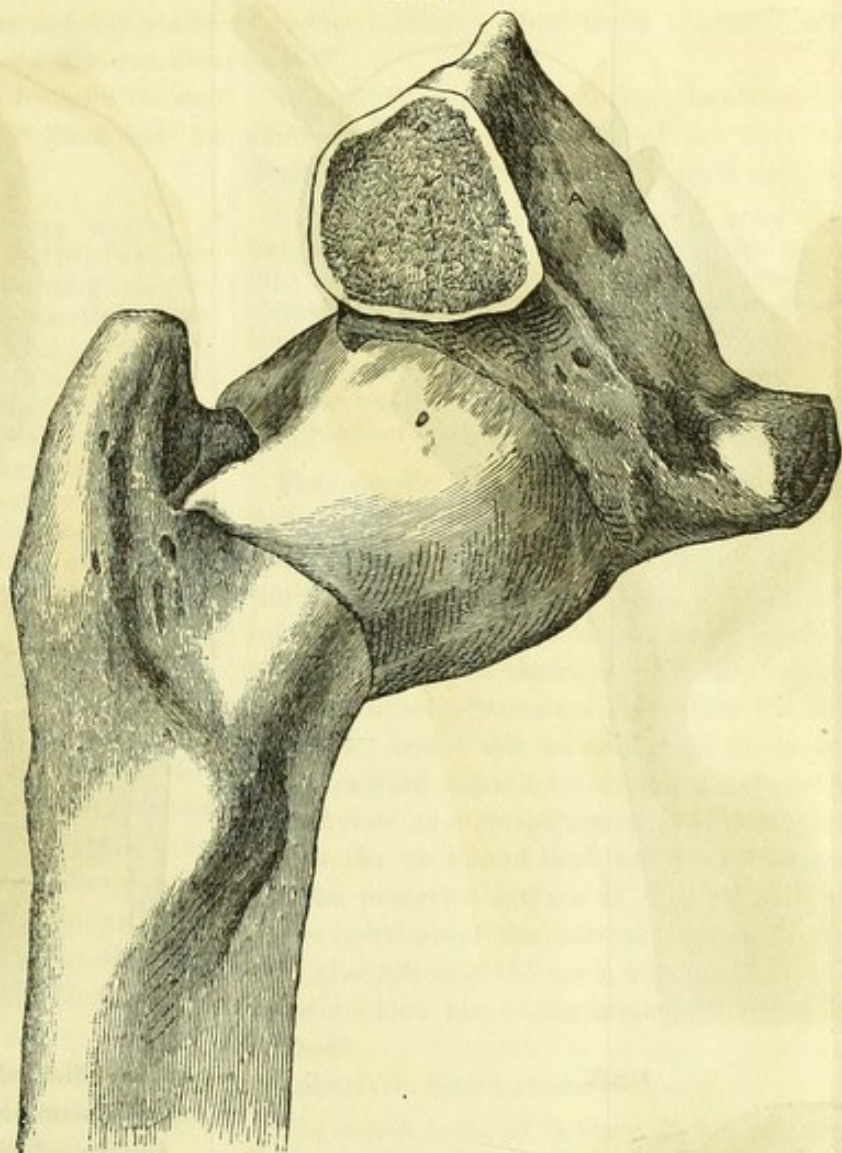
Figure 7, posterior view of specimen number 5, exhibits the capsular ligament entire, and filled with plaster of Paris. A represents the opening in the acetabular fragment through which the injection was made to distend the capsule. Specimen number 5 is the mate of specimen number 6, which, though not represented in the plates, has the same insertion for its capsule. (See table.)

Figs. 8 and 9 represent the posterior surfaces of specimens 7 and 8, which were taken from the same subject, and are identical in the insertion of their capsular ligaments.

Fig. 10 exhibits the capsular ligament with its insertion into the shaft of the bone, and illustrates the insertion of the morbid capsule in all those cases in which fracture has been followed by absorption of the entire neck. The specimen was prepared by dissection of the normal capsule in a manner to be described hereafter.

From the foregoing table and its illustrative engravings, it will be seen: 1st. That scarce any two specimens of the normal capsule, taken from different subjects, are alike in their insertion into the neck of the bone; consequently no definite description of its insertion can be given. 2d. That the normal capsules of the opposite femurs

FIG. 7.



of the same subject are alike in their insertion. Having measured twenty-four pairs, I have yet to see a single variation from this rule. Moreover, it is just what we must expect to find, in obedience to that law of symmetrical conformation which pervades the animal economy.

These facts are of great importance in the settlement of the question of bony union within the capsule; for, since the injured bone and its capsule often furnish little or no evidence of the exact location of the fracture, on account of the changes they have undergone since the injury, we are obliged to look elsewhere for facts to determine whether the given specimen be an example of fracture entirely within the normal capsule. This cannot be determined by comparing the specimen with the normal capsule taken from a different subject, since no two capsules taken from different subjects are alike; but may be ascertained by comparing it with the normal capsule of the opposite femur of the same subject, whose insertion into the neck of the bone is exactly the same as

Fig. 8.

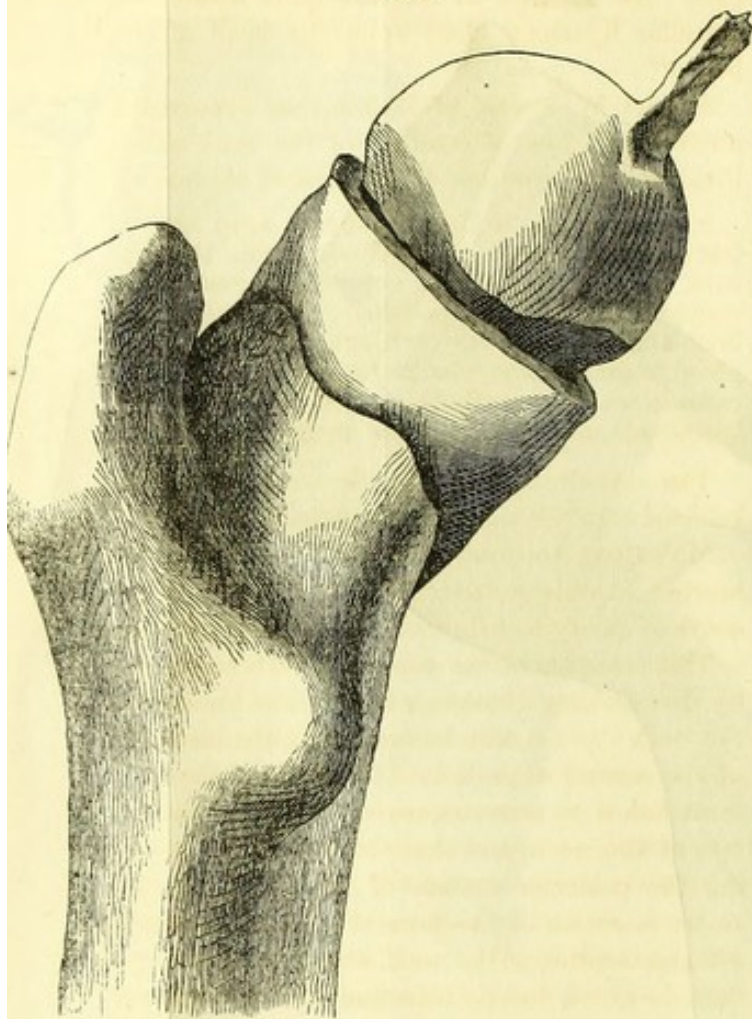


Fig. 9.

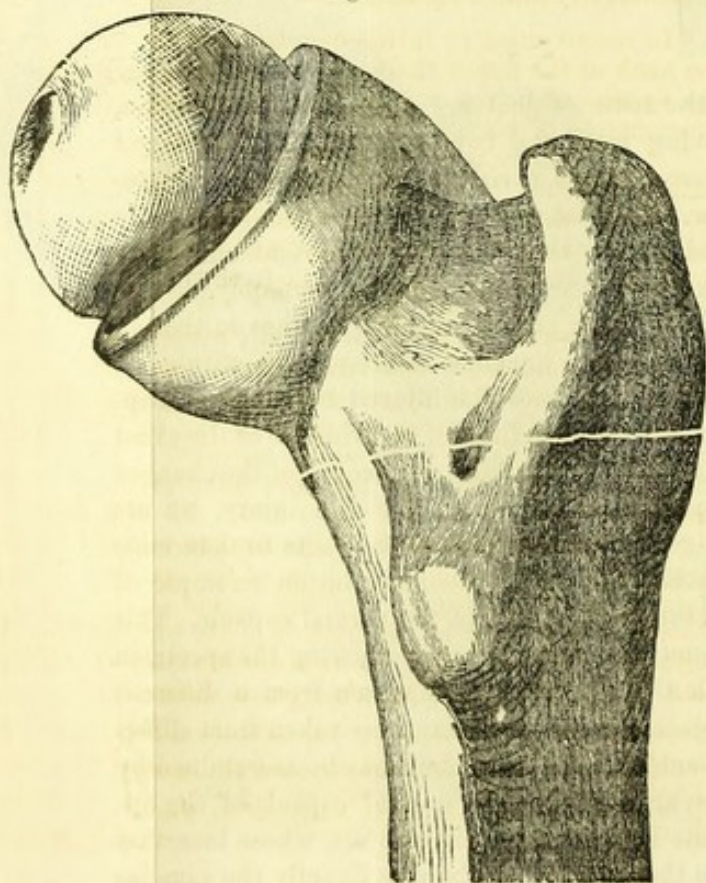
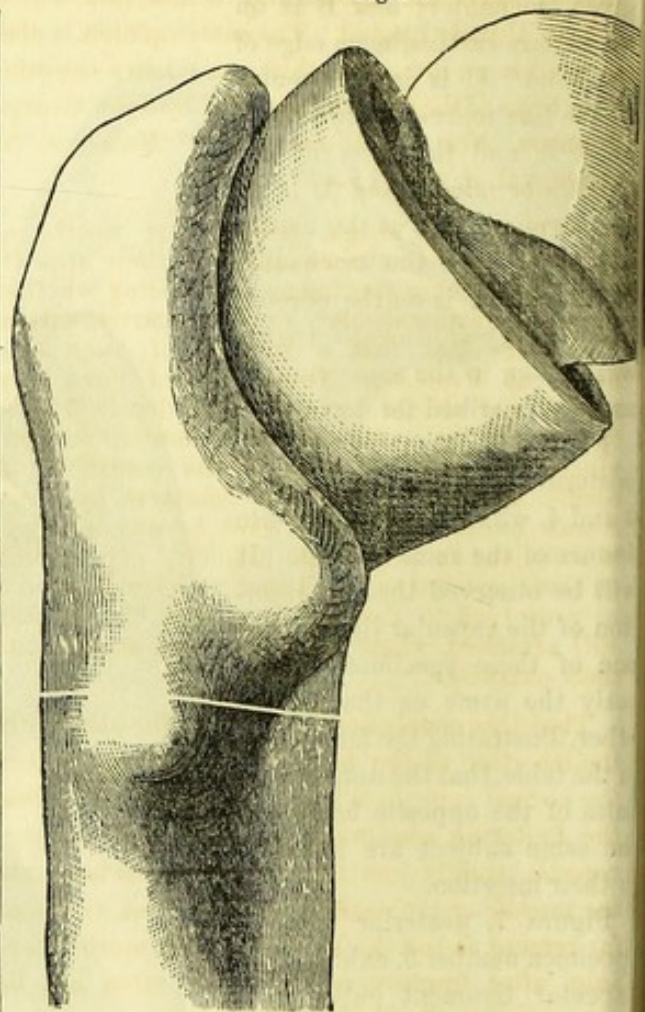


Fig. 10.



the insertion of the capsule into the neck of the injured bone previous to the fracture.

Before entering upon a review of the specimen presented as proofs of bony union of intra-capsular fracture, I propose to consider briefly some of the pathological changes which follow the injury, and particularly the effect of these changes in removing the insertion of the normal capsule since some surgeons who have written on the subject have regarded the insertion of the capsule of the morbid specimen as being identical with the insertion of the normal capsule, and have considered as examples of union of intra-capsular fracture all specimens in which the line of union was included by the morbid capsule. Thus, Professor March has questioned the authority of Wilson's Anatomy in locating the attachment of the capsule at the middle of the posterior surface of the neck, and cites, as proof to the contrary, the appearance of the dried capsule attached to one of his specimens representing union after fracture of the neck. The engraving of this specimen represents the capsule as being inserted into the neck of the bone just within the posterior inter-trochanteric line, and corresponds with the

description of the capsule and its insertion, which I have already quoted. The same opinion is also noticed in an inaugural thesis on "Intra-capsular Fractures of the Cervix Femoris," by John George Johnson, *New York Journal of Medicine*, 3d series, vol. ii. p. 321:—

"There is a single point more worthy of notice; it is the extreme difficulty there appears to be in all these specimens, of deciding whether they are intra-capsular, or only partly within. The mere fact that a surgeon of such eminence as Professor Mussey should have been misled and should have been so deceived as to take a specimen across the Atlantic, to convince Sir Astley Cooper of the possibility of ossific union of intra-capsular fractures, by whom it was conclusively shown that he was in error, is sufficient to prove the difficulty of deciding on these specimens. All such specimens should be preserved in the wet state, with the capsule still attached, when there could be no doubt of their character."

That this conclusion concerning the identity of the insertion of the morbid capsule with that of the normal capsule is incorrect, will be seen from the following observations: First, the *normal capsule* usually has its posterior insertion into the *middle of the neck* of the bone, and NEVER as far remote as the shaft. Second, the morbid capsule, after fracture of the neck, often has its insertion into the shaft of the bone.

Two instances of this attachment of the morbid capsule are reported by Dr. John C. Warren, of Boston. He states that in the first—

"The principal object of attention was the hip. On cutting into this articulation, the head of the os femoris was found to be fixed in its socket, being ankylosed throughout with the os innominatum. The neck of the bone had disappeared. The shaft had been drawn up an inch and a half higher than the head, and on the surface corresponding with the ankylosed head a regular, smooth, articulating surface was formed, which was mostly surrounded by an adventitious capsule, shorter and more closely embracing the bone than the normal capsule."

In the second:—

"The muscles about the thigh were thin and wasted, the capsular ligament was thickened, but regular on the outside. On cutting into the articulation, there was no appearance of recent inflammation; the neck of the thigh-bone was absorbed."

The engraving of this specimen shows the neck entirely absorbed, the capsular ligament inserted into the shaft of the bone, and the head of the bone united to the shaft. This Dr. Warren

calls "An instance of fracture quite within the capsular ligament, close upon the head of the bone."*

Robert W. Smith, of Dublin, has reported a number of cases of fracture of the neck which illustrate this insertion of the morbid capsule:—

"Case XXV. Robert Donovan, aged eighty, fracture of the neck of the femur within the capsule. The surface of the superior fragment was concave, smooth, and polished; the neck of the bone absorbed, and the cartilage of the head atrophied, and in some places totally removed; the capsule was unusually thickened, and organized lymph adhered to its internal surface."†

The capsule is shown in the engraving to be inserted into the shaft of the bone.

Malgaigne records an instance in which the morbid capsule extended "from the edge of the cotyloid cavity to below the lesser trochanter."‡

This insertion of the capsule is fully explained by the resulting changes which follow fracture of the neck; and it will be seen that the insertion of the morbid capsule into the shaft of the bone must follow, as a consequence, the entire absorption of the neck, and that the periosteum covering the posterior surface of the neck external to the insertion of the normal capsule becomes, after absorption of the neck, a part of the morbid capsule which has its insertion into the shaft of the bone.

Robert W. Smith states that—

"In recent cases of intra-capsular fractures of the neck of the femur there are but few phenomena worthy of notice revealed by the anatomical examination of the joint.

* * * "There is generally observed a preternatural amount of vascularity of the synovial membrane, and in some cases a small quantity of blood is found within the capsule, and sometimes coagulable lymph is seen adherent to the internal surface of the capsular ligament. * *

"The capsular ligament is usually greatly increased in thickness, and occasionally osseous matter is deposited in its structure.

* * * "In general, the head of the femur preserves its globular form, and is movable in its socket; but sometimes it becomes adherent to the acetabulum.

"The superior fragment of the broken cervix disappears to the level of the brim of the acetabulum, either in consequence of the action of the absorbent vessels, or by the friction of the broken surfaces, or perhaps it is due to a combination of both these causes. The absorption, however,

* Cooper on Dislocations and Fractures, Amer. edit., p. 199.

† Smith on Fractures, p. 82. See also Case V. p. 59.

‡ Description of Plate No. XII., Malgaigne on Fractures, Fig. 67.

sometimes extends much further; I have seen half of the globular head of the bone thus removed, and a case has been recorded in which the head of the bone was completely absorbed. In old cases the femoral fragment is likewise absorbed to a greater or less extent; sometimes it disappears entirely to its base, and the portion of the shaft from which in the normal state it springs, presents a smooth and even surface, limited by the trochanters and their connecting lines."*

When fracture occurs entirely within the capsule and is followed by absorption of the neck, the process of absorption soon reaches that point on the posterior surface of the neck to which the capsule is attached. At this point the capsule is not only inserted into the bone, but also blended with the periosteum which covers the neck external to this point. If the progress of absorption continue, that portion of the neck to which the capsule is attached is soon removed, and the capsule is left, having no other insertion than its connection with the periosteum.

If the whole of the neck be removed in this manner, the periosteum covering it is loosened, thickened by fibrous deposit, and constitutes, by its connection with the normal capsule, a part of the morbid capsule which now has its insertion into the shaft of the bone. If now the fragments be approximated and union occur, we shall have extra-capsular union of intra-capsular fracture, and yet the line of union will be included within the morbid capsule.

It is highly probable that intra-capsular fracture is sometimes followed by union without the capsule, in this manner; but this, if it ever does occur, can never be proven, since the diagnosis of intra-capsular fracture cannot be made with positive certainty during the life of the patient; and it is impossible, after absorption of the neck, to tell at what point the neck was broken. I have succeeded, by dissection of the normal capsule, in illustrating the insertion of the morbid capsule into the shaft of the bone, as seen after removal of the entire neck by absorption. (See Fig. 10.) In the dissection I commenced just within the normal capsule, and, cutting through that portion of the capsule which is reflected upward on the neck of the bone, dissected the capsule loose from its insertion into the neck, leaving it attached to the periosteum covering the neck external to this point. Continuing my dissection outward to the shaft of the bone, I raised the

periosteum, which by its connection with the normal capsule exhibits a lengthened capsule inserted into the shaft of the bone.

Numerous specimens have been exhibited, both in this country and in Europe, as illustrations of bony union of intra-capsular fracture, yet but few if any of these furnish positive evidence that this desirable result has ever been obtained. Of the specimens found in European museums, Robert W. Smith recognizes seven, while Malgaigne admits but three, and Sir Astley Cooper only one. The number of specimens in this country, for which this honor is claimed, is quite equal to the number recognized by Robert William Smith. Of these, Reuben D. Mussey, Professor of Surgery in the Miami Medical College at Cincinnati, Ohio, has three; Alden March, Professor of Surgery in the Albany Medical College, has two; Willard Parker, Professor of Surgery in the College of Physicians and Surgeons in the City of New York, has one; Daniel Holmes, M.D., of Canton, Bradford County, Pa., has one. Others will be mentioned hereafter.

A review of the cases of fracture of the neck, reported by Robert W. Smith, will show us that this eminent writer has claimed, as illustrations of intra-capsular fracture, a large number of specimens in which the entire neck of the bone has been removed by absorption; therefore, we have a right, in discussing the subject of bony union, to regard with some skepticism his cases in which the exact location of the fracture is left dependent on an expressed opinion, and has not been given in the description of the specimen.

In cases x., xi., xviii., xx., xxiii., and xxv., Mr Smith states that "the fracture was within the capsule," and that "the entire neck of the bone has been removed by absorption." We ask how it is possible for him to tell the point at which the neck was fractured, after the neck has been removed by absorption? We do not feel under obligation to believe the expressed opinion of any surgeon until we know the facts on which that opinion is founded. The first case adduced by Mr. Smith in proof of osseous union within the capsule, is that originally reported by Mr Langstaff.* The history of this case is quite unsatisfactory, inasmuch as Mr. Langstaff tells us that the bone was fractured, without giving us a single symptom which led him to such a conclusion. The following is the history:—

* Smith on Fractures, p. 41.

* Medico-Chirurgical Transactions, vol. xiii. p. 491.

"In this case the patient was a female aged fifty, when the fracture happened. She was confined to bed for nearly twelve months after the occurrence of the accident, and during the remainder of her life, a period of ten years, walked with crutches. On dissection it was found that the principal part of the neck of the bone was absorbed; the head and remaining portion of the neck were united principally by bone, and partly by a cartilaginous substance. On making a section of the bone, it was evident that there had been a fracture of the neck within the capsular ligament, and that union had taken place by osseous and cartilaginous media. With a view of ascertaining whether there was real osseous union, the bone was boiled many hours, which, by destroying all the animal matter, satisfactorily proved the extent and firmness of the osseous connection, and exhibited the spaces which had been occupied by cartilaginous matter."*

Mr. Langstaff states that "on dissection it was found that the principal part of the neck of the bone was absorbed." From this we conclude that more than half of the neck was removed, and, if so, it is more than probable that the line of union was, at least, partly without the normal capsule, since the measurements of sixty-one specimens of the normal capsule show that its insertion into the posterior surface of the neck is in many instances nearer to the head of the bone than it is to the posterior inter-trochanteric line. The line of union, in this specimen, is undoubtedly external to the normal capsule; yet we cannot say, from this, that the fracture was also without, neither that it was within the capsule, since the fragments of the neck suffered loss by absorption before union occurred, and it is consequently impossible to give the exact location of the fracture. He also states that "on making a section of the bone it was evident that there had been a fracture of the neck within the capsular ligament." This opinion was undoubtedly founded on the appearance of the morbid specimen, while its capsule still remained attached to the bone; and, if so, cannot be considered conclusive, for the exact location of the insertion of the normal capsule must be determined before we can state that the fracture was intra-capsular. We have already shown that the insertion of the morbid capsule, after a portion of the neck has been removed by absorption, is not identical with the insertion of the normal capsule; hence, even though the section of the bone shows that the line of union is included within the morbid capsule, which still

remains attached to the bone, it furnishes no evidence that the line of fracture was entirely within the normal capsule.

If, on the contrary, the opinion that the fracture was intra-capsular were founded on the authority of any anatomist who has definitely located the insertion of the capsular ligament, it is still liable to error, since the line of capsular attachment to the neck of the bone is so variable in specimens taken from different subjects that no definite location can be assigned to it.

On referring to Mr. Langstaff's history of this case, I find that he has also reported in the same paper six other cases, as illustrations of intra-capsular fracture, one of which he states, was—

"A transverse fracture of the neck of the os femoris, within the capsule, closely united by ligament. The neck of the bone had been absorbed nearly in a line with its origin from the trochanter."

In four of these cases the neck was "nearly absorbed," and in another he states that the neck was "completely absorbed." In the last case the line of fracture may have been either close to the head or close to the shaft of the bone, or at any point intermediate, and neither Mr. Langstaff nor any other surgeon could assign a definite location to the line of fracture after the removal of the entire neck by absorption. In most of these cases he describes the capsular ligament as being thickened by fibrous deposit, but does not speak of its having an abnormal insertion. After loss of the entire neck by absorption, the capsule is found to have its insertion into the *shaft of the bone*, and there can be but little doubt that Mr. Langstaff regarded *this* as its *normal insertion*. If so, fracture at any point between the head and the shaft of the bone would, in his opinion, be intra-capsular. We do not doubt the *honesty* of Mr. Langstaff's report, but we must be allowed to question the truth of his opinions, when we find that in six of the seven cases of "intra-capsular fracture" reported by him, the neck of the bone had lost so much of its length by absorption that it was impossible to know whether the fracture had been *entirely within* or partly without the capsule.

No. II. *Dr. Brulatour's Case* is as follows:—

"Dr. James, an English physician, (residing at Bordeaux,) aged forty-seven, was thrown from his horse on the 29th of March, 1826; he fell directly upon the great trochanter, but got up and walked a step or two, which occasioned such acute pain in the hip-joint that he instantly fell

* Smith on Fractures, p. 57.

again. On examination, immediately after the accident, Dr. Brulatour observed the principal signs of fracture of the neck of the femur, such as shortening of the affected limb, eversion of the foot, and a feeling of crepitation in the joint when counter-extension was made. Extension of the limb was kept up for two months, so as to preserve it of its natural length. Three months after the receipt of the injury, Dr. James was able to walk with only the assistance of a cane, and subsequently recovered the full use of the limb.

"On the twentieth of December, nine months after the accident, he was attacked with hæmatemesis, which proved fatal in two days. The post-mortem examination of the right hip showed the capsule a little thickened, the cotyloid cavity and inter-articular ligament in a natural state; the neck of the femur shortened, an irregular line surrounding the neck, denoting the direction of the fracture, and considerable bony deposit at the bottom of the head of the femur, and at the external and posterior part. A section of the head of the femur was made in a line drawn from its center to the bottom of the great trochanter so as perfectly to expose the callus. The line of union indicated by the callus was smooth, and polished as ivory. The line of callus denoted also that the bottom of the head of the femur had been broken at its superior and posterior part."

Definite measurements of this specimen are not given in the description of the post-mortem appearances in Mr. Smith's work; consequently we have no means of knowing the exact location of the line of union. The history states that the neck was shortened, but does not tell us how much. In most cases of union, after fracture of the neck, it is shown that union did not occur till after the posterior surface of the neck had been nearly or quite removed by absorption. All of Prof. Mussey's cases of union are examples of this kind. Prof. Parker's has suffered the same loss. Mr. Adams's case is another illustration of this change.*

If a great portion of the posterior surface of the neck be removed before union takes place, the line of union will be found without the normal capsule, and in these cases it is impossible to tell at what point the fracture occurred. In Dr. Brulatour's history of the case, the following definite measurements of the specimen are given, which Mr. Smith did not quote:—

The post-mortem examination showed the neck of the femur shortened; "from the bottom of the head to the top of the great trochanter was only four lines, and from the same point to the top of

the small trochanter, six lines."* The line of union was at some point between the head and the trochanters, and was therefore less than four lines distant from the top of the trochanter-major, and less than six lines from the top of the trochanter-minor, and could not have been included by the normal capsule.

"No. III. *Mr. Stanley's Case.*—A young man, aged eighteen, fell from the top of a loaded cart upon his right hip, the injury of which was attended with the following symptoms: He was wholly unable to move the limb; the thigh was bent to a right angle with the pelvis, and could not be extended; abduction was difficult; the limb was everted, but there was no shortening, nor could crepitus be felt in any motion of the limb. This patient died, of what was supposed to be small-pox, about three months after the occurrence of the accident. In the examination of the joint, after death, the capsule was found thickened, the round ligament uninjured; a line of fracture extended obliquely through the neck of the femur, and entirely within the capsule; the neck of the bone was shortened, and its head approximated to the trochanter-major. The fractured surfaces were in the closest apposition, and firmly united nearly in their whole extent by bone. There was an irregular deposition of bone upon the neck of the femur, beneath its synovial and periosteal covering, along the line of the fracture."†

The history of this case, as given by Mr. Smith on page 58 of his work on Fractures, affords but little evidence that the bone was ever fractured and had Mr. Smith quoted *the whole* of Mr. Stanley's report of the case, it would have convinced most surgeons that there was at least reasonable doubt that fracture had ever occurred. We can see no good reason why a portion of the history, as important as the following, should be suppressed:—

"The age of the patient was unfavorable to the occurrence of a fracture of the neck of the thigh bone. The general opinion, therefore, of the several surgeons to whose judgment the case was submitted, favoring the belief of a dislocation into the foramen ovale, forcible extension of the limb was made by means of the pulleys, and the thigh then moved in several directions, by which the head of the bone might be replaced in its socket."‡

The symptoms which attended the injury seem to be in harmony with the diagnosis of dislocation, for the patient was "wholly unable to move the limb; the thigh was bent to a right angle with the pelvis, and could not be extended; a

* See Smith on Fractures, page 59.

* Med.-Chirurg. Trans., vol. xiii.

† Smith on Fractures, page 58.

‡ Medico-Chirurgical Transactions, vol. xviii. p. 257.

action was difficult; the limb was everted, but there was no shortening, nor could *crepitus* be felt in any motion of the limb." If the neck of the bone had been broken by the fall, it seems possible that forcible extension of the limb by the pulleys, together with the moving of the limb in different directions, should have failed to enable Mr. Stanley to detect *crepitus*. If there had been impacted fracture of the neck, the extending force applied would have loosened the apposition of the fragments, and then, according to Mr. Smith's rule, we could not have hoped for the occurrence of bony consolidation.* Maligne affirms, of this specimen, that the neck has lost nothing of its form or length by absorption; while Mr. Smith states that the neck was shortened and its head approximated to the trochanter-major. It is impossible to reconcile these conflicting statements. If the neck was not shortened, it is probable that the insertion of the capsule was not removed. If, on the contrary, the neck was shortened, and its head approximated to the trochanter-major," it is quite probable that the insertion of the capsule had receded toward the shaft of the bone, and that the site of union was at least partly without the normal capsule. Mr. Stanley's history of the case states that "the neck was shortened, and its head in consequence approximated to the trochanter-major."

No. IV. *Mr. Swan's Case*.—Mrs. Powel, above eighty years of age, fell down, Nov. 14th, 1844. Sir Astley Cooper, who saw her soon after, believed that there was a fracture of the neck of the femur, although there was no appreciable shortening of the limb, and only a slight inclination of the toes outward; *crepitus* could not be perceived. The patient died about five weeks after the occurrence of the accident. Upon examination of the joint, after death, the fracture was found to have been entirely within the capsular ligament, and the greater part of it was firmly united. A section was made through the fractured part, and a faint white line was perceived in one portion of the union, but the rest appeared to be entirely bone. The cervical ligament had not been injured.†

Sir Astley's opinion that the bone was fractured, does not seem to be well founded on the recorded symptoms of the case. The only symptom which can be said to lead to such a conclusion is "a slight inclination of the toes outward;" and this is what we have reason to expect in every severe contusion of the muscles of the hip,

as an effort on the part of the patient to relieve pain by relaxing these muscles, all of which rotate the limb outward. Sir Astley states:—

"I saw her soon after, and found her complaining very much of pain in the left hip; the limb could be moved in every direction, but this motion produced excessive pain. She was laid on her back, with the limb extended, and nothing was ever done beyond the application of fomentations for the first few days. I believed there was a fracture of the neck of the thigh-bone, although *the limb remained quite as long as the other; and I could neither perceive a crepitus, nor any altered appearance in its position, except a slight inclination of the toes outward.* She had no appetite for common food, and for three weeks appeared so weak that she was under the necessity of taking wine and brandy."*

The patient "was above eighty years of age" when she received the injury, and the vital powers were so nearly exhausted that her death occurred five weeks afterward. After the injury, "she had no appetite for common food, and for three weeks appeared so weak that she was under the necessity of taking wine and brandy." It is difficult to conceive it possible that, under such unfavorable circumstances, bony union of an intra-capsular fracture should occur in so short a time *without any treatment*, when more than that time is required for bony union of a fracture of the shaft of the femur in a patient enjoying full health in the prime of life. If we admit that the neck was fractured, and that it was subsequently united, then we wish to know if the specimen has been submitted to the test of maceration or boiling to prove the statement of Mr. Swan, that "the greater part of the fracture was firmly united by bone"? If not, there exists a possibility that the bond of union may be composed of fibrous tissue instead of bone.

No. V. *Mr. Adams's Case*.—Owen Curran, aged seventy, was, for the last five years, an inmate of the pauper department of the House of Industry. * * On the first of August, 1837, while walking across his ward, he fell on his right side; he was unable to rise, and felt pain in his right hip. * * He was visited by Mr. William Johnstone, who found the limb everted, and only half an inch shorter than the other. * * Mr. Johnstone considered the case a fracture of the cervix femoris, which required no other surgical treatment than that of placing and preserving the limb in a semiflexed position over pillows."

"This man survived the accident one year and nearly ten months, and was able to walk." At

* See page 64, Smith on Fractures.

† Smith on Fractures, page 59.

* Cooper on Dislocations and Fractures of the Joints. London edition, page 157.

the expiration of this time, he had an attack of bronchitis, which terminated fatally in four days.

"An examination of the body showed that the right leg and thigh were very much everted; the trochanter-major was elevated and projected much outward; the degree of shortening just amounted to one inch; the muscles presented a healthy appearance; the capsular ligament was of a yellowish color, and somewhat thickened. * * * The round ligament was sound. The head and neck of the bone had lost their normal obliquity, and were directed nearly horizontally inward; the cervix presented, both anteriorly and posteriorly, evidence of a transverse intra-capsular fracture having occurred; the globular-shaped head of the femur was closely approximated behind and below to the posterior intra-trochanteric line, and to the lesser trochanter; so that the neck seemed altogether lost, except anteriorly, where a very well-marked ridge of bone showed the seat of the displacement and of the union of the fragments. * * * The fracture of the neck, posteriorly, was found to have been closer to the corona of the head than anteriorly. * * * Scarcely any portion of the neck can be said to have been left.

"The bone was, in its recent state, on the 25th of May, 1839, laid before a meeting of the Pathological Society. It seemed to be the universal opinion of the members present, that it was a decided specimen of the intra-capsular fracture of the cervix femoris which had been solidly united by bony callus."* Accurate engravings of this specimen may be seen on page 61 of Mr. Smith's work.

It is difficult to see how it is possible that "the cervix presented, both anteriorly and posteriorly, evidence of a transverse intra-capsular fracture," when "scarcely any portion of the neck can be said to have been left." In the normal condition of these parts, full half of the posterior surface of the neck is usually found to be external to the capsule; and since "the neck seems altogether lost, except anteriorly," it is plainly a case in which union occurred at least partly without the normal capsule, even though the line of union was included by the capsule of the morbid specimen, as seen by the members of the Pathological Society. We have already shown that it is impossible to locate the fracture after the neck has

been removed by absorption. The fact that the line of union was included by the morbid capsule, furnishes no evidence that the fracture was intra-capsular.

"No. VI. *Mr. Jones's Case.*—Jenkins Thomas slipped down as he was returning home one evening about the middle of October, 1838; he was seen on the following day, by Mr. Cole, House-Surgeon to the Infirmary, (Worcester,) who detected what he considered to be a fracture of the neck of the femur. He applied a splint to the outside of the limb, extending from the pelvis to the foot, and bound the legs together, making use of the left as an inner splint; a bandage was applied around the pelvis. In about eight weeks the splints and bandages were removed, and he was allowed to get up soon afterward. During the following spring and summer, he was able to move about with the assistance of a stick, but with the limb shortened about an inch and a half and considerably everted. He came under my care as an inmate of St. Oswald's Hospital, January 13th, 1840, and died on the 20th of April following, of chronic disease of the lungs. At the time of the accident, he was more than eight years of age, and he survived the injury one year and a half. On dissection, the capsular ligament was found very much thickened, and the space between the trochanter major and the edge of the acetabulum greatly contracted; the bone was macerated, and a vertical section made through the head, neck, and upper part of the shaft; the neck of the bone was found to have been broken within the capsule: the fracture extended through the basis of the head of the bone, in the line of junction with the neck: it was firmly united by osseous matter. The bone was first macerated it was subsequently immersed for several days in a strong solution of carbonate of potash, and one-half of it was boiled in water for three hours without the slightest yielding perceptible in the line of fracture. This specimen, which is preserved in the museum of St. Bartholomew's Hospital, was sent to Sir Astley Cooper, for examination. Sir Astley was of opinion that the fracture was 'in part within, and in part external to the capsular ligament; in part united, and in part not, and the neck of the thigh-bone absorbed.'"*

On referring to the original history of the case I find that Mr. Smith has omitted to quote some of its most important points. Mr. Jones states that:—

"On dissection, the capsule was found very much thickened, and it was not until the shaft of the bone was divided that the knife could be passed around the joint, so contracted was the space between the trochanter major and the edge of the acetabulum. The direction of the fracture could not be traced, or the bond of union traced out, until the bone had been macerated. As the contents of the capsule became loose, they were

* Smith on Fractures, page 60. The history of this case being very lengthy, has not been quoted in full, yet it is believed that no important fact has been omitted.

* Smith on Fractures, page 62.

moved by the forceps, which enabled me to discover, what I believe to be the case, that the fracture occurred entirely within the capsule."*

Mr. Stanley saw the patient, and the following is from his history of the case:—

"The history of the case is clearly that of fracture of the neck of the femur; the appearances of the bone show that there has been a fracture which has reunited by an osseous medium, and the direction of the fracture is such as, in my opinion, can permit no doubt that it was confined to the portion of the neck covered by synovial membrane; consequently, that it was wholly within the capsule. The fracture extends through the basis of the head of the bone in the line of its junction with the neck. As in other cases of the same kind, a great part of the neck has disappeared, and, in consequence, the head is proportionately nearer to the trochanter major and shaft of the bone; *its reunion has*, in fact, taken place a part to the remaining portion of the neck and a part to the shaft."†

If it be true that "the fracture extended through the basis of the head," it is equally true that the head of the bone remained in its socket, unchanged, during the time required for the complete removal of the neck by absorption, and that, after this process was completed, the shaft was approximated to the head, and union occurred. It is by no means probable that the fracture occurred at this point; for we are bound, in obedience to the laws which govern the process of absorption, to expect that the fragment which is most imperfectly supplied with the elements of nutrition will suffer greatest loss by absorption. After fracture of the neck, the femoral fragment is abundantly supplied with blood by the nutrient artery of the femur and the vessels of the periosteum covering the neck, while the acetabular fragment is left with no other supply than that of the small vessels which enter the joint through the ligamentum teres; therefore we cannot conceive it possible that the loss by absorption was entirely at the expense of the fragment attached to the shaft of the bone. It is impossible to tell the point at which the neck was broken; yet it is highly probable that the fracture was nearer the shaft of the bone than the middle of the neck, and that the loss by absorption was mainly at the expense of the fragment attached to the head of the bone. The engraving of the posterior surface of the specimen exhibits the neck removed by absorption, and the head of the bone closely approximated to the inter-tro-

chanteric line, and to the apex of the trochanter minor, and consequently there can be no doubt that the line of union on this surface is external to the normal capsule. This engraving may be found in the twenty-fourth volume of the *Medico-Chirurg. Trans.*, but is not seen in "Smith on Fractures." Mr. Jones's opinion that the fracture was intra-capsular, was founded on the fact that the line of union was included by the capsule of the specimen, and since the insertion of this capsule was removed so far from its normal position that it was found to include the line of union, which was close to the shaft of the bone, the opinion of Mr. Jones furnishes no evidence that the fracture was within the normal capsule.

No. VII. *Mr. Chorley's Case*.—This case is cited by Mr. Smith in proof of bony union of intra-capsular fracture, while the description of the specimen affords positive evidence that the fracture was not entirely within the capsule; thus we find that "a portion of the upper fragment extended in one situation a little external to the capsule."* Malgaigne, under the head of "Intra-Capsular Fractures of the Cervix Femoris," says:—

"This name is given to fractures dividing the cervix within the limits of the synovial membrane, so that if this membrane were divided at the same level, the fracture would communicate at once with the joint."†

Mr. Smith concludes by saying that—

"The preceding cases furnish ample evidence of the possibility of the occurrence of osseous union in cases of intra-capsular fracture of the neck of the femur, and it is highly probable that they have all been examples of impacted fractures: certainly in all those, of which delineations have been given, there has been either penetration of one fragment by a portion of the other, or else the irregularity of the line of fracture has been such that the displacement of the fragments has been prevented; they have been maintained in contact and at rest, and it is under such circumstances alone that we are to hope for the occurrence of bony consolidation."‡

Mr. Smith's conclusion that union in all those cases "of which delineations have been given," is due to the fact that the fragments have, in each case, been impacted in such a manner that displacement has been prevented, is beautiful in theory; but unfortunately it does not harmonize with his record of the changes consequent upon the injury. He states that—

* Smith on Fractures, p. 63.

† Malgaigne on Fractures, p. 530.

‡ Smith on Fractures, p. 64.

* *Medico-Chirurg. Trans.*, vol. xxiv.

† *Ibid.*

"The superior fragment of the broken cervix usually disappears to the level of the brim of the acetabulum, either in consequence of the action of the absorbent vessels, or by the friction of the broken surfaces, or perhaps it is due to a combination of both these causes. The absorption, however, sometimes extends much further; I have seen half of the globular head of the bone thus removed, and a case has been recorded in which the head of the bone was completely absorbed. In old cases the femoral fragment is likewise absorbed to a greater or less extent; sometimes it disappears entirely to its base. * * * The absorption of the lower fragment is sometimes effected with extraordinary rapidity; in Case No. IX. the shortening of the limb which immediately followed the receipt of the injury was only a quarter of an inch, but after the expiration of six weeks it amounted to one inch and a half; and in Case No. XII. the removal of the greater part of the neck of the bone was accomplished in less than a month."*

If Mr. Smith regards the cases in question as exceptions to the general rule, that absorption follows the fracture, then we ask how he accounts for the complete removal of the neck in Cases V. and VI.?

The history of No. V. (Mr. Adams's case) states that—

"Scarcely any portion of the neck can be said to have been left. The head and shaft seem to be mutually impacted into each other, and almost the whole of the cervix has been absorbed."

The history of No. VI. (Mr. Jones's case) states that—

"This specimen was sent to Sir Astley Cooper for examination. Sir Astley was of opinion that the fracture was 'in part within, and in part external to the capsular ligament; in part united, and in part not, and the neck of the thigh-bone absorbed.'"

If absorption did follow the fracture in each of these cases, to the complete removal of the neck, the impaction of the fragments, which Mr. Smith considers so indispensable to bony union of this fracture must have been loosened, so that in accordance with his own theory he could not have "hoped for bony consolidation." Certainly the force of the blow which produced the fracture was not sufficient to crush and obliterate the neck. The sections of these specimens show that the neck has neither been driven into the shaft nor the head of the bone; yet the neck is gone, and the head is united to the shaft. (See plates on pages 61 and 63 of Mr. Smith's work.) *I do not see how these specimens*

can be regarded as examples of impacted fracture; neither do I see how it can be known that the fracture, in either case, was within the normal capsule; but if the fracture in each case were intra-capsular, these specimens furnish strong encouragement for us to hope for bony union, under favorable circumstances, if the fragments be approximated, even after the entire removal of the neck by absorption.

The following seven cases were reported in the April number of the *American Journal of Medical Sciences* for the year 1857, by Reuben D. Mussey, Professor of Surgery in the Miami Medical College of Cincinnati, Ohio.

"Case I.—Mr. S., aged 78 years, a hardy yeoman from one of the hilly districts of New England, when more than a hundred miles from home, upset his two-horse wagon, fell on his left hip, and could not get up. He was carried into a house and was visited by Dr. J. C. Dalton, a highly distinguished professional gentleman, who pronounced the case to be one of fracture of the neck of the thigh-bone, and proceeded to apply a modification of Desault's long splint. In four or five days the patient became so restive under his confinement among strangers, that he employed a carpenter to prepare him a box which should receive a bed together with himself and splint, with a view to return home

"When the doctor heard of this he remonstrated with no small degree of emphasis against the project, but without avail; the old man said he might as well die in one way as another, and home he would go. When the box was ready he was wagoned home, and was carried forty miles on the last day of his journey.

"Eighteen days after the injury I visited him. He made a somewhat singular appearance lying in his box, which, to accommodate himself and splint, he being over six feet high, was not much less than ten feet in length. On removing the bedclothes, I perceived that his knee and foot were turned considerably outward. I took off the splint, and gave some passive motion to the hip, without his complaining of pain; I then flexed the thigh to a right angle with the body, and kept it a minute or two in that position. This, too, was done without giving pain; on flexing the thigh to an angle a little acute, he complained that it hurt him in his groin. Pressure with the fingers upon the groin and behind the trochanter major, both in the flexed and extended position of the limb, gave him decided uneasiness. I compared the length of the limbs as well as I then could, without being able to satisfy myself that there was shortening of the injured limb. I then asked the old gentleman if he wished to get up. He said that he did, but could not. He was assisted to get into a chair, and sat for some time. From that day onward he wore no splint, and was got up from his bed daily. I gave it as my opinion that the neck was not fractured, inasmuch

* Smith on Fractures, p. 42.

as it had strength enough to support the weight of the whole limb for a minute or two, but did not satisfy myself as to the exact nature of the injury. Soon after this I received a letter from Dr. D., who expressed surprise at the opinion which he understood I had given, saying that on his first visit to the patient he found the limb inverted and shortened more than an inch, and also detected crepitus. I wrote him in reply that I founded my opinion on the fact that there was strength enough in the neck to support the limb without causing pain or doing manifest injury. In the course of four months the patient could walk with a cane, but remained lame, and could never ride on horseback, as he had formerly been accustomed to do. Between two and three years after this, he died of an acute attack of visceral disease. The bone, on being carefully cleaned, presented the following appearances, viz.: the neck shortened, and on its front a groove or depression running in a zigzag direction close to the head. The shaft rotated outward, so as to bring the corona of the head within one-third of an inch of the posterior inter-trochanteric ridge; while the distance of the corona of the head from the anterior inter-trochanteric line is one inch and three-eighths, and the head sunk below the level of the top of the trochanter major, making a shortening of more than half an inch. A vertical section of this, made by a saw, shows a consolidation of the fracture by a deposit of a mass as compact and white as ivory."*

The history of this case is interesting, as an illustration of the extreme difficulty which often attends the accurate diagnosis of injuries about the hip-joint. No one questions the ability of either of these distinguished surgeons, yet while Dr. Dalton was positive that the neck of the thigh-bone had been fractured, Professor Mussey was equally confident that the fracture had never occurred; and it was only the appearance of the dried specimen after the death of the patient that convinced him of the truth of Dr. Dalton's opinion. This is the specimen which gave rise to such a diversity of opinion among European surgeons when exhibited to them by Professor Mussey in the year 1830.

Assuming that the bone was fractured, a supposition which is not clearly proven to be based upon truth, either by the history of the case or by the appearances of the specimen, we have only to ask, was the fracture and its subsequent union entirely within the normal capsule?

The description of this specimen corresponds with the engraving accompanying it, and shows—

"The neck shortened, and on its front a groove or depression running in a zigzag direction close

to the head. The shaft rotated outward, so as to bring the corona of the head within one-third of an inch of the posterior inter-trochanteric ridge; while the distance of the corona of the head from the anterior inter-trochanteric line is one inch and three-eighths."

The shortening of the neck of this specimen has been mainly at the expense of its posterior surface, the anterior surface remaining nearly as long as it was before the injury. In this respect it closely resembles the specimen owned by Professor Parker, and nearly all other specimens, the necks of which are in any degree shortened.

The outward rotation of the limb, and the consequent friction of the posterior surfaces of the fragments with each slight movement of the patient, is without doubt the exciting cause of this local absorption of the neck, and is probably due, in most instances, to an effort on the part of the patient to relieve pain by relaxing the muscles of the hip which have been injured by the blow producing the fracture. The force of gravitation would also, especially during his sleeping hours, rotate the limb outward, the weight of the limb being on a line external to its point of support at the hip.

The line of union, on the posterior surface of the neck, as shown by the engraving of a section of this specimen, approaches as near to the shaft of the bone as the base of the trochanter minor, a point which, in some instances, will be found three-fourths of an inch or more external to the normal capsule; and I have yet to see a single specimen of the normal capsule which would include this line of union.*

"Case II.—Mr. N., a corpulent man, aged fifty-one, on getting out of his chaise fell upon his left hip, and was unable to walk. I saw him on the third day after the injury and found the knee and foot everted, and the limb shortened from an inch to an inch and a third. I could extend the leg to within about one-third of an inch of its natural length. When extended and rotated, it gave a distinct crepitus. I applied a long splint modified from Desault's by Dr. Hartshorne, of Philadelphia. With this I kept up permanent extension, but was never able to bring the limb to its full length. When an attempt was made to do so the patient complained of great pain in the groin. During the whole course of treatment the limb remained from a third to half an inch shorter than natural. * * * * The splint was removed in eighty-four days; the patient from that time was able to sit in a chair, but could never flex the thigh to a right angle

* American Journal of the Medical Sciences for April, 1857.

* See American Journal of the Medical Sciences for April, 1857, p. 300, Fig. 2.

with the body. * * * * He ultimately walked with a cane.

"He survived the injury twelve years; and eight years after his death I obtained the specimen of injured bone together with its fellow. The head is a little elongated and depressed, with a shortening of five-eighths of an inch, and much absorption of the neck. The distance of the corona of the head from the anterior inter-trochanteric line is seven-eighths of an inch, and the corona, posteriorly from the ridge, scarcely one-fourth of an inch."

The history of this case clearly shows that the neck was fractured, and the specimen shows that the fracture has been united, but that the line of union is partly without the normal capsule. The remarks on Case I. are applicable to this case, also to that of Mrs. Mason, Case III., in which the neck has suffered a similar loss by absorption. The line of union in each of these three specimens is near the posterior inter-trochanteric line, and near the base of the trochanter minor, as will be seen by reference to the illustrative engravings in Prof. Mussey's paper.

Figures 8 and 9 exhibit a pair of normal capsules having their insertion into the posterior surface of the neck, an inch and a quarter from the center of the posterior inter-trochanteric line, and their insertion into the inferior surface of the neck, one inch and a half from the center of the apex of the trochanter minor. Figure 1 shows the insertion of the capsule an inch and a half from the middle of the posterior inter-trochanteric line, and an inch and three-quarters from the center of the apex of the trochanter minor. If the neck of the bone in this specimen had been fractured during the life of the patient, and union had occurred as close to the shaft of the bone as it is in either of Prof. Mussey's cases, the line of union would have been nearly or quite an inch external to the normal capsule on the posterior and inferior surfaces of the neck.

"Case III.—Mrs. S. Mason, aged seventy-three, a small, thin woman, was rendered helpless by falling upon her right hip. Two days after the accident I was called to see her in consultation with my friend Dr. William Judkins, who was in attendance. The knee and foot were a little everted, with slight shortening and tenderness on pressure in the groin and behind the trochanter major. She was averse to the application of any kind of splint, and, being in a delicate state of health, we allowed her to remain upon her couch, with the thigh and leg somewhat flexed and supported by a pillow. She remained in this situation about three months, after which she could move, with the aid of crutches, in a manner not very satisfactory to herself. She died

in a year and a half after the accident, worn out by age and exhaustion.

"A considerable ridge runs across the anterior part of the neck, with a depression or irregular superficial groove between it and the head. The head of the bone is three-eighths of an inch below its natural level. The distance anterior from the corona of the head to the inter-trochanteric line is seven-eighths of an inch; posteriorly, half an inch. The interior of the bone shows a narrow, white, and eburnated line corresponding with the aforesaid ridge, exhibiting a firm consolidation; the neck somewhat shortened."

While we entertain the highest respect for the opinions of Prof. Mussey, we do not find recorded in the history of this case conclusive proof that the neck of the bone was ever fractured; if, however, the diagnosis of fracture was correct, so much of the neck has been absorbed that the line of union is external to the normal capsule on the posterior surface of the neck, and it is impossible to tell whether the fracture was entirely within or partly without the capsule.

"Case IV.—Mr. F., aged eighty-two, a hardy yeoman, who had spent most of his life in Kentucky, fell upon his hip upon a slippery sidewalk. He was helpless, and complained of great pain under any attempt at motion of the hip-joint. The limb was shortened, but to what extent could not then be ascertained, as he was unwilling to submit to so much manipulation. It was judged best by Dr. Fore and myself to leave him without dressings. After three months lying upon his bed he could move upon crutches. In the course of a year he occasionally got about with a staff. He died in two years from the time of the injury.

"The *post-mortem* examination showed the bone with an intra-capsular fracture; the osseous portion of the neck wholly gone, and the entire of the osseous surfaces of the two fragments occupied by strong fibrous bands of one-third of an inch in length. The head, when pressed downward, just rested upon the trochanter minor, causing a shortening of one inch and an eighth. The strength of this fibrous production was amply sufficient to sustain the weight of the body."

Professor Mussey states that "the *post-mortem* examination showed the bone with an intra-capsular fracture." We cannot see how he arrives at positive knowledge of this fact after "the osseous portion of the neck is wholly gone." He seems to have been misled by the appearance of the morbid capsule, in the same manner that Robert W. Smith was in Cases X., XI., XVIII., XX., XXIII., and XXV. (See *Smith on Fractures*.)

"Case V.—Fig. 10 exhibits a posterior view of an intra-capsular fracture of the neck of the os femoris. The specimen is without history. It is

interesting on account of the ligamentous connection of the fragments which, from appearances at the time it was obtained, must have been sufficient for the ordinary purposes of locomotion. "The bony portion of the neck absorbed." (See remarks on Case IV.)

"Case VI.—Fig. 11, without history, shows a fracture at the neck which corresponds with the anterior inter-trochanteric line. The shaft is rotated very considerably outward. It is interesting from the evidence it affords that the fragments were never entirely separated from each other. The head, unchanged in form, is depressed three-eighths of an inch below its proper level; its corona, from the anterior inter-trochanteric line, one and three-eighths of an inch; posteriorly, three-eighths of an inch; the neck in front not shortened. Fig. 12 shows the line of osseous consolidation of this fracture." * * * "The line of consolidation, as marked on Fig. 12, is wholly intra-capsular—the fragments having been kept *situ* after the injury, perhaps by the cervical ligament, or the mutual crushing into each other of the fractured surfaces, or both."

If the line of fracture "corresponds with the anterior inter-trochanteric line," it cannot be said to be entirely within the capsule, for it is only the external fibers of the capsule which have their insertion into the anterior inter-trochanteric line, the deeper fibers of the capsule being inserted into the neck of the bone within this line. The synovial membrane lining the capsule usually approaches very close to the upper part of the anterior inter-trochanteric line, but diverges from this line as we pass downward, so that at a point midway between the trochanters it is generally half an inch distant from the line. (See fig. 1.)

The line of union in this specimen, as shown in Fig. 12 of Prof. Mussey's paper, is plainly without the capsule, since it is close to the shaft of the bone.

"Case VII.—Without history. Head depressed; shortening nearly the fourth of an inch; irregular depression or wide groove in the upper and anterior part of the neck. The corona of the head from the anterior, one and a half inches; posterior, one-fourth of an inch." (See remarks on Case I.)

Alden March, Professor of Surgery in the Albany Medical College, has two specimens which he regards as examples of bony union of intra-capsular fracture of the neck of the femur. It is with pleasure that I refer the reader to Prof. March's report of these cases, which is accompanied with accurate engravings of the specimens, and may be seen in a paper entitled "Osseous Union of Intra-Capsular Fracture of

the Neck of the Femur," published in the Transactions of the Medical Society of the State of New York, for the year 1858, from which I quote the following:—

"Of the two specimens here presented for examination as examples of intra-capsular fracture of the femur united by bone, the smaller one, numbered 884, was procured in London some years since, and at that time was regarded by the curator of the old London Hospital Museum as a good specimen of fracture and bony union of the neck of the femur within the capsular ligament. I can give no history of the patient, or subject, from whom it was taken. I think it could not have belonged to an old person; and it is quite clear that he or she, as the case may be, lived long enough after the occurrence of the fracture for it to become thoroughly reunited by bony material.

"The neck of the bone is very much absorbed, which will be found to be the case in almost all instances of intra-capsular fracture, whether united by bony or ligamentous material. This specimen, with several others of various kinds of organic change, was submitted to the examination of an able professor of surgery, who has recently devoted much attention to the study of fractures, and who remarks upon it as follows: 'Specimen 884 is plainly enough a *fracture*, and I think there can be no doubt that on one side of the neck the fracture was within the capsule; but I have no means of determining whether it was also within the capsule on the opposite side, since the neck is almost completely absorbed.'

"On close examination, it will be found that about all the part of the bone that can be called *neck* is connected with the shaft, and that the fracture appears to be nearly transverse and close to the *articulating* or cartilaginous border of the head. It strikes me that it is just as clearly *altogether within* the capsule as it is a fracture."

Some weeks since, I addressed a note to Prof. March, requesting measurements of one of his specimens, to which he very kindly replied by sending both his specimens that I might examine them at my leisure.

The appearances of specimen 884 seem to have misled each of the distinguished surgeons whose descriptions of the specimen are given above. Moreover, my first impressions concerning the specimen exactly coincided with the opinion of Prof. Hamilton, who thought that the posterior surface of the neck was "almost completely absorbed." A more careful examination of the specimen, some days after, revealed the fact that nearly or quite one-half of the length of the neck, even of its posterior surface, still remains attached to the shaft of the bone, and that the other half of the neck, which probably was attached to the head of the bone after the fracture,

was entirely removed by absorption before union occurred. After removal of the acetabular fragment of the neck, the limb was rotated outward and drawn upward and forward in such a manner that the posterior surface of the femoral fragment of the neck rested against the head of the bone which still remained in its socket, the inferior edge of the head being close to the base of the trochanter minor, and its posterior edge close to the posterior inter-trochanteric line, while the anterior edge of the head extended a little beyond the fractured extremity of the remaining portion of the neck. The capsular ligament must still have retained its normal insertion when union occurred, since enough of the neck remains to warrant such a conclusion, and but little doubt can be entertained that the union, such as it is, occurred entirely within the normal capsule. The insertion of the capsular ligament into the posterior surface of the neck, must have been close to the fractured extremity of the femoral fragment, and, as this fragment was drawn forward, the limb being rotated outward, the posterior surface of the capsule was folded backward toward the shaft of the bone, thus intervening between the head of the bone and the posterior surface of the neck, and preventing union of the fragments at this point. A portion of the dried capsule still remains occupying this position; and, if the specimen be held between the eye and a bright light, it is plainly seen that the posterior surface of the neck is not united to the head of the bone. The union is by no means extensive, and exists only between the posterior surface of the fractured extremity of the femoral fragment and that portion of the head with which it is in immediate contact. Prof. March asserts that "it is quite clear that he or she, as the case may be, lived long enough after the occurrence of the fracture for it to become thoroughly reunited by bony material." Concerning this statement there exists, in my mind, a little doubt, for I know that some of the bond of union is composed of ligamentous material; yet I cannot state that it is all of this character. Maceration will prove the merits of the specimen. I have called the attention of Prof. Hamilton to the fact that much more of the neck still remains attached to the shaft of the bone, in specimen 884, than he thought at the time the specimens were submitted to his examination by Prof. March; also, that the fracture and its subsequent union were probably entirely within the

normal capsule. After a careful examination of the specimen, Prof. Hamilton requested me to state that he now "regards the specimen as one of great interest," although he "cannot consider it a positive proof of bony union until it has been subjected to the test of maceration."

The following is the description of Professor March's second specimen, together with the evidence cited to prove that the neck of the bone has been fractured:—

"The large bi-section of a more recent specimen was procured about three years since, the description and history of which is as follows: The subject from whom the specimen was taken was a large-framed man, about fifty-eight years of age at the time of his death. I think I must have known the person twenty-five or thirty years. His gait was peculiar—a kind of side waddle—one limb appearing to be two or three inches shorter than the other, and the hip of the shortened side greatly projecting laterally.

"When the two sections are replaced, and on looking at the head of the bone, it will be observed that a pretty large surface at its upper part, and toward the trochanter major, is a little flattened, and has the appearance of having been worn away, deprived of cartilage, and becoming eburnated, or presenting at one point a *porcelaneous polish*. This change I regard as the result of *interstitial* and *progressive* absorption, aided by *attrition*, as having occurred at an advanced period of life.

"The ridge of bone on the anterior and superior part of the neck, where I suppose the fracture existed, is still covered with a portion of the dried capsular ligament. At the back and inner part of the head there is a portion of cartilage to be seen, of a brown color, and thinner than natural. That part of the head occupied by the ligamentum teres seems to have been getting into a state of ulceration, but how long before death I cannot conjecture. Most of the cartilage of the head of the femur, on the other side, is absorbed, and its surface more or less polished. In the specimen of this, in the right side of the same patient, there appears to have been a fracture in the shaft, about two or three inches below the trochanter minor, which was united without much distortion.

"If we continue the examination of the bisected specimen—that of the left limb—after replacing the sections, it will readily be observed that the *head* of the bone has been *depressed* and *turned obliquely* backward—in these respects occupying almost precisely the position in which we find the head of the bone situated in specimens where no doubt can be entertained as to the existence of fracture through the neck, as two or three of the accompanying specimens will prove.

"The distortion of the head, or altered relation between it and the shaft of the bone, is due to the action of the muscles that carry the shaft, and the

ortion of the neck attached to it, upward; and those that evert it, or roll it outward.

"The long spine or rib of bone extending upward and inward, was found imbedded in the tendons of the psoas and iliacus muscles; and seems to have its attachment at its base, to the point where we should look for a trochanter minor.

"In comparing the inner face of the sawed specimen with Mr. Jones' case, a wood-cut of which is given in R. W. Smith's work on Fractures, at page 63, we shall see that the appearances are almost identical.

"Thus much for the ocular, demonstrative proof of the existence of a former fracture; and after giving the historical facts connected with the accident, at the time the fracture was produced, we shall then undertake to demonstrate that it was *complete*, and altogether *intra-capsular*. If we succeed in establishing these two points, the third, that of *bony union*, we conceive to be self-evident.

"Fred. L., the subject of our morbid specimen, according to the alms-house record, died May 18th, 1854, aged sixty; although it is believed that he was not as old by some two or three years.

"I instituted inquiries of a great number of our old citizens as to the *cause* of 'Fred.'s lameness, and the time of its occurrence. I shall select only a few from the large catalogue, those that appear to be the most definite and to the point.

"A. C., aged seventy, a colored woman, born and had always lived in Albany, knew Fred. and his mother well, when she (the witness) was young, and then a slave. When he, the said Fred., was a mere lad, she knew him to be lame, and about as much of a cripple as at the time of his death; also that he (Fred.) had informed her that a shed fell upon him, or that he fell from a shed, and injured him severely in the hip, and that was the cause of his lameness.

"W. H., a very reputable colored man, over seventy years of age, had known 'Fred.' many years; and from his earliest acquaintance knew him to be a distorted cripple.

"Mrs. S., the wife of a late distinguished citizen and statesman, now eighty-three years of age, says, she knew Fred. from childhood until near the time of his death. She very well remembers when he broke his hip or upper part of the thigh-bone; and thinks that he could not have been more than ten or twelve years of age at the time, as she was in the habit of seeing the nurse, or woman who took care of him, carry him up and down stairs on her shoulders during his confinement with the injury; and, also, immediately after getting about; that he was just about as lame, as much of a cripple, and as much distorted in his figure as he was at any time previous to his death.

"Mrs. L. H., eighty-three years of age, now, and at the time of Fred.'s birth, a resident of Albany, says, she was intimately acquainted with the family in which Fred. was raised; remembers well the time when Fred. broke his thigh; knew

the physician who attended him; and thinks he could not have been more than twelve or fourteen years of age at that time. She also knew that he was from that time, and ever after, lame; one limb being much shorter than the other; and that he continued to be a cripple as long as he lived.

"But the testimony of the following two witnesses is as clear, as to *time* and *place*, as incontrovertible proof can possibly establish any given fact.

"Mr. G. D., now about fifty-seven years of age, and one of our most respectable citizens, was with Fred. at the time he fell from the shed, or the shed fell upon him, and very distinctly remembers the time and place of the accident; knew of his having been attended by a physician for a broken thigh; and, also, has known him ever since to have been a great cripple, with the left limb much shorter than the right.

"J. D., Esq., the senior of the above eye-witness to the accident, saw Fred. the next day after he was injured, and knew that Dr. James Low, a talented and well-educated surgeon, attended him for a fracture of the thigh.

"Now, when we come to consider the history of the case, and compare the left *morbid* with the right normal specimen, and observe how strangely and strongly-marked the contrast is, in relation to the *head, neck, trochanters*, and *shaft* of the two bones, it seems to us that the proof of the existence of fracture at an early period of life is absolutely conclusive.

"The proof of its being *complete fracture* and not *impacted*, is to be found in the *great shortening* of the limb, and in the *angular* and *rotary distortion*.

"The evidence of the fracture being *intra-capsular* is to be found in the existence of the original attachment of the capsular ligament, anteriorly and posteriorly, in a dried state, and may be easily examined by any one who may see fit to do so.

"The American professor of surgery, to whom reference has been made, and to whom I presented the specimen for examination, together with a detailed description of it, as well as a partial history of the occurrence of the accident, which resulted in the fracture of the neck of the femur, as I allege, at an early period of life, disposes of the whole matter in the following laconic language: 'I must concur with Dr. A., in believing that specimen No. 1 is simply an example of chronic rheumatic arthritis, or interstitial absorption.'"

The history of this case does not seem to afford conclusive proof that the neck of the bone was ever fractured, and the appearances of the specimen are quite as unsatisfactory. If the neck of the bone were ever broken, it is impossible to tell the point at which the fracture occurred, since nearly all of the neck has been removed by absorption. The sections of the specimen exhibit

nothing which can be regarded as the line of union of the fragments, the cancellated structure of the head, neck, and upper part of the shaft being almost entirely replaced by solid bone.

Professor March states that—

“The evidence of the fracture being *intra-capsular* is to be found in the existence of the original attachment of the capsular ligament, anteriorly and posteriorly, in a dried state, and may be easily examined by any one who may see fit to do so.”

We have already shown that the removal of the neck, by absorption, is accompanied by a removal of the insertion of the normal capsule—a fact which is well illustrated by the insertion of the morbid capsule of this specimen. The neck has been so completely removed by absorption, that the greater part of the trochanter minor is lost in its connection with the head of the bone. A portion of the conjoined tendon of the psoas magnus and iliacus internus muscles still remains, and exhibits, by its insertion, the position of the trochanter minor. The capsular ligament is inserted so far remote from its origin that it includes nearly, or quite all of the trochanter minor, and is so closely blended with the conjoined tendon of the psoas and iliacus muscles that this tendon seems to form a part of the morbid capsule. The insertion of the capsular ligament of this specimen cannot be regarded as its “original attachment,” and so little of the neck still remains that, if the supposed line of union be located at any point between the head and the shaft of the bone, it will be in a great degree external to the normal capsule, and consequently extra-capsular, even though it is included by the morbid capsule of the specimen.

At a meeting of the New York State Medical Society for the year 1860, Daniel Holmes, M.D., of Canton, Bradford County, Pennsylvania, exhibited a specimen as an illustration of bony union of intra-capsular fracture of the neck of the femur. The following is extracted from the report of the case published in the Transactions of the Society, page 80:—

“In the evening of July 19th, 1859, I was called in haste to see Mrs. C. W., who had just received an injury by falling on the floor; and as her residence was near at hand, I reached it in a short time. I found her lying on the bed with both limbs extended. She complained of pain in the left groin and down the limb, which was aggravated by motion and by pressure on the trochanter.

“I learned that as she was about to retire, she extinguished her light; but wishing to sit down

a moment, she placed her right hand on the left arm of her chair, supposing it to be the right arm thus missing the chair she came to the floor with her whole weight on the left hip. The left lower limb being wholly disabled by the fall, she was taken up and laid upon the bed. The limb was measured and found to be one-half of an inch shorter than the other.

“The toes were everted, and by placing one of my hands on the trochanter, and grasping the limb, and by rotating it with the other, I discovered a distinct crepitus. I then gave a positive diagnosis of fracture of the neck of the femur, and probably within the capsule.

“About the middle of the eleventh week, just as we were about to make the experiment of having her sit up, and to try the strength of the limb, a large carbuncle made its appearance on the upper part of the sacral and lower lumbar region. A large slough soon came out, extending in depth to the ligaments of the sacrum. In spite of all restorative means, the powers of life soon began to falter, and she expired on the 17th of October, fourteen weeks and three days from the time the injury was received.

“A post-mortem examination, on the 18th, proved the correctness of the diagnosis. It revealed a fracture of the neck of the femur, wholly within the capsule, which was restored by bony union, and sufficiently strong to almost support the weight of the body. The coaptation of the extremities of the fracture was nearly perfect, and had the patient survived to have used the limb, its length would have been nearly perfect.”

Dr. Holmes not only exhibited this specimen at the New York State Medical Society, but also presented it at the meeting of the American Medical Association at New Haven, in the summer of 1860, and again before the Southern Central Medical Association, in Binghamton, Broome County, New York. In each of these societies he was met with the objection that the fragments might possibly be united by ligamentous, instead of bony material, and was urged to prove his statements by macerating or boiling the fractured bone. This he neglected to do. About three months since I addressed a note to Dr. Holmes, informing him that I was preparing a paper on the subject of intra-capsular fracture of the neck of the femur, and requesting definite measurements of his specimen, showing the distance of the line of union from the inter-trochanteric lines. I also inquired if the specimen had ever been macerated or boiled to prove that the bond of union was bony instead of ligamentous, and requested that, if it had not been submitted to such a test, he would boil it for some hours, and inform me of the result. This note remains unanswered.

However reluctant Dr. Holmes may be to sub-

ect the bone to such a test of the truth of his opinion, it is to be regretted that he has not, at least, given such measurements of the specimen as will assign a definite location to the line of union. He states that the post-mortem examination "revealed a fracture of the neck of the femur, wholly within the capsule." This may be very true, and yet the line of union may be without the normal capsule; for the capsule of the morbid specimen is found to include the line of union, when the head is united to the shaft of the bone, after removal of the entire neck by absorption. The simple fact that Dr. Holmes did not comply with the request made at each of the three societies mentioned, would seem to imply an unwillingness on his part to subject the specimen to this important test, and, to one unacquainted with him, it might suggest the existence of a doubt in the mind of Dr. H. that the fragments were united by bone.

No surgeon can be more anxious than I am, to establish the fact that bony union of intra-capsular fracture does occasionally occur; yet I am quite unwilling to admit, as positive proof of this desirable result, any specimen which has not been submitted to long-continued maceration or boiling, to test the solidity of its union.*

The insertion of the capsule, in specimen 25, was seven-eighths of an inch distant from the center of the apex of the trochanter minor, and that is the only one I have seen in which this distance was less than an inch. In specimens 5, 6, and 8, the distance from the center of the apex of the trochanter minor to the insertion of the capsule was one inch and a half, and in specimens

After completing my paper, I received a reply to my note to Dr. Holmes, which, he said, had been delayed by his illness, absence from home, etc. The following are the measurements of the neck of the fractured bone, showing the length of the neck, and the distances from the inter-trochanteric lines to the line of union, measuring from the points indicated on Figs. 3 and 4:—

Length of the Neck.

Anterior	$1\frac{3}{4}$ — $2\frac{1}{4}$.
Posterior	$\frac{7}{8}$ — $\frac{7}{8}$ — $1\frac{5}{8}$ — $1\frac{1}{2}$.

Length of Neck of Sound Bone.

Anterior	$1\frac{1}{2}$ — 2 .
Posterior	$1\frac{1}{2}$ — $1\frac{3}{4}$ — $1\frac{5}{8}$.

Distance from Inter-trochanteric Lines to Line of Fracture.

Anterior	$1\frac{1}{2}$ — 1 .
Posterior	$\frac{3}{4}$ — $\frac{7}{8}$ — $\frac{3}{4}$.

In comparison of the length of the neck of the fractured bone with that of the sound femur of the same subject, shows that about half of the length of the posterior and inferior surfaces of the neck was removed by absorption before union occurred, and it is almost certain that the insertion of the capsule was removed by this absorption; for the line of union, although included by the capsule of the specimen, is distant from the center of the apex of the trochanter minor, only three-fourths of an inch, and I have yet to see a specimen of the normal capsule which would entirely include it.

1 and 27 this distance was one inch and three-fourths. (See Table.) Dr. Holmes states that

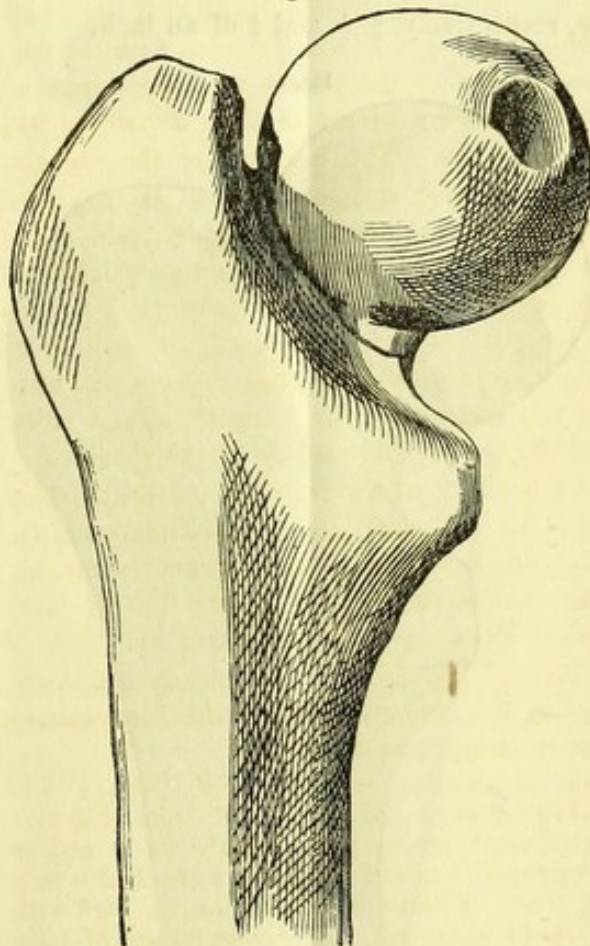
"The bone has been boiled and sufficiently tested to satisfy all those who have examined it, of the bony union. The specimen has been examined by many of the best surgeons in the country, who were all abundantly satisfied. The capsular ligament is entire on the bone."

If the fragments of a fractured bone be united by fibrous material, long-continued maceration or boiling of the bone will destroy the fibrous union and separate the fragments. The ligaments attached to the bone, and the periosteum covering it, will also be removed by the process; hence, since the "capsular ligament is entire on the bone," we are forced to conclude that the specimen has not been boiled a sufficient length of time to prove that the fragments were united by bony material.

The following is a brief history of the specimen owned by ~~William~~ Parker, M.D., Professor of

*Willard
Parker*

Fig. 11.



Surgeons in the College of Physicians and Surgeons of the City of New York. The patient was an unmarried female, about sixty years of age when the accident occurred, and was at that time an inmate of the Almshouse of Barnard,

Vermont. "One morning while going out of doors she fell, striking upon her hip." "On examination, the physician in attendance diagnosed a fracture of the neck of the femur, there being present crepitus, shortening, eversion of the foot, etc." The doctor applied the straight splint, and on removing it at the expiration of six weeks, found that the limb was shortened half an inch. Four years after the injury, the fractured bones, together with the sound femur of the same subject, came into the possession of Professor Parker, and I am under many obligations for his kindness in lending me the specimens till the artist could represent them by the drawings.

Fig. 11 represents a view of the posterior surface of the fractured bone. The shaft of the bone is rotated outward, and the posterior surface of the neck is very much shortened by absorption; so that, measuring from the points indicated in Fig. 4, the distance from A to B is only $\frac{3}{8}$ of an inch; C to D, $\frac{1}{2}$; and E to F, 1 inch; while the distances from A, C, and E to the line of union are, respectively, $\frac{3}{8}$, $\frac{1}{2}$, and $\frac{5}{8}$ of an inch.

Fig. 12.

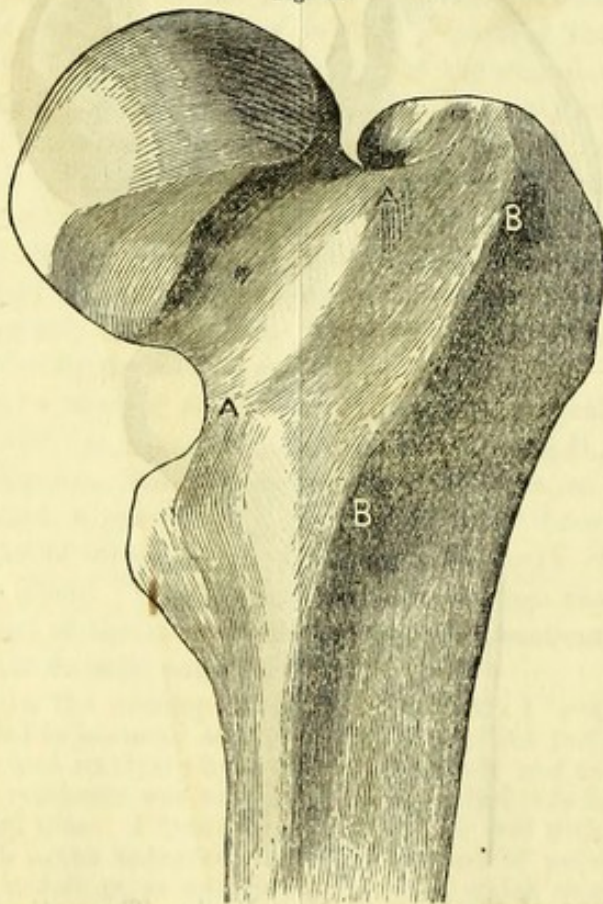


Fig. 12. Anterior view of same specimen. A A is the line of union, and B B the inter-trochanteric line. The length of the anterior sur-

face of the neck is exactly the same as that of the sound bone, the neck having lost nothing by absorption on this surface. The line of union is internal to the inter-trochanteric line, $\frac{1}{2}$ an inch above, and $\frac{5}{8}$ of an inch below, consequently the fracture was, without doubt, entirely intra-capsular on the anterior surface of the neck.

Fig. 13.

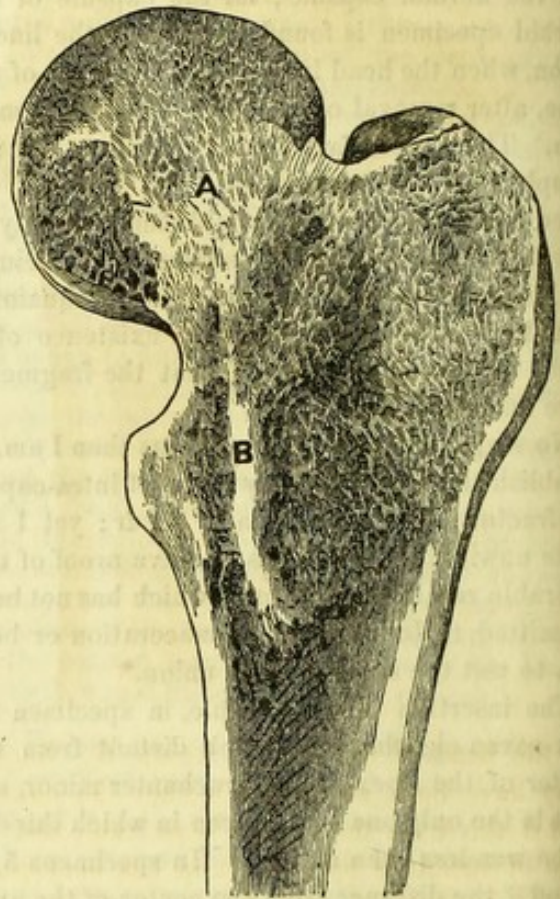


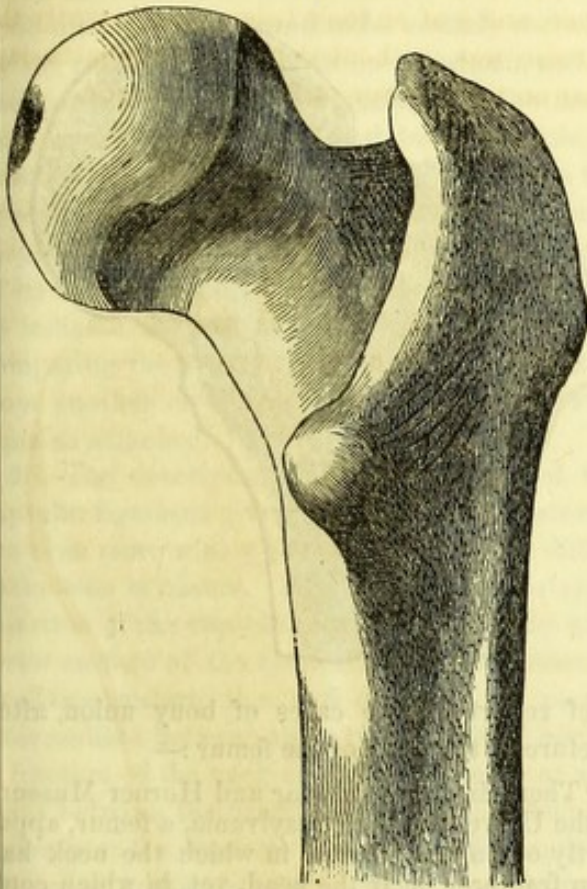
Fig. 13 exhibits a section of the fractured bone. The white portion, represented by the letter A, is a condensed bony structure, shooting upward in parallel plates from the line of union into the head of the bone. B is a similar condensation of the cancellated structure, passing downward from the line of union into the shaft of the bone.

Fig. 14. Posterior view of sound femur of the same subject. The length of the neck on its anterior surface is 1 inch, and $1\frac{3}{4}$; and the length on the posterior surface is $1\frac{1}{4}$, $1\frac{1}{4}$, $1\frac{3}{4}$, measuring from the points given in Figs. 3 and 4.

The line of union, on the posterior surface of the neck of this specimen, is too near the shaft of the bone to be included by any specimen of the normal capsule which I have seen. The line of fracture may have been as close to the shaft of the bone as the line of union is; and, if so, the shortening of the posterior surface of the neck

by absorption has been entirely at the expense of that fragment of the neck which was attached

Fig. 14.



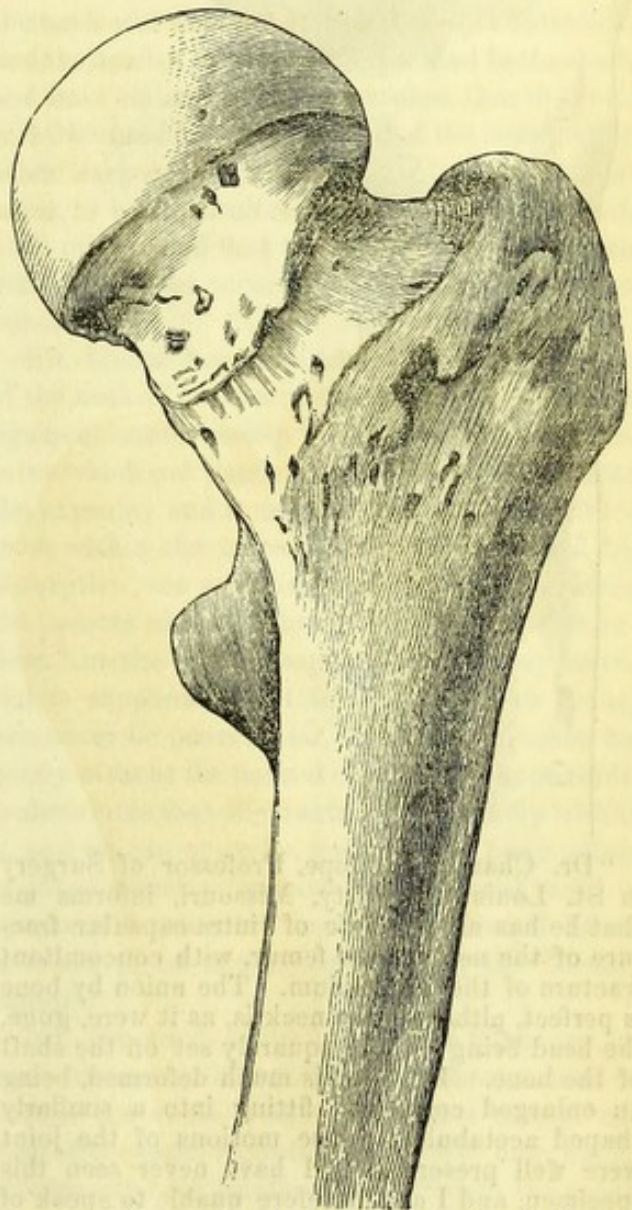
to the head of the bone. Again, the fracture may have been altogether within the capsule, and if this were the case, it is probable that the loss of structure by absorption has been partly at the expense of each fragment of the neck, union having occurred after the absorption of the humeral fragment had reached a point far without the normal capsule. The line of union has, by many writers, been considered identical with the line of fracture, but this can only be true of those specimens in which the neck has lost nothing of its length by absorption; for if a portion of the neck be removed before union occurs, it is impossible to determine that the absorption was entirely at the expense of either fragment.

The specimen represented by the following engravings was very kindly loaned to me by Alfred J. Post, M.D., Professor of Surgery in the University Medical College of the City of New York. It is to be regretted that this specimen came into the possession of Prof. Post unaccompanied by a history. Prof. Post states that he exhibited this specimen at a meeting of the Medical and Surgical Society of the City of New York," and that "it was believed by most of the

members present to be an illustration of bony union of intra-capsular fracture; but a few of the members took opposite ground, and contended that the bone had never been broken."

The external appearances of this specimen are strongly indicative of bony union of fracture within the capsule, while a section of the specimen exhibits no evidence that the neck was ever broken. The cancellated structure of the head, neck, and upper part of the shaft is perfect and entire; and this appearance is seldom, if ever, seen in well-authenticated cases of bony union after fracture of the neck. If the neck were ever broken, the fracture and the union of the fragments occurred, without doubt, entirely within

Fig. 15.

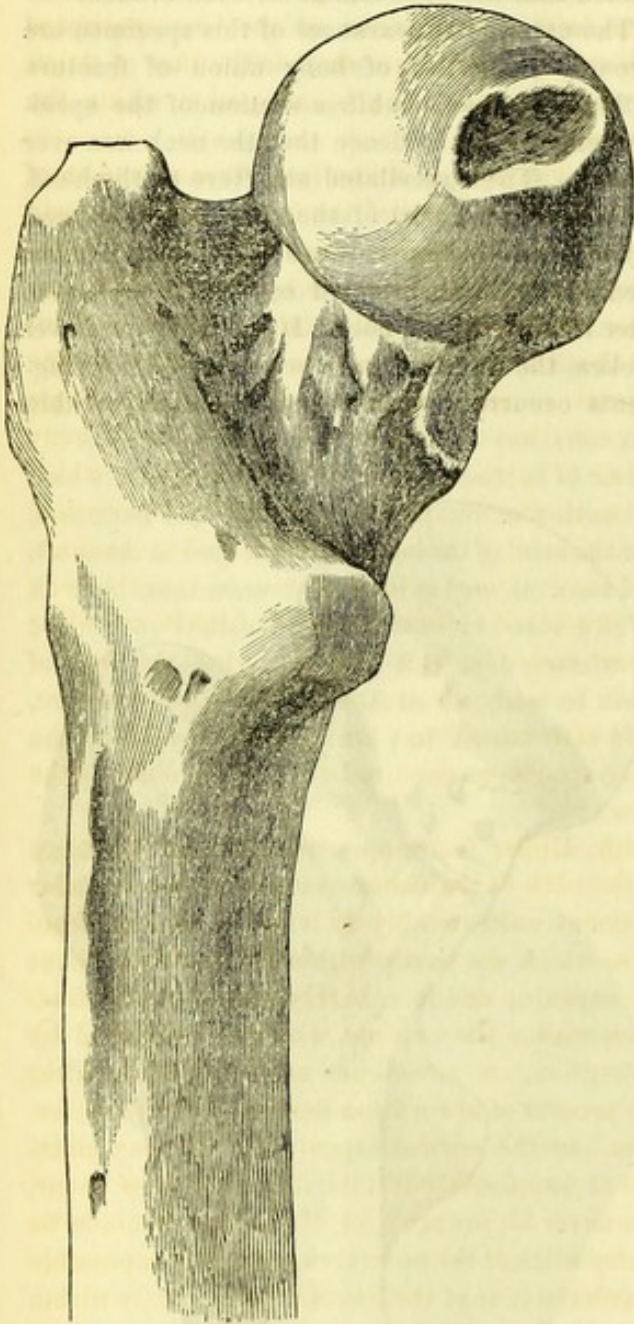


the normal capsule; but there must exist some doubt that the neck was ever fractured.

Fig. 15 is an anterior view of Prof. Post's specimen. Fig. 16 is a view of the posterior sur-

face of the same specimen. Fig. 17 exhibits a section of the specimen.

Fig. 16.

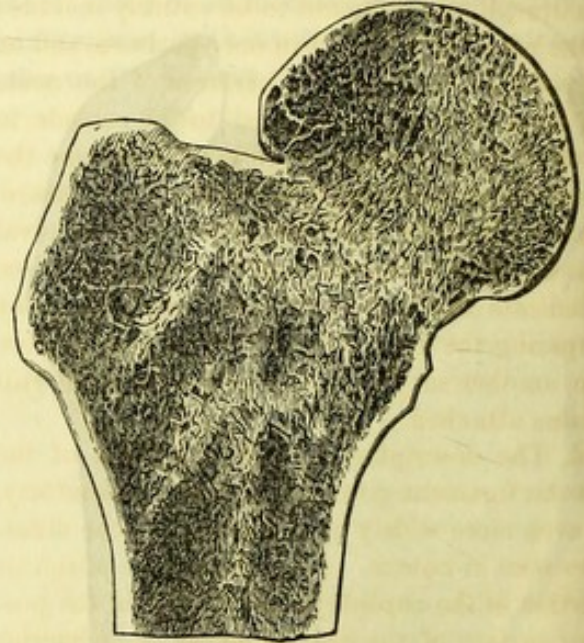


"Dr. Charles A. Pope, Professor of Surgery in St. Louis University, Missouri, informs me that he has an example of 'intra-capsular fracture of the neck of the femur, with concomitant fracture of the acetabulum. The union by bone is perfect, although the neck is, as it were, gone, the head being almost squarely set on the shaft of the bone. The head is much deformed, being an enlarged cone, and fitting into a similarly shaped acetabulum. The motions of the joint were well preserved.' I have never seen this specimen, and I am therefore unable to speak of it authoritatively; but I confess I do not see how it is possible to know that the fracture was wholly within the capsule when the neck is gone."*

* Hamilton on Fractures and Dislocations, page 370.

Professor H. H. Smith, of Philadelphia, in his work on Surgery, page 399, has the following

Fig. 17.



brief report of two cases of bony union, after fracture of the neck of the femur:—

"There is in the Wistar and Horner Museum of the University of Pennsylvania, a femur, apparently of an old woman, in which the neck has been fractured near the head, yet, in which complete osseous union, though with some degree of shortening, has taken place. I have, moreover, in my own cabinet, a specimen in which the bone has been fractured through the neck near the head, the fragment having slid down beneath its natural position, and the fracture traveled obliquely down the neck, though still within the capsule, splitting it off in the line of the inter-trochanteric ridge. In this case, which must have produced marked shortening of the limb, there is complete osseous union."

The report of the first case is very brief and unsatisfactory, while that of the second is given more at length. Prof. Smith states that "the fracture traveled obliquely down the neck, though still within the capsule, splitting it off in the line of the inter-trochanteric ridge," and if this be true, the fracture extended some distance beyond the limits of the synovial membrane, and cannot therefore be regarded as an intra-capsular fracture. (See Fig. 1.)

SUMMARY.

1st. The insertion of the capsular ligament of the hip-joint varies so greatly, that scarcely any two specimens of the normal capsule, taken from different subjects, can be said to be inserted into

the neck of the femur at the same point, and so these are the differences seen that, if a transverse fracture of the neck of the femur be located at a given distance from the posterior inter-trochanteric line, it will be found to be entirely included in the capsular ligament in one specimen, and on the other; hence it is impossible to determine the precise location of capsular insertion by measurements of the neck of the femur after the removal of its capsular ligament; and it is also impossible to indicate the line of capsular attachment by comparing the dried bone with a specimen taken from another subject, to which the capsule still remains attached.

2d. The descriptions of the insertion of the capsular ligament given in our works on anatomy, are even more widely at variance than the differences seen in nature. Some locate the posterior insertion of the capsule at the middle of the posterior surface of the neck, some at the posterior inter-trochanteric line, and others at all points intermediate between these two extremes; hence, if a fracture of the neck of the femur occur at any point between the head of the bone and the posterior inter-trochanteric line, we can find authority among anatomists for believing that the fracture is intra-capsular; and it will be observed that, notwithstanding the extreme diversity among authors in describing the insertion of the capsular ligament, not a single one even intimates that it ever varies from the position which he, himself, has assigned to it.

3d. The insertion of the capsular ligament is often removed by the morbid changes consequent on fracture of the neck of the femur; therefore the capsule of the fractured bone cannot be said to furnish reliable evidence that the fracture was within the normal capsule. The normal capsule is usually inserted into the middle of the posterior and inferior surfaces of the neck; in some instances a little nearer the head of the bone than this point, and in others more remote, but never as far distant as the shaft of the bone; while the capsule of the fractured bone is often found to have its insertion into the shaft, the entire neck of the bone having been removed by absorption before union occurred.

4th. The capsular ligaments of the opposite humeri of the same subject, are exactly alike in their insertions into the neck of the bone; hence the surgeon who makes an autopsy after union

of fracture of the neck of the femur, removes both hip-joints, the insertion of the capsular ligament of the sound femur will show the normal insertion of the capsular ligament of the fractured bone, and a comparison of the two specimens will determine at once whether the line of union in the given specimen be altogether within the normal capsule.

5th. The line of union in a given specimen of fracture of the neck of the femur cannot be said to indicate the exact position of the line of fracture, if the neck suffered loss by absorption before union occurred; since it is impossible to determine that the loss of structure was entirely at the expense of either fragment of the neck. Some surgeons have recorded, as examples of bony union of intra-capsular fracture, cases in which the neck was completely removed by absorption, and the head of the bone closely united to the shaft, and have claimed in these instances, that the neck was fractured close to the head of the bone; while other surgeons, who also regarded the line of union as being identical with the line of fracture, have maintained that the fracture in each of the given specimens occurred close to the shaft of the bone.

6th. Under favorable circumstances fractures of the neck of the femur external to the capsular ligament unite readily by bone, so also do fractures which are partly within and partly without the capsule; and it is highly probable that fractures within the capsule, which are followed by absorption, are sometimes united by bone, after the process of absorption has reached a point external to the normal capsule, where bony material is supplied; but this, if it ever does occur, can never be proven; for, if the line of union be partly without the normal capsule, it is impossible to determine that the fracture was entirely within it, and we can never be positive that bony union of intra-capsular fracture has occurred, until a specimen is presented in which the line of union is found to be entirely included by the normal capsule.

7th. Fractures of the neck of the femur are, in most instances, followed by the absorption of a part or the whole of the neck, and a careful review of the cases recorded as proofs of bony union of intra-capsular fracture shows that, in the great majority of the cases, the posterior surface of the neck of each specimen had lost very much of its length by absorption before union occurred, and that the line of union on this surface, although

included by the morbid capsule of the specimen, was too near the shaft of the bone to be included by any specimen of the normal capsule.

8th. Fracture within the capsule is followed, to a greater or less extent, by disease of the different tissues which constitute the hip-joint, and the neck of the femur being very imperfectly nourished after the fracture, usually suffers great loss by absorption before union occurs, so that its appearance after union resembles that appearance of the neck which is described by pathologists as the result of an interstitial absorption of the neck which occurs without fracture, as a consequence of old age. So closely allied are these appearances, that eminent pathologists in this

and in other countries have claimed, with at least a fair show of reason, that many of the specimens hitherto exhibited by surgeons as proofs of bony union of intra-capsular fracture, have been examples illustrative of the changes produced by interstitial absorption; hence, in the further investigation of this subject, it becomes a matter of great importance that the diagnosis of fracture of the neck be clearly made out, and that it be vindicated by competent surgeons in consultation, and placed upon record in anticipation of an opportunity to complete the history of the case, it may be many years afterward, by describing the post-mortem appearances of the fractured bone.

DISCUSSION UPON THE FOREGOING PAPER IN THE SURGICAL SECTION OF THE NEW YORK ACADEMY OF MEDICINE.

Dr. James R. Wood, Chairman.

Stated Meeting, November 22, 1861.

DR. GEORGE K. SMITH, of Brooklyn, having at a previous meeting read an elaborate and interesting paper on the "Relation of the insertion of the capsular ligament to intra-capsular fracture of the neck of the femur," opened by appointment the discussion upon it by reviewing the whole subject briefly as follows:—

In opening the discussion I propose to mention, briefly, some of the reasons why different surgeons, equally honest in their search for truth, and equally competent to judge of the points at issue, have hitherto been so much at variance in the investigation of this subject; and afterward read the summary of my paper.

The *first* of these reasons is, that different surgeons have located the posterior insertion of the capsular ligament at different points—some at the middle of the posterior surface of the neck, some as far remote as the shaft of the bone, and others at all points intermediate between these two extremes; so that a fracture, located three-fourths of an inch distant from the posterior inter-trochanteric line, would, in the opinion of one surgeon, be extra-capsular, while, in the opinion of another surgeon, it would be entirely included by the capsule. *Second*, surgeons have not seemed to be aware of the fact that the insertion of the

capsular ligament is removed by the morbid changes which occur as a consequence of the fracture. This circumstance has given rise to the following difference of opinion. The surgeons who have made autopsies, after union of a fracture of the neck, have found the line of union included by the capsule of the specimen, even after the removal of the entire neck by absorption. In this circumstance they have found (as they supposed) positive evidence that the fracture, and its subsequent union, were intra-capsular. Having determined this point, they have macerated the specimen to prove that the bond of union was composed of bony material; and when, after maceration, the bone has been viewed by other surgeons, some, finding the line of union close to the shaft of the bone, believed it to be ~~intra~~-capsular; while others, who found the line of union equally close to the head of the bone, interpreted its proximity to the head in favor of an extra-capsular fracture. Mr. Jones's case furnishes a fine illustration of this difference of opinion. Mr. Jones states that

"On dissection, the capsule was found very much thickened, and it was not until the shaft of the bone was divided that the knife could be passed around the joint, so contracted was the space between the trochanter major and the edge of the acetabulum. The direction of the fracture

intra

ould not be traced, or the bond of union made out, until the bone had been macerated. As portions of the capsule became loose, they were removed by the forceps, which enabled me to discover, what I believe to be the case, that the fracture occurred entirely within the capsule."

After maceration the bone was presented to Sir Astley Cooper for inspection. He was of opinion that

"The fracture was in part within, and in part external to the capsular ligament; in part united, and in part not, and the neck of the thigh-bone absorbed."

The following is Mr. Stanley's history of Jones's case:—

"The history of the case is clearly that of a fracture of the neck of the femur; the appearances of the bone show that there has been a fracture which has reunited by an osseous medium, and the direction of the fracture is such as, in my opinion, can permit no doubt that it was confined to the portion of the neck of the bone covered by synovial membrane; consequently, that it was wholly within the capsule. The fracture extends through the basis of the head of the bone in the line of its junction with the neck. As in other cases of the same kind, a great part of the neck has disappeared, and in consequence the head is proportionately nearer to the trochanter major and shaft of the bone; *its reunion has*, in fact, taken place in part to the remaining portion of the neck, and in part to the shaft."*

(Dr. Smith here exhibited a plate representing the posterior surface of the specimen, taken from the *Medico-Chirurgical Transactions*.)

For the conclusions to which I have arrived, see summary of the paper on page ~~519~~ 28

PROFESSOR WOOD has suggested that I should give a brief review of the specimens of union within the capsule which have been reported.

Robert William Smith has reported seven cases of osseous union of this fracture. Four of these cases are not illustrated by the engravings of the specimens, and their histories have failed to assign a definite location to the line of union; therefore, if we admit in either case that the bone was fractured, we have no means of determining whether the line of union was within, or without the normal capsule. The histories of three of these cases are also defective in other very important points. Mr. Stanley's case does not show conclusively that the bone was ever fractured, nor does the history state that the patient was treated for a fracture; on the contrary, Mr. Stanley's history of the case shows that most of

the surgeons who saw the case believed that, instead of a fracture, there was "a dislocation into the foramen ovale;" also, that the patient was treated for a dislocation. "Extension was made with the pulleys, and the limb moved in different directions, to replace the head of the bone."

In the history of Mr. Swan's case, the only evidence that the neck of the bone was fractured is found in the opinion of Sir Astley Cooper, who, however, acknowledged his inability to detect crepitus, or any other symptoms of fracture, except pain on movement of the limb, and "a slight inclination of the toes outward."* In the history of Mr. Chorley's case, Mr. Smith admits that "a portion of the upper fragment extended in one situation a little external to the capsule;" an admission which at once excludes the specimen from the class under consideration. In each of the three remaining cases reported by Mr. Smith, the appearance of the specimen is represented by engravings, which show that the posterior surface of the neck has been mainly removed by absorption, and that the line of union on this surface is too close to the shaft of the bone to be included by any specimen of the normal capsule. Mr. Smith regards these cases as examples of impacted fracture, in which the fragments have been so locked together that "they have been maintained in contact and at rest;" and states that "it is only under such circumstances that we are to hope for the occurrence of bony consolidation."† The histories of these cases state that the neck has been absorbed, and the engravings show that nearly the whole of the neck has been removed; hence the impaction, which Mr. Smith considers so essential to bony union, must have been loosened by the subsequent absorption. Again, I cannot see how Mr. Smith is able to determine that the fracture was intra-capsular, after so great a portion of the neck has been removed. The line of union in each of these specimens is too near the shaft of the bone to be included by any specimen of the normal capsule I have seen, and I have taken accurate measurements of more than sixty.

Professor Mussey has reported three cases of bony union, in each of which the line of union is shown, both by the history of the case and the engraving of the specimen, to be close to the

* *Medico-Chirurg. Trans.*, vol. xxiv.

* Cooper on Dislocations and Fractures of the Joints, p. 157.
† Smith on Fractures, p. 64.

shaft of the bone; too close to be included by any specimen of the normal capsule. It is evident that he located the posterior insertion of the capsule close to the shaft of the bone, since it must of necessity be so in order to include the line of union in either of his specimens; moreover, he has reported, as illustrations of intra-capsular fracture, two cases of fibrous union in which the whole of the neck has been removed by absorption.

Dr. Smith next reviewed the cases reported by Professor March. He said that as Professor March was present, he hoped to hear something interesting from him on the subject, and would be as brief as possible. He read the history of the first case, and remarked concerning the specimen, that the fracture and its subsequent union were probably within the normal capsule; that about half of the neck had been removed by absorption, and that the remaining half is attached to the shaft; also, that the head of the bone, which appears to be united to the posterior surface of the remaining fragment of the neck, is in reality separated from it by the capsular ligament, which was folded between the two fragments. He then exhibited the specimen, stating that if it were held between the eye and the gas-light, one could see through between the posterior surface of the neck and the head, proving that the fragments are not united in that situation, and that only the extremity of the neck is attached to that portion of the head overlapping it. He further stated, that some of the bond of union is composed of fibrous material, but could not say that it was all of that character. He, however, suggested the importance of macerating the specimen to settle that point. He then exhibited Professor March's second specimen, calling attention to the fact that the capsular ligament which has been preserved with the specimen is inserted so far remote that it includes nearly all of the trochanter minor; that the history does not afford conclusive proof that the neck was fractured, and that, if ever broken, the line of union is too near the shaft of the bone to be included by the normal capsule.

He next proceeded to give an account of a case reported by Dr. Holmes, of Canton, Pa. He said that the posterior surface of the neck of the specimen had lost about half of its length by absorption, and that the line of union, as given by Dr. Holmes, was too near the shaft of the bone to be included by any specimen of the normal

capsule examined by him. He said that Dr. Holmes had informed him, by letter, that "the specimen had been boiled, and sufficiently tested to satisfy all those who have examined it, of the bony union," and further, that "the capsular ligament is entire on the bone." He thought that the specimen had not been sufficiently tested in this particular; for, if the bone had been boiled long enough to separate a fibrous union, the capsular ligament could not now remain attached to the specimen. He then read the history of Professor Parker's case, and said that there seemed to be no doubt that the bone had been fractured, for the attending surgeon noticed shortening of the limb, eversion of the toes, and detected crepitus on moving the limb. He said that the anterior surface of the neck retained about its normal length, while the posterior surface had been almost completely removed by absorption, and thought that the line of union on this surface could not be regarded as intra-capsular.

In regard to Professor Post's specimen, he regretted that no history of the case could be obtained. The external appearances of the neck were strongly indicative of fracture, with bony union; the sections of the bone, however, gave no evidence of fracture, the cancellated structure of the head and neck being perfect throughout. If the bone was fractured, the line of union was without doubt within the normal capsule.

PROFESSOR ALDEN MARCH, of Albany, (who was present by invitation,) being requested to give his views upon the points before the meeting, remarked that, so far as the question related to the varying points of attachment of the capsule to the os femoris, Dr. Smith's simple and ingenious mode of measurement set the matter at rest. He believed that we should find a difference in the point of attachment at the posterior part of the neck of the bones in the normal and abnormal specimens. He agreed with Dr. Smith, that in all cases of *intra-capsular* fracture, the neck, whether more or less attached to the head or shaft of the bone, was almost or entirely absorbed before any effort at reunion took place, either by ligamentous or bony material. And, furthermore, that as absorption progressed, when it began to encroach upon the attachment of the capsule in its natural site, the attachment gradually receded or was carried outward, so as either to approach closely to or be transplanted into the posterior inter-trochanteric line. This view of the subject, he stated, was supported by the analogy

which existed between the pathological conditions of the capsule in those cases, and in those of *morbus coxarius*. In the latter disease, as the destructive process goes on, the capsule will be carried back upon the face of the bone, to correspond with the enlargement of the acetabulum. He then exhibited several specimens of hip disease, with the capsular ligament thus abnormally attached, which fully illustrated the point referred to. Three specimens of his own, of intra-capsular fracture of the cervix femoris, were next exhibited; the first, to show the rapid absorption of the neck, without any effort at union; the second, absorption of the entire neck and ligamentous union at a later period; and the third, to illustrate nearly the same amount of absorption as in the other cases, but with *bony union*. The first specimen of fracture was from a white-washer, who fell from a ladder and injured himself in the hip. He was taken to the almshouse, where he died in the course of a few weeks. Dr. March saw the case at the time of the accident, and called it a fracture of the neck of the femur. On making the post-mortem examination, he found, to his surprise, that the neck of the bone had completely disappeared, as if it had been cut out. There was, however, no ligamentous or other attachment of the head to the shaft of the bone.

The second specimen was recently obtained from an almshouse subject, who, in January, 1860, while engaged in sport with other inmates of the institution, was merely thrown upon the injured hip. The attending physician, Dr. Bouleware, (who reported the case to Dr. March,) diagnosed the injury to be fracture within the capsular ligament. It was treated by placing the fractured limb upon a pillow, and confining the patient on his back for several weeks. In the course of a few months he could get about pretty comfortably by holding on to chairs, tables, etc. with his hands. On the 28th of August, 1861, nearly twenty months after he received the injury, he died from an attack of dysentery.

In the third specimen of intra-capsular fractures, (in which there appeared to be bony union,) there was more of the neck attached to the shaft on the anterior face of the bone than in either of the other specimens, though posteriorly the relation of the head and shaft appeared nearly the same. No history of this specimen could be obtained; it was purchased abroad some years since, with other pathological specimens, for the museum of the Albany Medical College.

A fourth specimen, which he claimed to be an intra-capsular fracture, was also shown. It occurred in a boy ten or twelve years of age, who, from the date of the accident, was always lame. He died at the advanced age of sixty-two years. The history of the case could not be procured, since the attending surgeon died some thirty or thirty-five years before the patient. The non-professional testimony was abundant, and strongly in favor of the nature of the accident assumed. In this case, the line of the fracture on the anterior face of the neck, and in fact on the posterior face, corresponded in a remarkable manner with the last specimen exhibited. The upper part of the thigh-bone of the same subject, from the opposite side, was exhibited, and found to be nearly in a normal condition, with the exception of a slight change in the form of the head of the bone, which must have taken place at an advanced period of life, from chronic arthritic inflammation.

He next exhibited several specimens of extra-capsular fracture of the neck and trochanter, some of which were beautiful examples of that variety called impacted fracture. But one specimen seemed to be peculiar in these particulars—there was little or no distortion; no *shortening*, no *inversion*, and but the slightest amount of *eversion*; without doubt, no crepitus could have been detected at the time of the accident, and hence a direct diagnosis would have been almost impossible. He remarked that it was curious to observe that in those specimens (and he thought it would be found true in all other extra-capsular fractures, whether impacted or not) there was no absorption or shortening of the neck. Whereas there was great shortening, and in most instances almost entire absorption of the neck of the bone, when the fracture was within the capsule; while the contrary was the case when the fracture was without the capsule. This being the case, would not the post-mortem condition of the part furnish complete and satisfactory evidence of the nature and situation of the fracture during life?

Dr. March suggested to all present to apply the test of injecting plaster of Paris in all those cases of *suspected intra-capsular* fractures where death occurred at a period remote from the receipt of the injury, that we might ascertain as conclusively in the pathological, as Dr. Smith had done in the anatomical specimen, the precise extent of the attachment of the capsule on the posterior face of the neck of the bone. He also

suggested, as a subject worthy of study, and needing explanation, why it is that the bony material of the neck of the femur was so freely and so rapidly absorbed in intra-capsular fracture—and by what means it was accomplished, while the same effect does not follow in other fractures.

Assuming as he did, that in most cases of intra-capsular fracture of the neck of the femur the fracture took place near or close to the head of the bone, and that *all* of the neck on that portion connected with the shaft was absorbed; and that the capsule *recedes* as the destructive process goes on, so as to be found in due time attached posteriorly near, or upon the posterior inter-trochanteric line, as has been shown in the specimens exhibited by Dr. Smith, he believed that one of the difficulties in deciding whether a certain fracture was entirely within the capsule was satisfactorily removed. This discussion was calculated to bring two points prominently before the medical public, viz., the *rapid absorption* of the neck of the bone in intra capsular fractures, and the abnormal connection of the posterior portion of the coxo-femoral capsule.

The specimen of Dr. Holmes, to which Dr. Smith had referred, was submitted to the examination of the Medical Society of the State of New York, at its session of 1860. Dr. March was of opinion that it was a genuine case of complete intra-capsular fracture, with bony union. But as some of the members of the society seemed to doubt the correctness of this opinion, a committee, consisting of Dr. Brinsmade, of Troy, Dr. Parker, of Poughkeepsie, and the speaker, was appointed, to whom the subject was referred for a critical and thorough examination, both by maceration and the microscope. But the committee never obtained possession of the bone, and reported accordingly at the session of 1861, with the request (suggested by Dr. Holmes) that it be continued, which was done. But up to this time, the committee have neither received the specimen nor heard from its possessor.

The doctor, in conclusion, took occasion to say something about morbus coxarius. He presented several specimens of necrosis of the head of the bone detached from the neck; one from the living subject, from whom it worked out spontaneously, and the patient recovered; and another which had been found in a post-mortem specimen. In a third specimen, about one-third of the head of the bone was found dead, but not entirely cast

off. A fourth specimen was exhibited, in which an exfoliation of the head of the bone, somewhat larger than the thumb-nail, was cast off, and extracted through an incision made into the joint at an early period of the disease. This patient also recovered. These specimens, he thought, would go to prove the correctness of his views presented to the medical public in a published paper of the *Transactions of the American Medical Association* for the year 1853, on the Pathology of Hip Diseases, and the mechanical means suggested to prevent progressive absorption. They will, he said, especially help to prove the efficacy of the treatment of my friend, Dr. Sayre, who not only uses extension and counter-extension to relieve the inflamed and tender parts from pressure, but advocates cutting freely into the hip-joint, under certain circumstances. If nature feels the necessity and adopts the means, painful and tedious though they be, to separate the dead head from the shaft of the bone, Dr. Sayre can do it much more speedily and effectually with his knife. The effort, he said, that was made a few years ago, to bring into disrepute the mechanical treatment of hip disease, (as suggested by himself,) and to recommend exercise, and motion of the joint in all stages of the disease, and to rely upon constitutional remedies, seems about as preposterous as would be the treatment of a broken leg without any dressings or means of support, and directing that the individual thus affected should move about and take free outdoor exercise.

Stated Meeting, December, 27, 1861.

DR. A. C. POST remarked as follows:—

“I appreciate highly the laborious and scientific investigations, the results of which Dr. Smith has presented to the Section. I believe that they will lead to important modifications of the views which have been entertained by surgeons with reference to the important class of injuries to which they relate. But I am not prepared, without further demonstration, to assent to all the conclusions at which he has arrived. I have no objection to make to either of the first four propositions, as stated by Dr. Smith. The fifth proposition seems to me to be founded on an error, or at least on a statement which has not been demonstrated to be a fact. The statement to which I allude is this, viz., that when the cervix femoris has been fractured, and the fragments have reunited, and the cervix is found on post-mortem examination to be shorter than that of the opposite side, the absorption, to which this shortening is due, preceded the union of the frag-

ments. It appears to me more probable that the union, in such cases, takes place in the first instance, and that the interstitial absorption is a subsequent event. This view would seem to be supported by the fact that before union has taken place the fragment connected with the head of the bone has a very imperfect supply of the veins or lymphatics, through whose agency the absorption would be likely to occur.

"In order to demonstrate the truth of Dr. Smith's proposition it would be necessary to present a series of preparations taken from patients who had survived intra-capsular fractures for variable but known periods antecedent to union, and to show that there was a progressive shortening of the neck before the occurrence of union. Dr. Smith's sixth proposition seems to me to involve errors, or at least unsustained hypotheses, more glaring than that which is objected to in the fifth proposition. The language which is employed by Dr. Smith, in the sixth proposition, seems to convey the idea that the main obstacle to bony union, in intra-capsular fracture, is to be found in the condition of the fragment connected with the shaft of the bone; and that when the portion of the neck between the fracture and the shaft has been absorbed, the obstacle to bony union is thus removed. Now, I conceive the principal obstacles to bony union in intra-capsular fractures to be found in the condition of the fragment connected with the head, which, having no supply of blood-vessels, except those which are conveyed to it by the ligamentum teres, does not receive sufficient nourishment to secure its union by bone with the other fragment. The seventh proposition seems to be founded on the same errors or unsustained hypotheses which are contained in the fifth and sixth. The first sentence in this proposition requires to be qualified by confining the statement to intra-capsular fractures, as it has not been demonstrated that there is ordinarily any shortening of the cervix femoris following extra-capsular fractures. The eighth proposition is founded on the same error or unsustained hypothesis as the three preceding ones, viz., that the shortening of the neck by absorption precedes the union of the fragments by bony or fibrous tissue. From the similarity in the appearances of certain cases of fractured cervix in which union has taken place, and in which a large portion of the cervix has been absorbed, to certain cases of disease in which shortening has occurred without fracture, it might be inferred that probably the union of the fragments has preceded the absorption of the cervix.

"The principal interest which attaches to Dr. Smith's report appears to me to be the demonstration that there is a considerable diversity in the extent of the portion of the cervix femoris which is included within the capsule in different subjects; and that the portions included within the capsules are equal on the two sides of the same subject. He has also demonstrated that there is a considerable portion of the cervix in-

tervening between the insertion of the capsule and the inter-trochanteric lines. From these facts which have thus been demonstrated, it may fairly be inferred that it will ordinarily be impossible to determine, during life, whether or not fracture is entirely within the capsule. And in old cases where absorption has taken place, and the capsule has shifted its position, it may be impossible, even by a post-mortem examination, to determine positively whether the fracture was originally within the capsule.

"I propose, therefore, to make a new classification of fractures of the cervix femoris, dividing them into two classes, viz., fractures between the caput femoris and the inter-trochanteric lines, and fractures at the inter-trochanteric lines extending more or less into the shaft of the bone. I propose to call the fractures of the first class *intra-cervical*; and those of the second class, *extra-cervical*. I think that these two classes of fractures will be found to correspond very nearly with those which have hitherto been described as intra-capsular and extra-capsular. They are somewhat distinct in the signs by which they are characterized during life, and are strikingly dissimilar in their appearances, as disclosed by examination after death. I submit the following propositions:—

"1st. Intra-cervical fractures are usually included within the capsular ligament, being near the head of the bone, and often involving a portion of it.

"2d. Intra-cervical fractures are attended with a shortening of the limb, which, in recent cases, rarely, if ever, exceeds an inch.

"3d. In intra-cervical fractures bony union very rarely occurs. When bony union fails, there is sometimes ligamentous union, and sometimes the fragments remain entirely detached from each other.

"4th. In intra-cervical fractures, whether bony union takes place or not, the cervix femoris becomes greatly shortened by interstitial absorption, and, after the lapse of several weeks or months, the limb may be shortened to the extent of two inches or more.

"5th. In intra-cervical fractures, as the neck of the bone is shortened by absorption, the capsule shifts its position, so that in some cases it ultimately becomes attached to the shaft of the bone.

"6th. In extra-cervical fractures, the cervix femoris is driven into the spongy structure at the junction of the trochanters with the shaft of the bone; and if the fracture be the result of a moderate amount of force, the upper fragment will be impacted into the lower. The shortening in such cases varies, according to Robert W. Smith, from a quarter of an inch to an inch and a half.

"7th. When an extra-cervical fracture is produced by a greater amount of force, the impaction is relieved by the splitting off of the trochanters, and the fragments acquire a considerable degree of mobility. In such cases, the shortening varies from one inch to two and a half inches.

"8th. In extra-cervical fractures, bony union may generally be expected, if the patient be not infirm, or of very advanced age. The union of the trochanters with the shaft of the bone takes place at an earlier period than the union of the neck with the shaft. An exuberant growth of bony matter is apt to take place at the junction of the trochanter with the shaft of the bone.

"9th. There is not usually any remarkable shortening of the cervix femoris after extra-cervical fractures."

The Society then, on motion, adjourned.

Stated Meeting, January 24, 1862.

Dr. George K. Smith, in replying to the remarks made at a previous meeting by Prof. Post, commenced by quoting the following from that gentleman:—

"The fifth proposition seems to me to be founded on an error, or at least on a statement which has not been demonstrated to be a fact. The statement to which I allude is this: when the cervix femoris has been fractured, and the fragments have reunited, and the cervix is found on post-mortem examination to be shorter than that of the opposite side, the absorption to which the shortening is due preceded the union of the fragments. It appears to me more probable that the union in such cases takes place in the first instance, and that the interstitial absorption is a subsequent event. This view would seem to be supported by the fact that before union has taken place the fragment connected with the head of the bone has a very imperfect supply of the veins or lymphatics through whose agency the absorption would be likely to occur."

It is very true that the fragment of the neck attached to the head of the bone is, to a great degree, deprived of its arteries and veins by the accident. If the force of the blow producing the fracture be sufficient to rupture the cervical ligament, and separate the fragments, the upper fragment is then supplied with blood by one, and in some cases two small arteries, which pass through the ligamentum teres to the head of the bone. The elements of nutrition being thus imperfectly supplied to this fragment, we infer that it will be absorbed with greater rapidity than the femoral fragment, which, after the fracture, has an abundant supply of blood. This will certainly be the case, provided that each fragment of the neck has a sufficient number of veins and lymphatics to accomplish its absorption. I have often examined that branch of the obturator vein which returns the blood from the head of the bone, and have usually found it about the size of a crow's quill; and while it is admitted that this

is quite unequal to the number and caliber of the veins supplied to the femoral fragment of the neck, it must be remembered that *absorption through this channel is not held in check by the antagonistic force of an abundant nutrition.*

Prof. Post assumes, as a fact, that "before union takes place the head of the bone has also a very imperfect supply of lymphatics, through whose agency the absorption would be likely to occur." It appears that the minute distribution of the lymphatic system is yet imperfectly understood by anatomists. Some authors state that bone tissue is not supplied with lymphatic vessels, while others claim that it is. Cruveilhier states that

"Lymphatic vessels have not yet been actually demonstrated in the bony tissue but it is probable that they really exist there; at least the process of nutrition in bones and certain morbid phenomena which they present lead to the belief of their existence."* "Cruikshank, Sæmmering, and Bonamy have succeeded in tracing them into the interior of the bones."† "Lymphatic vessels are found in most tissues and organs which receive blood, but have not been detected in the substance of the brain and spinal cord, in the eyeball and labyrinth, nor the placenta and its membranes. The principal lymphatic vessels are more numerous than the arteries and veins, but very much finer. They are long, threadlike, transparent tubes of difficult detection, unless some colored substance is injected into them. The mode in which the lymphatics commence has been imperfectly ascertained, in consequence of the extreme tenuity and transparency of the vessels and the impossibility of injecting colored liquids in a direction opposed to the opening of the many valves which occupy the larger branches. For the most part they appear to originate in close capillary nets, intercalated with the sanguiferous capillaries, but having no communication with them."‡ "The lymphatics are found in nearly every texture and organ of the body, with the exception of the substance of the brain and spinal cord, the eyeball, cartilage, tendon, membranes of the ovum, the placenta, and umbilical cord. Their existence in the substance of bone is doubtful."§

If, from the conflicting statements of authors concerning this subject, we are led to believe that lymphatic vessels have not yet been discovered in the bony tissue, we are by no means at liberty on that account to deny that they really exist; for this summary method of disposing of the question would exclude further investigation, which might lead to their discovery.

* Cruveilhier's Anatomy, p. 14.

† Pancoast's Wistar, vol. ii., p. 337.

‡ Leidy's Anatomy, p. 428.

§ Gray's Anatomy, p. 425.

Dismissing this point, we notice that Cruveilhier states that synovial membranes are abundantly supplied with lymphatic vessels, thus: the origin of the lymphatics can be shown only upon free surfaces, such as the mucous membranes, the skin, the serous and synovial membranes, and the lining membranes of arteries and veins. All the lymphatics arise by a net-work of such tenuity that when injected with mercury the whole surface appears changed into a metallic layer. The synovial membranes may be injected with the greatest facility, either near the cartilages where they are more tense than in other parts, or upon the ligaments to which they adhere.*

If synovial membranes are thus abundantly supplied with lymphatics, it can hardly be doubted that there are lymphatic vessels in the ligamentum teres which may become active agents of absorption after fracture of the neck of the femur; since the ligamentum teres is enveloped throughout its extent by synovial membrane. Gray states that "the deep lymphatics accompany the deep arteries," and that "the lymphatics of any part or organ exceed in number the veins, but in size they are much smaller."

If now the lymphatics originate in accordance with Leidy's opinion, "in close capillary nets, intercalated with the sanguiferous capillaries," and pass in a direction from without inward, accompanying the arteries, we can see no good reason why that branch of the obturator artery which supplies the head of the bone with blood should form an exception to the rule. With our present imperfect knowledge concerning the origin and distribution of the lymphatics, it appears to me that the statement of Prof. Post, that before union takes place the head of the bone as a very imperfect supply of the veins or lymphatics through whose agency the absorption would be likely to occur," is a statement which requires further anatomical investigation before it can be admitted as a fact.

Whatever the agency may be by which the result is accomplished, absorption of the head and neck of the bone does actually occur, without any apparent attempt at union of the fragments; and the rapidity of the absorption is sometimes so great that nearly the whole of the neck has been known to be removed in less time than is required for bony union of this fracture. Thus:—

"The superior fragment of the broken cervix usually disappears to the level of the brim of the acetabulum, either in consequence of the action of the absorbent vessels, or by the friction of the broken surfaces, or perhaps it is due to a combination of both these causes. The absorption, however, sometimes extends much further; I have seen half of the globular head of the bone thus removed, and a case has been recorded in which the head of the bone was completely absorbed. * * * * In old cases the femoral fragment is likewise absorbed to a greater or less extent; sometimes it disappears entirely to its base, and the portion of the shaft from which, in its normal state, it springs, presents a smooth and even surface, limited by the trochanters and their connecting lines. * * * The absorption of the lower fragment is sometimes effected with extraordinary rapidity; in case No. 9, the shortening of the limb, which immediately followed the receipt of the injury, was only a quarter of an inch, but after the expiration of six weeks it amounted to one inch and a half; and in case No. 12, the removal of the greater part of the neck of the bone was accomplished in less than a month."*

Here we see the effect, and from the effect we infer the cause which produced it; for, although we may be unable to trace the immediate connection of cause and effect, we know that nature never accomplishes any purpose without employing means which are adequate to the ends produced. If after fracture of the neck the whole head be removed by absorption, without any attempt at union of the fragments, we are forced to conclude that the supply of veins and lymphatics to the head of the bone is sufficient to produce this result, since it is through the agency of these vessels that absorption occurs, and we can therefore see no physiological necessity for the absorption of the neck to be preceded by bony union of the fragments. I would not, under any circumstances, knowingly put a wrong construction upon the language of any surgeon, but, if I correctly understand the following proposition of Prof. Post, it does not seem to me to be strictly in harmony with his criticism of my fifth proposition:—

"In intra-cervical fractures, whether bony union takes place or not, the cervix femoris becomes greatly shortened by interstitial absorption, and, after the lapse of several weeks or months, the limb may be shortened to the extent of two inches or more."

Prof. Post states that in order to demonstrate the truth of my fifth proposition "it would be necessary to present a series of preparations

* Cruveilhier's Anatomy, p. 612.

* Smith on Fractures, p. 42.

taken from patients who had survived intra-capsular fractures for variable but known periods antecedent to union, and to show that there was a progressive shortening of the neck before the occurrence of union." It appears to me that it would be almost impossible to obtain such a series of preparations, since they must be procured immediately after union, else Prof. Post would claim that this shortening of the neck by absorption did not occur till after the fragments were united. They cannot be obtained till after the death of the patient, and it will seldom happen that a patient, whose vital powers are sufficient to secure bony union of a fracture of the neck of the femur, will die immediately after union has occurred. Again, if it were possible to procure such a series of preparations, they would not be likely to illustrate "a progressive absorption of the neck," since the whole of the neck is, in some cases, removed in a few weeks or months, while in other cases as many years will transpire with a portion of the neck still remaining. The following extract, from Mr. Howship's report of "cases of fracture of the neck of the femur,"* will exhibit this fact:—

"1. Age seventy-six; lived three weeks after the fracture; neck shortened half an inch; no union. 2. Age seventy-five; lived two months after the fracture; neck shortened three-quarters of an inch; slight fibrous union. 3. Age seventy-eight; lived five months after the fracture; neck still undergoing absorption. 4. Age sixty-six; lived five months after the fracture; the neck completely removed by absorption; firm fibrous union. 5. Age seventy-nine; lived ten months after the fracture; neck nearly absorbed, with no attempt at union. 6. Age seventy-nine; lived twenty-two months after the fracture; neck entirely gone; no union. 7. Age seventy; lived eight years after the fracture; neck nearly absorbed; firm fibrous union. 8. Age fifty; lived fourteen years after the fracture; neck about half removed by absorption; the fragments not united."

In the last case the patient was not as old by many years as either of the patients mentioned in the preceding cases, and this fact would suggest a more abundant nutrition of the fragments, which accounts, to a great degree, for the slower progress of their absorption. Since the last meeting of the Section I received a letter from Dr. Asa Horr, of Dubuque, Iowa, informing me that he had lately obtained a specimen of fracture of the neck of the femur. He gave a brief history of the case, with a description of the specimen,

and said, that, if I should "regard the specimen as of any value to science," he would forward it to me on receipt of my reply. Through his kindness I am enabled to exhibit the specimen this evening. It is from a patient fifty-eight years of age, who died a little more than a year after the occurrence of the fracture. The fragments were not united. I have macerated the specimen, and you will observe that all of that portion of the neck attached to the head of the bone has been removed by absorption, while a portion of the neck, about half an inch in length, still remains attached to the shaft. The specimen is interesting as a further illustration of the fact that absorption after fracture of the neck does not proceed with any regularity, a given distance in a given length of time, but generally progresses with greatest rapidity in patients who suffer from this fracture at an advanced period of life, when the elements of nutrition are very imperfectly supplied.

It appears to me that the opinion of Professor Post, that "the union takes place in the first instance, and that the interstitial absorption is a subsequent event," is an opinion which necessarily involves the disastrous consequence of disunion of the fragments, as one of the results of such absorption, since parts newly formed are more readily attacked by absorption than those of longer standing; and we must, therefore, expect that the callus by which the fragments were united will be first attacked, and that its absorption will result in disunion long before the whole of the neck shall have been removed. The following is interesting as an illustration of this point:—

"The callus is subject to *softening*, disintegration, and absorption, if not also to the fatty degeneration. * * * Occasionally the absorption can be distinctly traced to the inordinate use of mercury, carried to profuse salivation; or it may be owing to a syphilitic taint of the system, especially when this affection has reached its third stage, in which the bones and periosteum are constantly and often so seriously involved. But the most common cause, perhaps, of all, is the impoverished and diseased state of the blood from the use of improper food, and especially from the want of a sufficient quantity of fresh vegetables and subacid fruits. The influence of ill health arising from this cause upon the condition of the callus was strikingly exemplified in Lord Anson's voyage to the Pacific Ocean, which many of the crew suffered severely from scurvy. It was noticed that those who had formerly had fractures were attacked with absorption of the callus, speedily terminating in d

* Medico-Chirurgical Review, (New Series,) vol. xxiv. p. 102.

nion of the ends of the broken bone. Cicatrices, whether the result of the healing of wounds or of ulcers, experienced a similar fate, the parts breaking out into open sores, remarkably pale, languid, flabby, and difficult of cure. Similar effects are occasionally observed to follow attacks of typhoid fever and anæmic states of the system, however engendered.*

Professor Post further states:—

“The sixth proposition seems to me to involve errors, or at least unsustained hypotheses, more glaring than that which is objected to in the fifth proposition. The language which is employed by Dr. Smith in the sixth proposition seems to convey the idea that the main obstacle to bony union in intra-capsular fracture is to be found in the condition of the fragment connected with the shaft of the bone, and that when the portion of the neck between the fracture and the shaft has been absorbed, the obstacle to bony union is thus removed.”

I confess that I am unable to see how the above inference can fairly be drawn from the language used. The following is the sixth proposition: Under favorable circumstances, fractures of the neck of the femur external to the capsule unite readily by bone; so also do fractures which are partly within and partly without the capsule, and it is highly probable that fractures within the capsule, which are followed by absorption, are sometimes united by bone, after the process of absorption has reached a point external to the normal capsule where bony material is supplied; but this, if it ever does occur, can never be proven; for, if the line of union be partly without the normal capsule, it is impossible to determine what the fracture was entirely within it, and we can never be positive that bony union of intra-capsular fracture has occurred, until a specimen is presented in which the line of union is found to be entirely included by the normal capsule.

It is well known that bony union is of frequent occurrence in fractures external to the capsular fragment; but it appears to me that we are yet without positive proof that bony union has ever taken place entirely within the normal capsule. Numerous specimens have been exhibited as illustrations of such union; but in the great majority of these specimens the line of union is found to be within the capsule on the anterior surface of the neck, and external to the capsule on its posterior surface, with a portion of the neck still remaining attached to the shaft. Professor Mussey's cases are examples of this kind,

and Professor Parker's specimen illustrates the same point. These specimens represent, without doubt, one or the other of two conditions; there has been either bony union of a fracture partly within and partly without the capsule, in which the shortening was mainly at the expense of the fragment attached to the head; or bony union of the fracture which occurred entirely within the capsule, in which union did not take place until absorption had reached a point which was external to the insertion of the capsule on the posterior surface of the neck; and it is impossible to determine the class to which either of the given specimens may belong. The posterior insertion of the capsule is usually near the middle of the neck, and a transverse fracture a little external to this point will be within the capsule on the anterior surface of the neck, and without the capsule on its posterior surface. It is plainly indicated in the sixth proposition that such a fracture is, under favorable circumstances, sometimes united by bone; also that a fracture at any point between this line and the shaft of the bone is united in like manner, and we are at a loss, therefore, to determine how it is that—

“The language which is employed in the sixth proposition seems to convey the idea that the main obstacle to bony union in intra-capsular fracture is to be found in the condition of the fragment connected with the shaft of the bone, and that when the portion of the neck between the fracture and the shaft has been absorbed, the obstacle to bony union is thus removed.”

Professor Post states:—

“I conceive the principal obstacles to bony union in intra-capsular fractures to be found in the condition of the fragment connected with the head, which, having no supply of blood-vessels except those which are conveyed to it by the ligamentum teres, does not receive sufficient nourishment to secure its union by bone with the other fragment.”

Many reasons have been given for the constant failure of bony union within the capsule; but it appears to me that none have been given which are altogether satisfactory. It is true that there is a want of due nutrition of the fragments in patients who meet with this fracture at an advanced period of life; but we find the same failure to unite within the capsule, if a patient is the subject of this fracture in youth or middle age. In old age the function of nutrition is but imperfectly performed, and the weight of the body is, in consequence, gradually diminished by absorption, each of the different tissues being more or less

* Gross's System of Surgery, 1st edition, vol. ii. p. 145.

affected by the slow decay; and it has been noticed that, for some reason which has not yet been fully explained, the neck of the femur is more seriously affected by this process than other parts of the skeleton. In this fact we see the reason why a fracture of the neck of the femur which is the result of a severe injury, and is of the rarest occurrence in youth, is frequently met with in old age, and often as the result of a most trivial injury. This atrophy or absorption of the neck is, then, the exciting cause of the fracture, and its progress, after the fracture, is seldom, if ever, arrested until a great part or even the whole of the neck has been removed. Malgaigne holds that the destructive absorption of the neck, which follows a fracture within the capsule, is incompatible with bony union. After a careful review of the reports of post-mortem examinations of fractures within the capsule, it appears to me that the materials provided by nature for the uniting callus in this situation are in many cases entirely removed by absorption, leaving no appearance of an attempt at union; and that in those cases in which the callus is not thus removed, it is arrested in its development, forming, in some instances, a kind of semi-cartilaginous material, rounding off the extremities of the fragments, and in others, a firm fibrous union which does not become fully developed into bone. Sir Astley Cooper states that, in recent cases, the capsule is found to be distended with a mixture of serum, synovial fluid, and blood, which—

“Is produced by the inflammatory process, and becomes absorbed when the irritation in the part subsides. I do not know the exact period at which this change takes place, but I have seen it in the recent state of the injury.”*

With regard to the new classification of fractures of the neck proposed by Professor Post, it seems to me that it will render the “vexed question of osseous union within the capsule” more difficult of solution than it will be with the classification now in use. He proposes—

“To make a new classification of fractures of the cervix femoris, dividing them into two classes, viz.: fractures between the caput femoris and the inter-trochanteric lines, and fractures at the inter-trochanteric lines extending more or less into the shaft of the bone. I propose to call the fractures of the first class *intra-cervical*, and those of the second class *extra-cervical*. I think that these two classes of fractures will be found to correspond very nearly with those which have hitherto

been described as *intra-capsular* and *extra-capsular*.”

He divides “*fractures of the cervix* into two classes;” but the class of *intra-cervical* fractures, representing fractures at any point between the head of the bone and the inter-trochanteric lines, includes all possible fractures of the cervix, and hence his *extra-cervical* fractures cannot properly be spoken of as fractures of the cervix, and do not, therefore, correspond in any degree with fractures hitherto described as *extra-capsular*, in which the line of fracture traverses the portion of the cervix included between the insertion of the capsule and the inter-trochanteric lines. The greatest objection to the classification is found in the fact that an *intra-cervical* fracture, which Professor Post thinks will be found to correspond very nearly with an *intra-capsular* fracture, may be either an *intra-capsular* fracture, an *extra-capsular* fracture, or a fracture partly within and partly without the capsule. This fact is important when we consider that these several fractures included under the name of *intra-cervical* differ widely from each other, bony union being of frequent occurrence in a fracture external to the capsule, occasionally seen in a fracture partly within and partly without the capsule, while it has not yet been satisfactorily demonstrated that bony union has ever occurred entirely within the capsule. It is highly important, both in a scientific and a medico-legal point of view, to know whether we can ever expect bony union of a fracture entirely within the capsule. If not, the surgeon who faithfully performs his duty, and fails to secure bony union of this fracture, can summon to his defense, when unjustly arraigned for malpractice, the scientific fact that a fracture within the capsule is never united by bone. Professor Post states that “in *intra-cervical* fractures bony union very rarely occurs,” and he tells us that an *intra-cervical* fracture will be found to correspond very nearly with an *intra-capsular* fracture. If from this we are to understand that bony union of an *intra-capsular* fracture does occasionally occur, we think that he requires us to admit as a *fact* that which surgeons have labored for fifty or a hundred years, and failed to prove. I do not deny the possibility of bony union within the capsule, but simply think that the evidence furnished in proof of such union is not sufficient to establish it as a fact and that further investigation is needed in this direction.

* Cooper on Dislocations and Fractures of the Joints, p. 145.

DR. W. R. DONAGHE spoke as follows:—

Mr. Chairman:—The eight conclusions of Dr. Smith's paper on fractures of the cervix femoris are before us for discussion. With the first four I fully agree, and I am happy to have an opportunity of expressing my appreciation of the obligation under which he has placed us all, by settling, after great and laborious research, points about which anatomists have so long differed.

To the fifth and sixth propositions I cannot fully subscribe. I quote the fifth: "The line of union in a given specimen of fracture of the neck of the femur cannot be said to indicate the exact position of the line of fracture, if the neck suffered loss by absorption before union occurred; hence it is impossible to determine that the loss of structure was entirely at the expense of either fragment of the neck."

In the negative of this I would argue that a specimen, (and the existence of such is undisputed,) in which the neck has been removed by absorption, and the head is closely united to the shaft, *proves that the line of fracture was intra-capsular.*

In such a case the fracture must have been extra-capsular; partly within and partly without the capsule; or intra-capsular. It could not have been extra-capsular, for (1st) in the numerous cases of this variety that have been recorded with illustrations, (R. W. Smith on Fractures, &c.) the neck is exhibited as retaining nearly its full original length. This is what we should expect. Though the vessels are severed which pass to it from the continuous shaft, yet there still remain sufficient sources of blood supply to maintain, in the great majority of cases, its integrity. The capsular ligament, commencing at the margin of the acetabulum, sweeps outward to its insertion, from which irregular line some of its deeper fibres are reflected upon the neck as far as the edge of its articular face, forming a true periosteum to the neck, designated by Dr. R. W. Smith as its "cervical ligament." The synovial membrane lines the internal face of the capsule, and is reflected upward on the "cervical ligament," as far as the head of the bone. Thus the elements of nutrition are supplied to the neck, and it retains its form. 2d. "Extra-capsular fracture is accompanied by fracture with displacement of one or both trochanters," (R. W. Smith, *Malgaigne*.) If the specimen above quoted had been an extra-capsular fracture, it should present evidences of the associated injury, but none are to be seen.

Could such a specimen have been the result of a fracture partly within and partly without the capsule? I cannot recall any cases in which this special variety has been carefully described from post-mortem examination. Its existence seems to have been assumed as an anatomical possibility rather than proved by either distinctive symptoms or autopsy. In such a fracture we may assume that a large part of the neck would remain connected with the head of the bone, and that its conditions of nutrition would be analogous to those

of the neck in extra-capsular fracture. The line of fracture, to bring it into this class, must cross the posterior aspect of the neck, *outside of* the insertion of the normal capsule into that face, (which is usually about midway.) The synovial membrane, guided by the still attached posterior insertion of the capsule, covers the fragment of the cervix connected with the head of the bone. This fragment is also covered by the "cervical ligament," which is continuous with the general capsule along the line of its posterior insertion to the neck. By these two structures the nutritive wants of this fragment are supplied, and it is placed beyond the probabilities of absorption. It must also be remembered, in this connection, that the absorbing powers of the head are feeble. The best histologists, Kölliker, Bowman, Morel, etc., have never been able to detect lymphatics in bone. *We have, then, no right to claim their aid. We are shut up to the veins as the only known absorbent agents in bone.* Could that small, solitary vein that runs back in the ligamentum teres cause the disappearance of nearly an entire femoral neck? I would not deny it some absorbing power. It is well known that in intra-capsular fractures, that small portion of the broken neck, which remains attached to the head, often disappears up to the level of the margin of the acetabulum, and in very rare instances the entire head has disappeared; but in these cases the synovial membrane and "cervical ligament" covering the portion thus absorbed were cut off by the direction and completeness of the fracture from continuity with the distal parts of those membranes which alone could supply their vessels. Hence they added nothing to nutrition. In this fracture (partly within and partly without the capsule) the reverse is true. To quote Dr. G. K. Smith's words, "absorption is held in check by the antagonistic force of an abundant nutrition."

But Dr. Smith argues that "there are lymphatic vessels in the synovial membrane covering the ligamentum teres, which may become active agents of absorption." It is true that the ligamentum teres is covered by a reflection of the synovial membrane; but it is equally true that the articular face of the head of the femur is not so covered. It is now an admitted fact of anatomy that the synovial membrane does not extend over the cartilaginous, articular surfaces. What could the lymphatics, then, of the synovial membrane, folded around the ligamentum teres, do, being obliged to act from a distance upon a head and neck from which they are separated by a thick plate of articular cartilage?

Again, in order that lymphatic vessels may absorb effete atoms, they must be in immediate contact with such atoms—they must be *interstitial*. Lymphatics of the synovial membrane, then, can only absorb elements of the tissue in which they are imbedded. They could not even absorb the component elements of the ligamentum teres which they envelop. If this power be claimed for the lymphatics of the synovial membrane that covers the fragment of the neck,

still attached to the head, the same reply may be made, viz., that *being on the surface* and not permeating the bone, their absorbent power cannot extend to the bone. This difficulty is still further increased by the interposition between them and the bone of the "cervical ligament." Moreover, the fact already enforced, that in extra-capsular fracture the neck, by the nutritive power of the "cervical ligament" and the synovial membrane, retains most of its length, shows that their office is nutritive and not absorbent. In the fracture partly within and partly without the capsule, these two structures are equally in contact with that portion of the neck joined to the head, and contribute to its integrity rather than its removal.

The specimen, then, which we took as a text cannot have been a fracture partly within and partly without the capsule; we have seen that it was not extra-capsular; it must have been intra-capsular. May we not, then, substitute Dr. Smith's fifth proposition, by asserting *that a line of union of a head immediately to the shaft proves an intra-capsular fracture?*

It remains now to explain how, in such specimens of united intra-capsular fracture, the neck was removed. Unless the line of fracture were close to the head, of course the neck would be divided between the head and the shaft, each of which could remove its portion. *Post-mortem examination has established the fact of the removal of the neck in cases of intra-capsular fracture.* Dr. R. W. Smith says: "The superior fragment of the cervix usually disappears to the level of the brim of the acetabulum. In old cases the femoral fragment is likewise absorbed to a greater or less extent. The absorption of the lower fragment is sometimes effected with extraordinary rapidity."

The vein of the ligamentum teres could remove the proximal fragment of the neck, its nutrition being now enfeebled by the rupture along the line of fracture of the "cervical ligament" and synovial membrane. (It may be stated in passing, that to put the fragments in the proper relations for bony union, it is not necessary that the proximal fragment of the neck disappear. If the head alone, or with a piece of neck still attached, comes into contact with extra-capsular parts, the conditions are fulfilled.)

The abundant veins of the shaft could readily remove the distal part of the neck. But it may be said that in intra-capsular fracture, the outer insertion of the capsule is still attached to the femoral fragment of the neck, and is reflected on it as a periosteum, and guides also to it the synovial membrane, which, by their nutritive supplies, will prevent its absorption. This view seems at first plausible; but let us look at the exact condition of the arteries going to this fragment of the neck. They run into it from the shaft and from the "cervical ligament." *They run toward the head.* Suddenly, by fracture, every one of them is torn across. They are now in the condition of arteries in a stump—that is, *they are closed at their ends*

—and thus a back flow in the current is produced. Is it any wonder that the nutrition of a part should be impaired that depends on streams of blood that lie almost stagnant in the *cul-de-sacs* of the torn arteries? To maintain nutrition you must have a continuous current; blood ever changing. The onward impulse of the blood in these torn arteries is checked. Each of them is in a state analogous to that of the proximal end of an artery after the application of a ligature. It is well known that no blood circulates in it as far back as the first collateral branch; and, on the other hand, the current of the veins (which are the absorbents in bone) is *toward* the shaft. The return of the blood in this direction is unimpeded, and it carries along in its flow atoms of the femoral fragment of the neck that have become disintegrated by reason of impaired nutrition.

The condition of the arteries is far different in the part of the neck attached to the head in extra-capsular fracture, and in that form partly within and partly without the capsule. The arteries are derived from the same periosteum or "cervical ligament;" but the periosteum covering the proximal fragment of the neck in these two forms of fracture is continuous outwardly with the general capsule, and inwardly it sweeps over the fragment up to the head without interruption. *It is not torn across*, and thus the arteries sent by it into the bone run along in their normal course toward the head, and terminate in their natural anastomoses; *thus giving to the blood free circuit*, which is the essential condition of full nutrition.

The sixth proposition of Dr. Smith is as follows: "Under favorable circumstances fractures of the neck of the femur, external to the capsular ligament, unite readily by bone; so, also, do fractures which are partly within and partly without the capsule; and it is highly probable that fractures within the capsule, which are followed by absorption, are sometimes united by bone after the process of absorption has reached a point external to the normal capsule, where bony material is supplied; but this, if it ever does occur, can never be proven: for if the line of union be partly without the normal capsule, it is impossible to determine that the fracture was entirely within it, and we can never be positive that bony union of intra-capsular fracture has occurred till a specimen is presented in which the line of union is found to be entirely included by the normal capsule." In opposition to the statement that "it can never be proven that a fracture within the capsule is ever united by bone after the process of absorption has reached a point external to the normal capsule," I have attempted to show that a line of union outside of the capsule proves an intra-capsular fracture which has united by bone. If this be true, the test that Dr. Smith proposes, requiring a line of union entirely "included by the normal capsule," to prove bony union of intra-capsular fracture, cannot be admitted. If the view I have presented

correct, bony union of intra-capsular fracture has been proved by specimens in which the line of union is partly or entirely without the capsule. I think it is such specimens which throw forth the truth in this much-disputed question. That an intra-capsular fracture, with impaction, might form an intra-capsular line of bony union, seems possible, but the fact has never been demonstrated. Under any other circumstances than those of impaction the difficulties in the way of bony union within the line of the normal capsule seem insuperable.

May we not, then, assert as the true statement of this matter, that *intra-capsular fracture of the neck of the femur never can present a line of bony union entirely included by the normal capsule, unless in cases of impaction, and that the possibility even under these circumstances has not yet been demonstrated; but that intra-capsular fractures have united by bone, and may again so unite when the inner fragment has, by absorption of the femoral part of the neck, been allowed to come wholly or partly in contact with that part of the femur which is extra-capsular, and for this reason affords abundant bony material?*

When such a change in the relation of the fragments has occurred, the analogy between their position and that of the fragments in fracture of the anatomical neck of the humerus becomes striking. In this latter form of fracture, when there is impaction, bony union almost always occurs; and even when there is no impaction, bony union is frequently the result.* The reparation of the injury is accomplished principally by the lower fragment, which throws out matter in great profusion.† The power of producing reparative material is as great in the femoral shaft as in the humeral, and the relations of the fragments being now identical in the two forms of fracture, why should not bony union occur in one as it is known to do in the other?

In conclusion, it may be stated that if the positions taken have been sustained, all criticisms of specimens, such as the sixth of Dr. R. W. Smith, and second of Professor Mussey, and others of like character, (admitted to be cases of ~~intra-capsular~~ fracture,) that are based upon the fact that "the line of union is external to the normal capsule," fall to the ground, and these specimens will exist as proofs of the bony union of intra-capsular fracture.

Stated Meeting, February 28th, 1862.

DR. A. C. POST remarked as follows:—

Mr. Chairman:—I rise for the purpose of explaining certain remarks which I made at a previous meeting with reference to Dr. Smith's paper on fractures of the cervix femoris, and which Dr. Smith seems to have misapprehended. In the remarks which Dr. S. made at the meeting of the Section in January, he attempted to show

that in fractures of the cervix within the capsule there were veins and lymphatics enough remaining in connection with the upper fragment to account for the absorption of the portion of the neck connected with the head of the bone. I did not intend in any remarks to deny the possibility of absorption without previous union of the fragments, but to throw upon Dr. S. the burden of proving that, when union and interstitial absorption both occurred, the absorption preceded the union, and to show that there were some reasons for believing that the union preceded the absorption.

With regard to the objections which Dr. S. made to my classification of fractures of the neck of the femur as being intra-cervical and extra-cervical, as implying that the term extra-cervical, as applied to fractures of the cervix, involves a contradiction, I admit that the expression is not strictly correct; but it does not involve greater error than the term extra-capsular fracture of the neck of the femur, as generally employed by surgeons to indicate a fracture which is situated at the junction of the neck with the shaft of the bone, and not in the proper substance of the neck. In speaking of extra-capsular fractures, Dr. Robert W. Smith says: "All extra-capsular fractures are, in the first instance, also impacted fractures, and all impacted fractures are necessarily accompanied by a fracture traversing some part of the trochanteric region. I have omitted no opportunity of investigating this point, and have now examined here and elsewhere upwards of one hundred specimens of the extra-capsular fracture, and have found in all, without a single exception, a second fracture traversing some portion of the inter-trochanteric space." Dr. Robert W. Smith gives a series of beautiful delineations of extra-capsular fractures, and in every one of them the fracture is at the junction of the neck and shaft of the bone, and is therefore properly extra-cervical. Cruveilhier's elegant and artistic delineations of extra-capsular fractures exhibit the same features. The fact is, that surgical writers, as far as I am informed, all describe these fractures substantially in the same manner. Intra-cervical and extra-cervical fractures are not simply bounded by the capsular ligament on one or the other side. Intra-cervical fractures are near the head of the bone, and extra-cervical fractures encroach upon the shaft. The two classes of fracture have each its distinct physiognomy, and it requires no accurate measurement of the attachment of the capsule to ascertain to which class a particular case may belong. The features of the two classes are as distinct as those of a man and of a baboon. In intra-cervical fractures, the neck becomes shortened by absorption; and in extra-cervical fractures, the neck is shortened by impaction. I have no knowledge of any cases of extra-capsular fracture which are not also extra-cervical. Whichever of these terms is used, it is not strictly proper to speak of them as involving the neck of the bone; but long usage has sanctioned the ex-

* R. W. Smith, Nélaton, Cloquet.

† R. W. Smith.

pression, and it is difficult to abandon it. The same difficulty exists here as in the use of the terms external and internal ring, as applied to the two extremities of the inguinal canal. Surgeons still use these terms as employed by the older writers, but are obliged to accompany them with the explanation that the internal ring is situated externally, and the external ring internally.

Concluding remarks of Dr. SMITH.

Prof. Post justifies the use of the term *extra-cervical*, by stating that it does not involve a greater error than the term extra-capsular fracture of the neck of the femur, as generally employed by surgeons to indicate a fracture which is situated at the junction of the neck with the shaft of the bone, and not in the proper substance of the neck. Hamilton states that "these fractures may occur at any point external to the capsule; but generally the line of fracture is at the base, corresponding very nearly with the anterior and posterior inter-trochanteric crests."* Gross states that—

"The extra-capsular fracture is situated at the base of the neck of the femur, extending from above downward, and from behind forward, in the direction of the inter-trochanteric line. It is not always, however, as the name declares, strictly exterior to the capsular ligament; on the contrary, it not unfrequently passes above the attachment of the ligament so as to partake of the character both of an inner and an outer fracture of the neck."†

It is evident that these surgeons regard an extra-capsular fracture as one which, to a greater or less extent, involves that portion of the neck which is external to the capsule. If, now, this portion of the neck be fractured, the term *extra-cervical*, when used to designate the fracture, is

* Hamilton on Fractures and Dislocations, page 382.

† Gross's System of Surgery, vol. ii., page 242.

a misnomer, and the term *extra-capsular* is correct. If the fracture be so far remote that it does not traverse any portion of the neck, it cannot properly be called an extra-capsular fracture of the neck. Prof. Post states: "I have no knowledge of any cases of extra-capsular fracture which are not also extra-cervical." Whichever of these terms is used, it is not proper to speak of them as involving the neck of the bone. Dr. Robert W. Smith gives a series of beautiful delineations of extra-capsular fractures, and in every one of them the fracture is at the junction of the neck and shaft of the bone, and is, therefore, properly extra-cervical. On viewing Robert W. Smith's delineations of extra-capsular fracture, it appears to me that the line of fracture is not in each instance *extra-cervical*. In the description of the specimen in Case 31, it is stated that "the fracture is oblique from above and without, downward and inward; at its upper part it extends within the capsule." I am unable to see how this fracture "is properly *extra-cervical*." Case 33, "a triangular portion of bone has been separated both from the shaft and from the neck of the femur." Cases 34 and 35 are described as fractures of the neck of the femur external to the capsular ligament, and I can see no error in calling the fracture *extra-capsular* in either of these cases.*

I have in my possession a specimen of the extra-capsular fracture, which I exhibited a short time since at the meeting of the Surgical Section. The fracture in this case extends into the neck of the bone some distance from the trochanters, and cannot therefore be called *extra-cervical*.

* See engravings, Smith on Fractures, pages 87 and 88.

ERRATA.

Nos. 5 and 6. Page 4, second line from bottom, second column of figures, read " $1\frac{1}{2}$ " instead of " $\frac{1}{2}$."

Nos. 7 and 8. Page 5, first line of figures, 8th column, read " $1\frac{1}{4}$ " instead of " $1\frac{3}{4}$ "; third line of figures, read " $1\frac{1}{4}$ " instead of " $1\frac{3}{4}$."

No. 22, Anterior. Second column of figures, read "2" instead of " $1\frac{3}{4}$."

No. 22, Posterior. Read whole line as follows: " $1\frac{7}{8}$ "—"2," "2"—"1," " $1\frac{1}{8}$," " $1\frac{1}{4}$," " $\frac{7}{8}$," " $\frac{7}{8}$," " $\frac{3}{4}$."

On page 9, second line from top, read "corona or cartilaginous edge."

On page 16, first column, third line from top, insert quotation mark before "an."

On page 25, second column, fourteenth line from top, read "this" instead of "the."

Same page and column, twenty-first line, read "Willard" instead of "William Parker."

On page 31, first column, nineteenth line from bottom, read page "28" instead of "540."

