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ORIGINAL MEMOIRS.

THE ANATOMY AND SURGERY OF THE INTERNAL DERANGEMENTS OF THE KNEE-JOINT.

BASED ON A STUDY OF 150 DISSECTED JOINTS AND THE LITERATURE.

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ANATOMY.

THE knee is a joint depending entirely upon ligaments for its strength. Disregarding the patella, there are only two small articular areas in contact in all positions of the limb. These areas are convex on the femoral side, and slightly concave, plain, or even convex on the tibial side. There is neither cup nor socket nor real concavity of any sort, though there is a short and shallow mortise-and-tenon effect produced by the projection of the tibial spines into the popliteal notch. The two bones with the articular cartilage left on and all the ligaments removed are in unstable equilibrium in all positions. This mechanical disadvantage and the arrangement of the lubricating apparatus which is at times inadequate, and at times an actual obstacle to the working of the joint, furnish the chief reasons why the knee is the most frequently deranged of all the joints in the human body.

The fresh articular surfaces differ somewhat in shape from the ends of the dried bones. The articular cartilage of the femur is thickest over the trochlear surface on which the patella slides. It is also thickened along the curve of the condyles over the area which has contact with the tibia, and from this thicker strip it thins out gradually towards the margins of the bone. This makes the trochlear groove appear shallower and the condylar surfaces rounder on the fresh than on dry specimens.

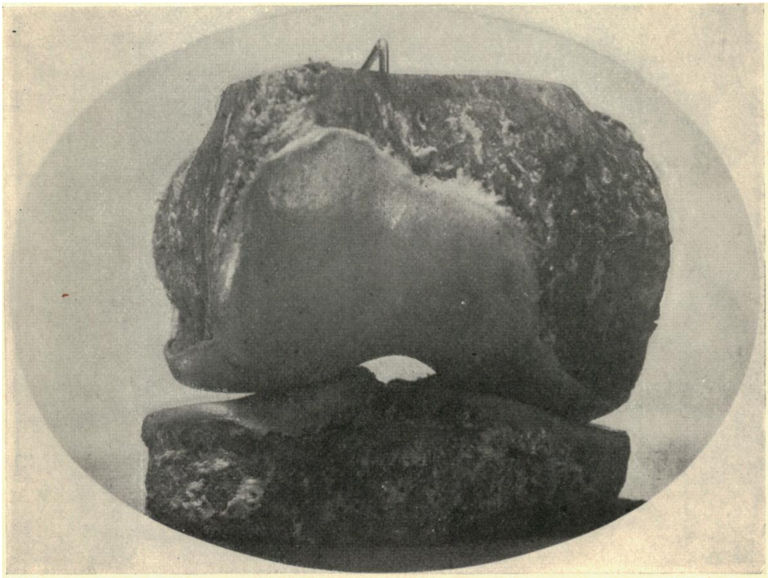
The articular surface of the external tibial tuberosity is distinctly convex from before backward, and shows but little concavity from the tip of its spine to its margins. The articular surface of the internal tuberosity is slightly concave in all diameters, but by no means corresponding to the convexity of the femoral condyle. Moreover its surface is not in a horizontal plane, but slopes decidedly from before backward, giving the internal femoral condyle a constant tendency to slip backward. The articular cartilage on the upper surface of the tibia is thickest for contact with the femur, and regularly thins out from this area in all directions. Except on the surfaces which face the interspinous space, both tibial spines are covered with articular cartilage clear to their tips. Braune and Fischer have demonstrated that the shape of these surfaces changes somewhat under pressure.

Of the ligaments which hold these two joint surfaces in contact in almost all positions of the limb, some things of interest have been noted beyond the usual text-book statements.

The anterior crucial has a smaller cross-section at its middle than at either end and appears to be weaker than the posterior crucial. In twenty-three joints out of forty noted it was joined towards its upper end by a very slender bundle of fibres from the anterior end of the external semilunar,* and in six joints a small slip from the anterior crucial split off to join and be inserted with the posterior crucial.

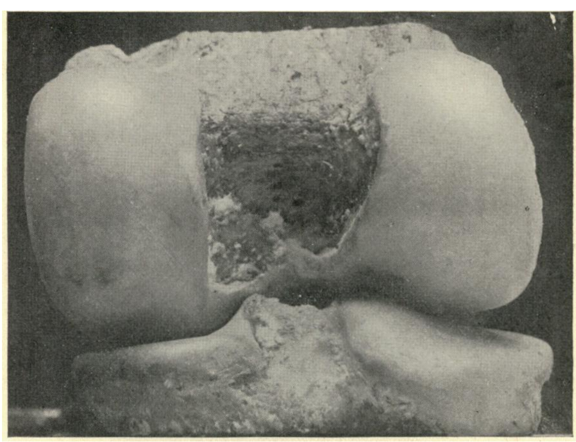
* This differs from the experience of Testut and Mouret.

PLATE I.



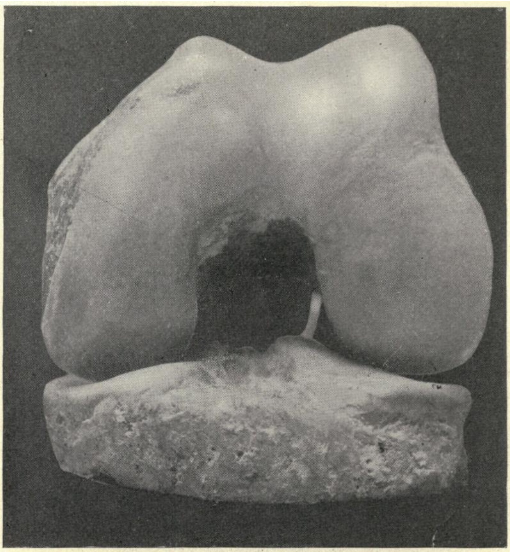
Bones of right knee in extension, front view. Ligaments all removed. Position adjusted by comparison with a partially dissected joint.

PLATE II.



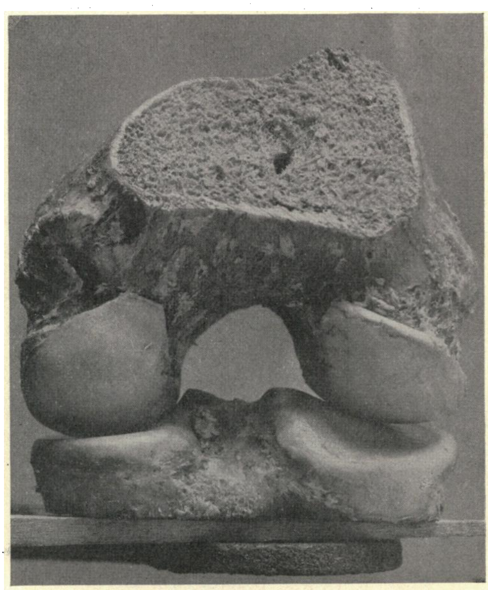
Bones of right knee in extension, back view.

PLATE III.



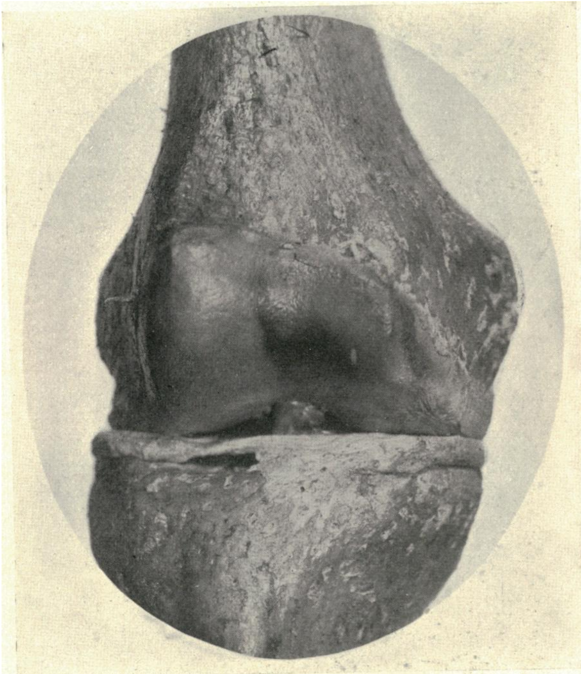
Bones of right knee flexed to 90°, front view.

PLATE IV.



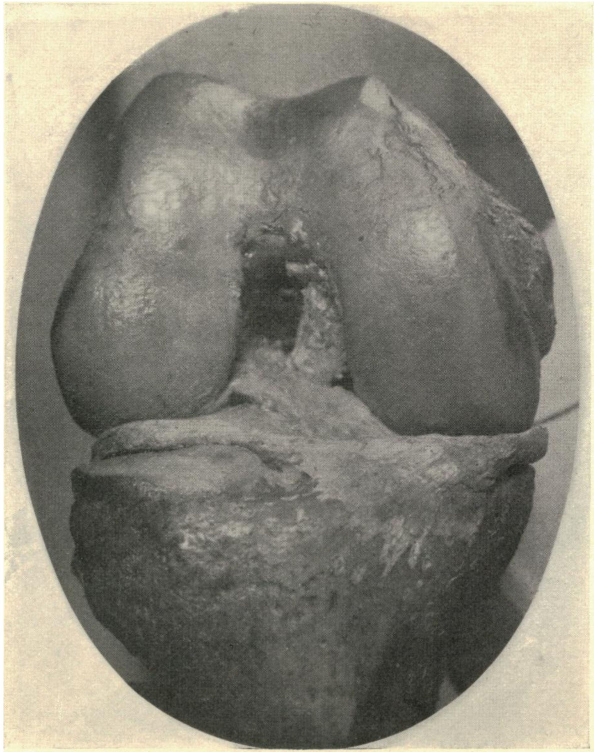
Bones of right knee flexed to 90°, back view.

PLATE V.



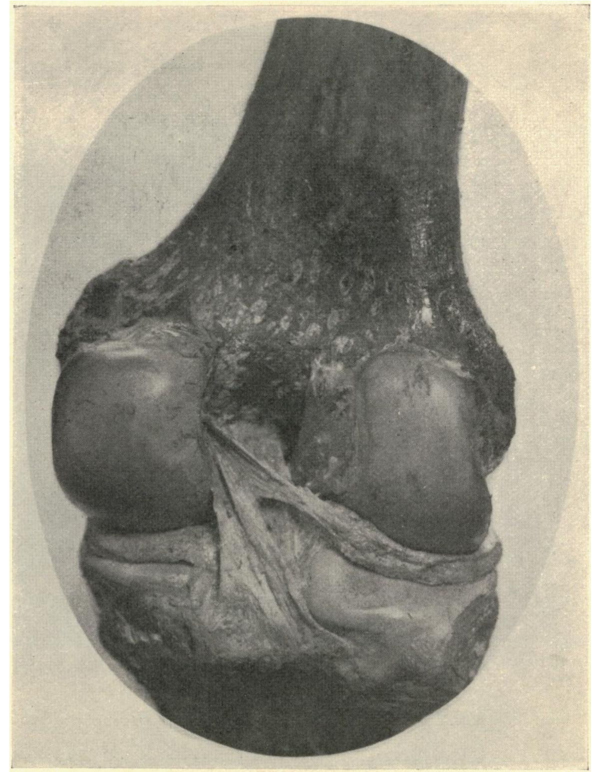
Right knee, joint extended, front view. Lateral ligaments removed, crucials and semilunars showing.

PLATE VI.



Same as Plate V, back view.

PLATE VII.



Same as Plate V, but flexed to 90°, front view.

The posterior crucial at its insertion on the femur is joined almost always—thirty-six times in forty—by a good-sized band from the external semilunar, which is more tense in extension than in flexion.

Between the two crucial ligaments where they cross and are continually rubbing, a bursa may be found which does not usually communicate with the general synovial cavity.

These ligaments are adjusted to limit extension,[1] to control the movements of the femur and tibia in the anteroposterior plane, to carry some of the weight when the leg is swinging clear of the ground, and possibly to assist in producing close contact of the joint surfaces in internal rotation.

The semilunar fibrocartilages may be considered as the semicircular remains of complete inter-articular fibrocartilage discs with the centres worn through, leaving sharp free edges directed towards the tibial spines, and a thick periphery still attached to the inside of the capsule.

Three specimens of the 150 joints examined showed external semilunars complete, except for a small opening against the tibial spine. The internal varies in width, but so far as known has never been found as a reasonably complete disc. Both are firmly blended at their peripheries with the capsule, fibres passing into them from above and from below. Both lose their layer of cartilage at their extremities, become fibrous bands, and blend with the tibial periosteum or become continuous with some ligament.

The external semilunar in front is mainly attached to the non-articular surface of the external tibial spine. Its peripheral attachment to the capsule is interrupted by the opening for the popliteus tendon. This opening is usually slightly wider above than below, measuring fifteen millimetres above and twelve millimetres below as an average in forty joints. It is always obliquely directed, the lower opening being internal.

Posteriorly the external semilunar sends its main attachment to the middle part of the interspinous space, and also sends a strong band to be attached parallel to the posterior crucial on the femur. These bands were noted as follows:

Inserted anterior to posterior crucial	11
Inserted posterior to posterior crucial	5
Split, one strand in front, the other behind	20
Absent	4
	40

Sometimes these bands blended with one or the other crucial, and sometimes they remained distinct to their point of insertion.

The internal semilunar has no break in its peripheral attachment, but on the contrary is firmly attached to the internal lateral ligament which holds it very closely to the tibia. Posteriorly it sends a fibrous end in between the posterior crucial and the tibia, to be attached to the non-articular surface of the internal tibial spine, and in front it blends with the origin of the anterior crucial ligament in front of the internal spine.

In structure the semilunar fibrocartilages are composed of fibrous tissue, with fibres arranged parallel to the periphery, covered above and below with a layer of cartilage. The thickness of the structure at its periphery as compared with its free margin is due to a greater proportion of fibrous tissue rather than to any thickening of the cartilage layer, which is indeed thinner here than at the free border. On cross-section some vertical fibres of the capsule can be seen to pass into and blend with the horizontal fibrous core of the semilunar both from above and from below. The greater strength of the lower fibres, which are in no other way to be distinguished from the capsule, probably accounts for the separate name of "coronary ligaments."

The transverse ligament is a continuation of the semilunars and usually connects the two in front. It is not a constant affair of appreciable size. Its absence was noted in sixteen joints, and in eight it is recorded as threadlike out of seventy-three recorded. It may be a continuation of either semilunar. Five times it was continuous with the internal only and twice with the external. When this arrangement exists, its free end spreads out into the mass of fatty tissue below the patella. This practically agrees with Higgins's observations,[2] and makes it difficult to agree with Pauzat's[3] conclusions as to its great importance.

At the inner side of the joint, the internal lateral ligament is firmly attached to the semilunar as before described, and at this point neither has motion independent of the other. On the outer side, the band of fibres called the anterior or long external lateral ligament has no connection with the outer semilunar, and frequently its synovial bursa is interposed. Internal and behind this, the posterior or short external lateral ligament, which is a part of the capsule, is separated from the semilunar by the opening through which the popliteus tendon passes.

Both semilunars have some freedom of movement independent of femur and tibia, though they only move with the joint capsule. The simplest description of their movements is to say that in flexion they move with the tibia, and in rotation with the femur. In full extension, they approach each other in their centres, and in flexion to a right angle or more their centres are somewhat separated. This is as might be expected from the divergence of the femoral condyles.

The external has much greater freedom of movement than the internal, lacking the restraint of anything like the short and powerful internal lateral ligament. Pauzat and others assert that their excursions in the joint are governed by muscular attachments; but the writer believes that their movement is entirely passive. They certainly move freely in a normal cadaveric knee.

The tibial surface exposed by the semilunars, when carrying no weight, is always larger than the surface of femur in contact in any normal position of the joint. When the knee is put under pressure in a vise, the external semilunar can be made to fit the external condyle snugly in extension, but in no other position. The internal cannot be made snug. In other words, the semilunars are not so well placed to carry the weight of the body, whether standing or with bent knees, as they are to assist the lateral ligaments of the opposite side, and to limit the excursion of the condyles from the tibial spines.

For example, if the internal semilunar be removed with as little damage as possible to the capsule, the joint works well in flexion, rotation, and extension, until some force acts to bend the knee outward. Then it is evident that the external lateral ligaments are insufficient to prevent an increase over the normal motion in this direction. The same is true of forces acting to bend the knee inward after removal of the external semilunar. With the removal of both, this fact becomes still more evident, and the lateral motion of the knee is increased from about five degrees to fifteen degrees or more.

With both semilunars present, these lateral movements are resisted not only by the opposite lateral ligaments, but by the horizontal fibres of the semilunars, and the increased tension of the crucials as the femur and tibia are separated by the wedge of fibrocartilage. With a semilunar absent the corresponding femoral condyle is free to slip down away from the tibial spines, with nothing to stop it save a flexible guy on the other side of the joint.

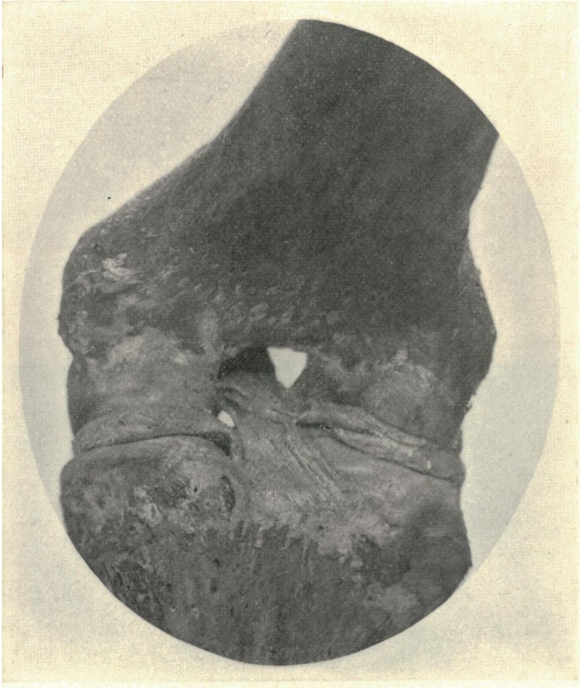
In full extension there is probably little weight carried on the semilunars unless there be side pressure. With any lateral strain on the joint, the semilunar on the side *against* which the force is exerted becomes immensely important in preserving the stability of the joint. In flexion the internal condyle rolls back on to the internal semilunar if the leg be rotated out, and this comparatively fixed part of the cartilage probably sustains some weight under these conditions, though most of the pressure comes through the external condyle in this position.

A small but constant artery runs around the periphery of each cartilage where the capsular fibres blend with it.

The joint cavity is enclosed by a synovial membrane, external to which is a covering of fibrous tissue thickened in certain locations and added to in others by the endings of active or outgrown muscles.

Of the ligaments which may be considered thickenings

PLATE VIII.

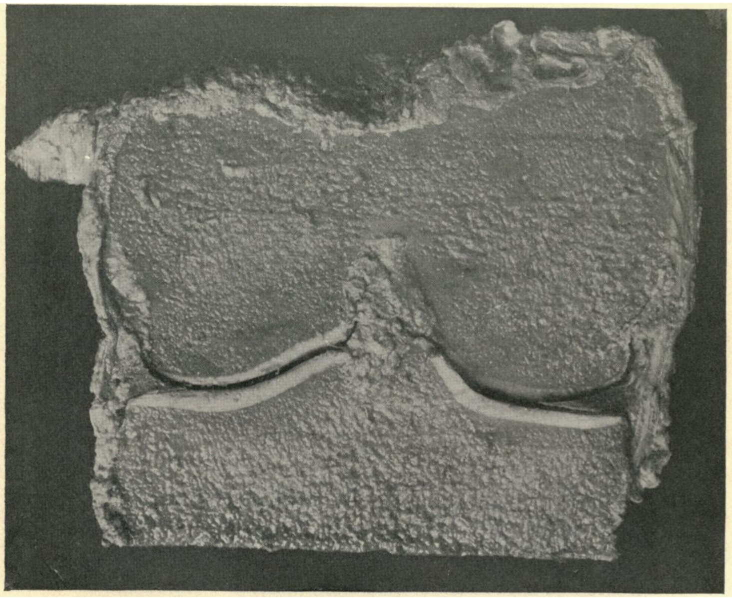


Same as Plate VII, back view.

PLATE IX.

Lower part of right capsule hardened in formalin. Femur removed, showing semilunar cartilages and crucial ligaments.

PLATE X.



Vertical transverse section through lateral ligaments left knee, joint extended.
Front view of section.

of the capsule, the internal lateral is the strongest and shortest, and is said to be the vestige of a long adductor magnus tendon to the tibia.

On superficial dissection, it appears fan-shaped, with fibres radiating from the prominence on the internal femoral condyle. In horizontal sections the bulk of the fibres can be seen to pass almost directly downward to be attached to the floor and margins of the groove for the semi-membranosus on the tibia, while only the most superficial fibres have the radiating arrangement—an anterior set passing down under and almost as far as the gracilis tendon, while the posterior fibres swing around even behind the internal condyle into the posterior part of the capsule.

Its length as measured on the outside of a dissected joint is much greater than that of its shortest fibres which are in contact with the synovial membrane and the semilunar cartilage.

Its working length is, of course, no greater than that of these shortest fibres, which do not measure over three and one-half or four centimetres,—twelve joints measured.

The function of this ligament is to guard against strains tending to bend the knee inward, to prevent over-extension of the joint, to limit rotation of the leg and foot, and to assist in carrying the leg weight when the foot is off the ground. It also greatly limits the movements of the internal semilunar fibrocartilage.

The external portion of the capsule is supported by the long external lateral ligament, the popliteus and the biceps tendon, and consequently shows less thickening than the internal part.

The long external lateral ligament shows plainly its connection with the upper end of the peroneus longus, and is said to be a vestigial attachment of that muscle. It is long and slender, and always has something of a synovial bursa about it, sometimes entirely surrounding it, so that the ligament is not attached to the capsule.

The biceps tendon is not only inserted into the fibula and tibia, but its tendon blends with the posterior and outer part of the capsule from the origin of the outer head of the gastrocnemius down. It can be separated from this part of the capsule only by a forced dissection, and cannot fail to take some of the side strain of the joint in extension.

Under these two lies the capsular thickening called the short external lateral ligament, which is less sharply defined than the internal lateral. These fibres also radiate from a prominence on the external condyle, and pass down to the tibia and fibula; but the shortest fibres are on the average one centimetre longer than on the inner side of the joint, thereby allowing more movement of one bone on the other than can take place at the inner side.

The function of the external lateral ligament and its assisting structures is to resist strains tending to bend the knee outward, and in other respects to act with the internal lateral in limiting external rotation of the leg, and carrying a share of the weight when the foot is lifted from the ground.

The posterior part of the capsule consists of two hoods which cover the two femoral condyles between the lateral ligaments and the crucials. At the popliteal notch they blend with the posterior crucial ligament. On the tibia they are attached just below the margins of the articular surface, except as the external continues on the posterior surface of the popliteus with the expansion of the semimembranosus, and on the femur they are attached very near the edges of the articular cartilage.

Superficial to this, but under the gastrocnemius, lie some oblique fibres of irregular arrangement and size which are grouped as the "posterior ligament of Winslow." In a general way they run as slender fibrous bands from the place where the semimembranosus tendon reaches the capsule to the upper and outer side of the popliteal notch. One or two strong bands usually arise from the semimembranosus tendon itself, but most of these strands have no connection with it, and seem better adapted for furnishing an elastic bed for the popliteal artery and preventing its kinking in flexion than for strengthening the articulation. The experiments of Poirier [1] point to the same conclusion. In two joints out of sixteen, some of the strands were so directed that they could possibly draw both semilunars backward as the semimembranosus contracted, but other dissections indicated that this was an exceptional arrangement.

In full extension the attachments of these posterior hoods to the tibia and femur are separated about five centimetres, while in flexion the distance is reduced to a single centimetre. This slack of the capsule in flexion is taken up by the two heads of the gastrocnemius which not only cover the two hoods behind, but take origin from them for a distance of about two centimetres.

The patella has a thick layer of cartilage on its posterior surface, even thicker than the layer to be found on the trochlear surface of the femur. This surface is convex in all diameters, most convex from side to side.

With complete contraction of the quadriceps, the whole of the articular surface of the patella is raised above the articular surface of the femur. With knee extended and quadriceps relaxed, the lower half or third of the patellar cartilage is in contact with that of the femur.

During flexion the patella slides down, having more contact with the external than with the internal condyle. With the knee bent to a right angle or completely flexed, its contact is very slight with the internal condyle, being one centimetre or less in width. Even this contact can be lost, and the inner border of the patella may slip in between the condyles.

In a kneeling position with the joint bent to a right angle most of the weight of the body is carried on the patella. When the joint is completely flexed, the body weight is carried on the tubercle of the tibia.

The bursæ in front of the patella and that beneath the patella tendon have always been found when sought, and the latter, though separated from the synovial cavity of the joint by a thin partition, has never been found to communicate with the joint.

English and American text-books of anatomy are curiously silent as to the lateral ligaments of the patella, and the latest German book does not even mention them. One or both existed in each of twelve joints dissected carefully, and the internal was identified in fifteen other joints taken at random.

The internal is much the stronger, and is a flat, triangular band passing from the prominence on the internal femoral condyle to the upper half or two-thirds of the inner border of the patella. It is a distinct band at its origin, has many almost horizontal fibres of the vastus internus inserted into its anterior surface, and finally, covered by the muscle, mingles with the complex fibres of the quadriceps aponeurosis surrounding the patella.

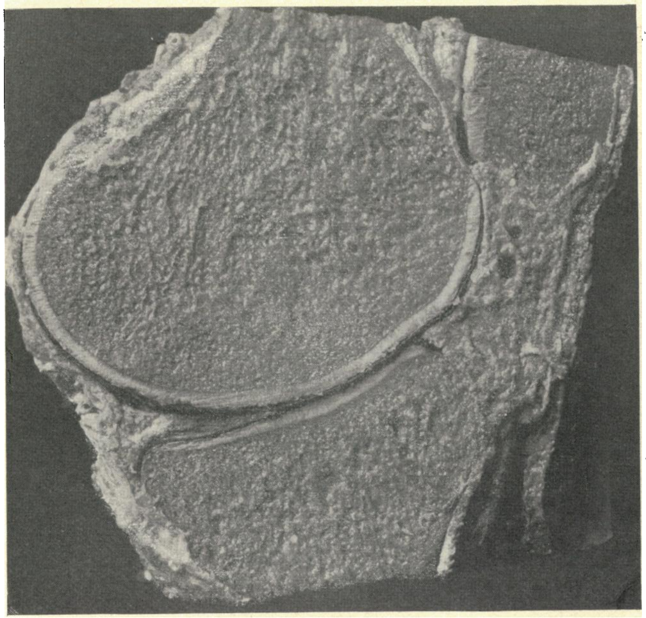
The external is thinner, narrower, and weaker, and was not found in two joints out of twelve as a distinct structure, though even in these there were a few slender transverse fibres. When present it passes horizontally forward from the prominence on the external femoral condyle to the upper third of the external border of the patella. It is interlaced with fibres of the iliotibial band and with the extensor aponeurosis near the patella.

The function of these ligaments is to steady the patella as it slides on the femur, and prevent lateral slipping or dislocation, and, as the strain is greater on the internal than on the external, the internal is not only much stronger, but it is reinforced by the lower vastus internus fibres which are inserted on its anterior surface.

The ligamentum mucosum is a thin, vertical partition of synovial membrane between the two sides of the joint. It has a free upper border which extends from just below the patella to the anterior crucial ligament. In a total of fifty-eight cases where it was noted, it was apparently lacking in two, and in two other cases the ligament had evidently been torn. It was a mere thread in eight cases, a band with an opening below it in four cases, and in nine cases it was a complete ligament.

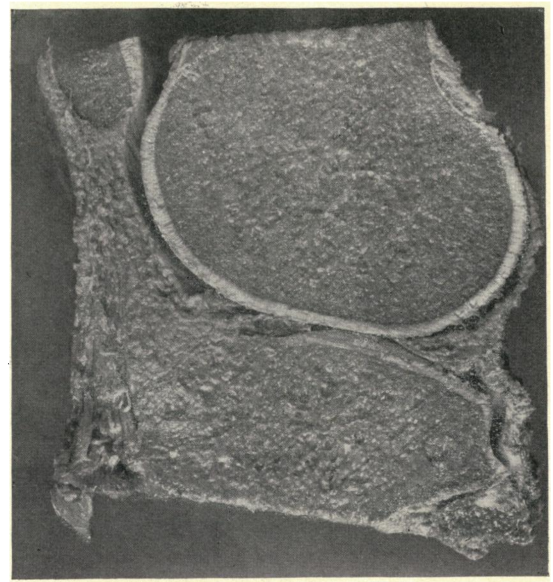
The mucosum may be a vestigial structure, but is of present use in holding the anterior synovial pad against the femur.

PLATE XI.



Sagittal section through internal condyle and tibia, left knee, outer side of section, joint extended.

PLATE XII.

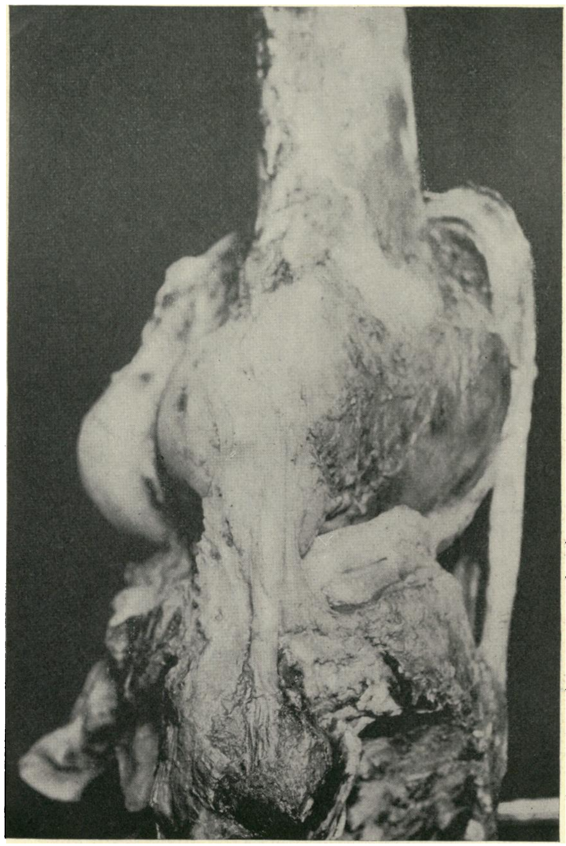


Sagittal section through external condyle and tibia, left knee, inner side of section, joint extended.

PLATE XIII.

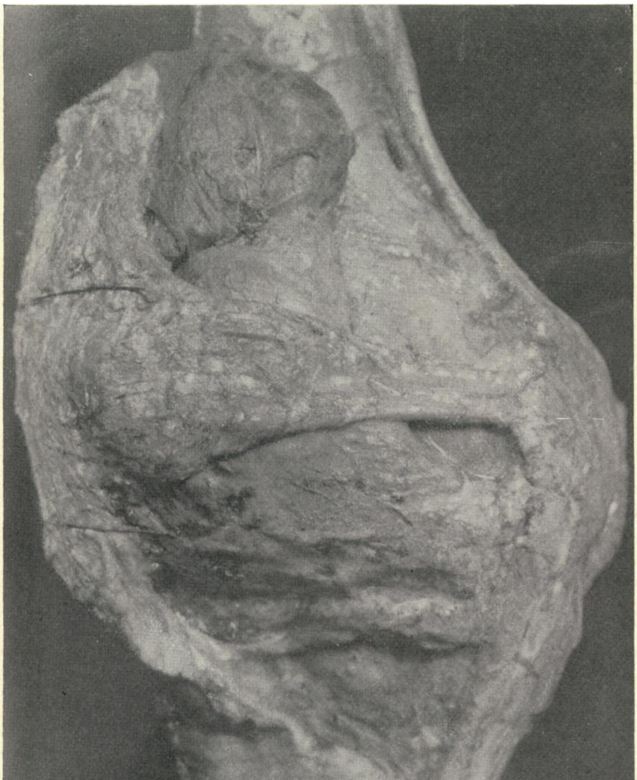
Right knee, internal lateral ligament.

PLATE XIV.



Right knee, external lateral ligament.

PLATE XV.



Internal patellar ligament and synovial pouch on front of extended joint, right knee. Joint cavity distended with wax. Upper and lower margins of patella marked by black lines.

There is some confusion in the literature as to the structures to which the name "alar ligaments" belongs. An instance of this is found in Allingham's [4] monograph, where he quotes Lang's description of the alar ligaments as "fringes of the ligamentum mucosum;" . . . "in many cases hard and cartilaginous; . . . always found to be introduced between the femoral condyle and the anterior portion of the semilunar fibrocartilages in complete extension." This description evidently applies to the postero-inferior free margin of the infrapatellar pad.

When the joint is opened by a transverse cut above the patella and this bone is turned down, two tense folds of synovial membrane can be seen passing forward from the ligamentum mucosum to the sides of the patella. These answer to the description of alar ligaments given by Morris and others, but do not appear on the interiors of joints hardened in formalin, from which the femurs have been subsequently removed. Their apparent continuation as two fibrous folds of the extensor aponeurosis on either side of the patella projecting backward into the joint can always be seen, though the external is much less prominent than the internal. The writer believes with Pauzat [3] that the synovial folds appear only in certain positions which do not exist in life. Pauzat has traced distinct bundles from the fibrous folds above described to the anterior ends of the semilunar fibrocartilages, and believes that they serve to pull the semilunars forward and up with the contraction of the quadriceps. The writer has not traced such bundles, but has found these folds spreading out generally into the fibrous framework of the infrapatellar pad, and believes that their function is to pull this pad forward and up out of harm's way during extension.

Within the joint there are several pads covered with synovial membrane, which are composed of fat, fibrous tissue in varying amounts, and blood-vessels. The largest of these pads is attached to the extensor tendon below the patella and is rather triangular on section. The broad base is in contact with the femur, and the two free extremities of the base project upward between the patella and femur, and backward between femur and tibia. The lateral boundaries of this pad are usually well defined, being opposite the margins of the femoral condyles. It is held in contact with the condyles by the tension of the ligamentum patellæ and the mucosum.

The pad shows a tendency to become lobulated, and the lobules to develop pedicles. These lobules are of two kinds, —one composed of fat covered with synovial membrane, soft, and often ending in fine fringes as if it had been caught and frayed between the adjacent bones, the other composed of tough, fibrous tissue, pediculated, and never frayed or fringed.

Besides this largest fatty and synovial pad, there is a smaller one loosely attached just above the articular surface on the front of the femur, which is in contact with the patellar articular surface in extension. This shows smaller lobules which are often fringed. Two other small pads are found posteriorly in the joint just above the attachment of the two semilunars to the posterior part of the capsule. In two cases fibrous strands from these were found over the external semilunar cartilage, but none were found over the internal. These are the only pads which are constant, but often small ones were found on the front and outer side of the anterior crucial ligament, and projecting from the synovial membrane on the sides just above the attachment of the semilunars to the capsule.

One function of these pads seems to be that of "wipers," which keep the synovial fluid spread evenly over the patellar cartilage and the condyles of the femur. They also increase the area of synovial membrane which secretes this fluid, and possibly this is their chief function.

The synovial cavity of the knee-joint is very extensive, the synovial surface being much greater than that of any other joint in the human body. The capacity of this joint is nevertheless not large, but varies according to the presence or absence of accessory cavities communicating with the joint.

In testing the capacity of the knee, a series of fourteen undissected joints was taken, all about the average size and adults. From a graduated reservoir two metres above the subject, a column of water was used to produce a pressure approximately that in the human arteries. The results varied as follows:

	Right. Cubic Centimetres.	Left. Cubic Centimetres.	
1. Female	80	90	No bursæ.
2. Male	200	180	Large bursæ about semimembranosus and biceps tendons.
3. Male	120	170	Small bursæ about semimembranosus tendons.
4. Female	90	80	No bursæ.
5. Female	120	84	Rheumatoid. Left anterior crucial ruptured. Free bodies. Bursa around right external lateral ligament communicates with biceps bursa and joint cavity.
6. Male	100	90	No bursæ.
7. Male	180	200	Large bursæ about biceps and semimembranosus.

With extended joint, this fluid was almost all anterior to the lateral ligament and under the quadriceps expansion. With joint flexed the fluid was forced to the back of the joint. After all the fluid had entered an extended joint that would, some thirty centimetres more would flow in if the joint were slightly flexed, and after this some little force was required to hold the knee in extension again. The patella could always be made to "float" after the admission of thirty cubic centimetres of fluid. Lübbe,[5] Picqué,[6] Meisenbach,[7] and O'Conor[8] report cases of hæmarthrosis from which blood has been aspirated in amounts varying from 130 to 180 cubic centimetres.

In no case has a large cavity been found under the quadriceps, the bursa extending upward less than seven centimetres, and communicating with the rest of the joint in every case which can be recalled. No notes were made on this. Higgins[2] reports that 98 per cent. of cases show such communication.

In extension there is a synovial cul-de-sac above and on either side of the patella where synovial membrane is in contact with synovial membrane. This disappears during flexion.

The anterior wall of the sac is intimately connected with the extensor aponeurosis, and the posterior wall lies loosely against the non-articular front of the lower end of the femur internal and external to the patella. It extends about five centimetres above the level of the upper border of the patella, and usually communicates freely with the bursa under the quadriceps expansion. Laterally, it slopes down to pass under the lateral ligaments of the joint.

Summary of Movements.—The *fully* extended joint is without lateral motion, anteroposterior motion, or rotation. All three movements are present to some degree after slight flexion and increase up to right-angled flexion, after which they diminish again.

Extension is limited first by the posterior crucial. After rupture or section of this ligament, extension is still further increased by rupture or section of the anterior crucial, and later after rupture of the internal lateral and external lateral ligaments.

The oblique or posterior ligament of Winslow resists this motion little, if any. Flexion is limited by contact of the soft parts.

External rotation is limited by the two lateral ligaments and increased after section or rupture of either.

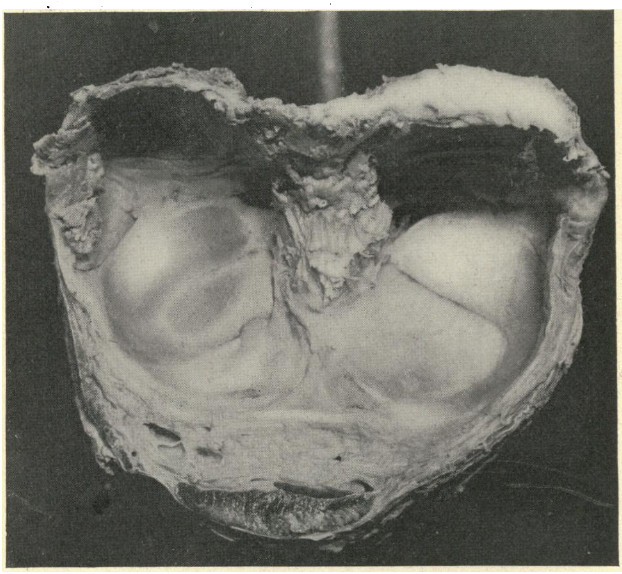
Internal rotation is limited by the internal lateral and anterior crucial in combination, and increased after section or rupture of either.

A slight forward slipping of the tibia on the femur is possible in external rotation, but is stopped first by the anterior crucial, and later by the two lateral ligaments. A slight backward slipping of the tibia on the femur is also possible on external rotation, but is limited first by the posterior crucial and later by the two lateral ligaments. Adduction and abduction are also possible in external rotation to a degree which can be felt with the hand on the joint. Adduction is limited first by the external lateral ligament, and later by the posterior crucial. It is also increased on the cadaver after removal of the internal semilunar. Abduction is limited first by the in-

PLATE XVI.

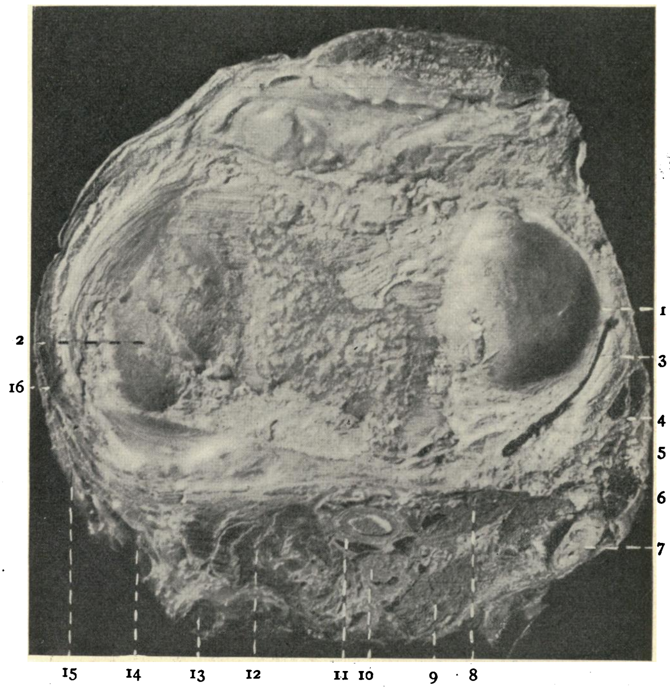
External patellar ligament and synovial pouch. Same joint as Plate XVI.

PLATE XVII.



Right knee, specimen hardened in formalin. Femur removed, showing two posterior hoods of the capsule.

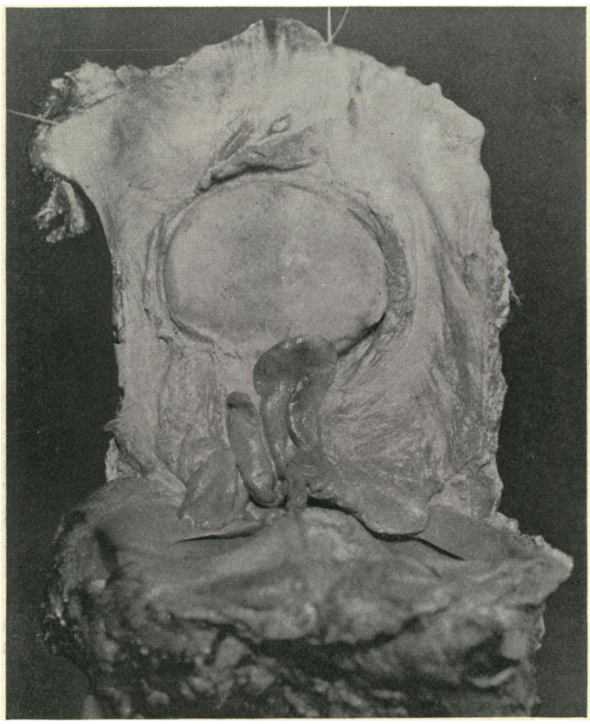
PLATE XVIII.



Horizontal section through right knee, joint hardened in formalin. Section passes through middle of internal semilunar cartilage and just above middle of the external.

1. External semilunar.
2. Internal semilunar.
3. Slit between popliteus tendon and external semilunar.
4 and 5. External lateral ligaments.
6. Biceps tendon.
7. External popliteal nerve.
8. Plantaris.
9 and 12. Gastrocnemius.
10. Internal popliteal nerve.
11. Popliteal artery with veins between it and nerve.
13. Tendon of semitendinosus.
14. Tendon of semimembranosus.
15. Tendon of sartorius.
16. Internal lateral ligament.

PLATE XIX.



Infrapatellar pad showing tabs, left knee.

ternal lateral, and later by the posterior crucial. On the cadaver abduction is greater after removal of the external semilunar.

SURGERY.

Among these 150 cadaveric joints were found examples of nearly every "internal derangement of the knee-joint" which has yet been described, as well as two which may be properly included under the same head, and which have not been described in print heretofore, so far as known.

A classification of internal derangements according to their frequency in my series of joints would be

1. Tabs from the lubricating apparatus.
2. Erosion of cartilage.
3. Damaged and displaced semilunar cartilages.
4. Ruptured ligaments.
5. Free and loose bodies.
6. Villous or papillary synovitis, of which no instance appeared in these joints, and which will not be discussed.

Hoffa [9] describes another condition as "atrophy of the quadriceps," which allows the capsule to catch between patella and femur or femur and tibia. He describes it from the double stand-point of surgeon and patient, and says that the condition usually dates back to some injury which requires rest in bed for a few days. It is curable by massage and gymnastics. My studies of cadaveric knees make me doubtful of the possibility of catching any portion of the normal synovial membrane except the tabs from the lubricating apparatus.

1. TABS FROM THE LUBRICATING APPARATUS.—Plate XIX.

The most frequently injured structure among my joints was the infrapatellar pad. Its condition was noted in 100 joints, and in every case there was some evidence of damage, unless the fine fringes on the edges of the soft fatty pads may be said to be normal constituents of the adult joint. These fringes were constant both for the part of the pad next to the femoropatellar contact and that nearest the femorotibial contact. During flexion the edge of the pad nearest the femoropatellar contact may be caught, and during extension the edge nearest the tibia. The suprapatellar pad often showed something of the same condition caused by its catching between the patella and femur during flexion, but here the apparent damage was less than below.

In either location a slight dryness of the joint will permit of a catch and pull, if not an additional crush of a tab.

No other joint in the body presents so favorable an arrangement for internal injuries, which, though slight and comparatively painless, may open both the lymphatic and general circulation into its cavity, and no other is so often attacked in the course of a general infection.

In one joint with marked loss of articular cartilage, where there was actual bony contact between patella and femur, with grooves and ridges worn in both, there were no fatty or fibrous tabs. Both pads were shrunken, and the fat was so largely absorbed, that the fibrous framework which is usually scarcely to be seen on the surface was more apparent than the fat.

Whether a loss of synovial secretion from an atrophied pad increased the friction between patella and femur and caused a wearing away of the articular cartilage is not known. The condition was interesting and unique in this series.

In twenty-two joints out of 100 noted there were seen tough fibrous tabs, pediculated and attached to the infrapatellar pad. These were situated as follows:

Internal to mucosum only in	18 joints.
External to mucosum only in	2 joints.
Both internal and external	2 joints.

These tabs were without fringes and were never found crushed, but in three joints were found injuries on the anterior part of the external semilunars which could be accounted for by a crushing force exerted through this tab in extension. These were the only semilunars seen with this injury.

There are but few references in the recent literature to operations for the removal of fatty and fibrous tabs as such. Some reported as growths from the synovial membrane above the patella were possibly tabs from the suprapatellar pad. Others described as fringes of the ligamenta alaria are evidently tabs from the infrapatellar pad.

Goldthwait[10] removed tabs and fibrin masses from nineteen out of thirty-eight knee-joints opened. Allingham[4] removed them in two cases out of fifty-nine joints opened, and Turner[11] in three cases out of twenty-nine.

From my study of the cadaveric knees, it seems as if a much larger number of individuals must suffer from the conditions which appeared in connection with the supra- and infrapatellar pads than Allingham and Turner's figures indicate.

Where these form a mechanical obstacle to the perfect working of the joint, they can only be removed by mechanical means. The only treatment is operation.

2. EROSION OF ARTICULAR CARTILAGE.—PLATES XX, XXI.

A frequent injury found in these joints was seen on the articular cartilage at the back of the upper surface of the external tibial tuberosity. The damaged area usually measured a little over a centimetre in diameter, and was always rounded. It was noted as follows:

Normal tibial surfaces	59
Softened tibial surfaces	19
Old fibrous surfaces	43
Not noted	29
	150

It showed all stages from a shallow cracking or "crazing" of the smooth cartilaginous surface to bare bone with a few tufts of fibrous tissue projecting from the edges and from small centres inside the bare space. Five joints in which the "lipping" of bone was well marked showed normal cartilaginous surfaces at this point. There was no constant relation between this condition and gross injury to the semilunar.

Dorsal decubitus with antemortem or postmortem maceration might be suggested as a cause for this condition, but one-third of all these joints showed tough fibrous tissue in place of the articular cartilage which would indicate antemortem change. Moreover, if it result from maceration, the damage should be as evident in the synovial pouch under the popliteus, which is lower than this tibial area in the dorsal position. This was not found to be the case. The appearance of these areas suggests mechanical damage rather than maceration.

If an individual is kneeling for any considerable time, the fluid contents of the joint must gravitate towards the patella, leaving the back part of the joint comparatively dry, and most individuals when working on their knees do so with internal rotation of the leg, which brings this part of the tibial surface in contact with the back of the external condyle of the femur.

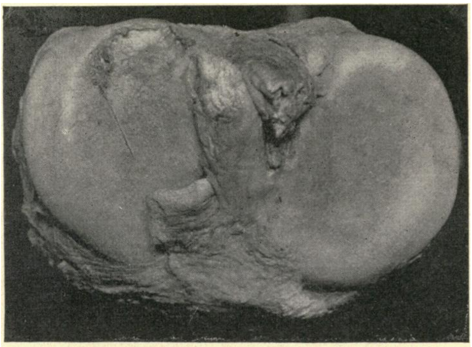
The first movement, on rising to the standing position, is to draw one foot forward and plant it on the floor, putting this knee in nearly complete flexion. Then extension begins with the entire body weight resting on this knee. This gives us motion with a maximum of pressure and a minimum of lubrication as a possible cause for the damage seen.

If this condition exists as often among those whose work is done while kneeling as in this series, it perfectly accounts for the stiffness and difficulty with which they rise to their feet, and the absence of stiffness and pain when they are erect and walking about.

Another pathological condition was a loss of cartilage along the inner border of the patella. Where the cartilage appeared normal, there was often a fraying out of the edge of the internal alar ligament, or of the loose tissue lying partly covered by the alar and between it and the inner edge of the patella.

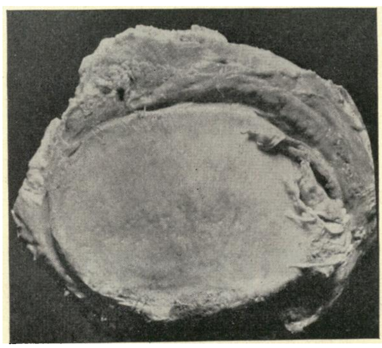
In right-angled flexion the main contact of the patella is with the external condyle, there being normally about one centimetre of its width in contact with the internal. With a lateral movement while kneeling, the inner edge of the patella might be forced into the popliteal notch, provided the internal

PLATE XX.



Articular surface right tibia, showing erosions at back part of external tuberosity.

PLATE XXI.



Left patella, showing damage to articular cartilage at inner margin.

PLATE XXII.

Three right internal semilunar cartilages, showing fracture opposite internal lateral ligament upper surface.

PLATE XXIII.

Same as Plate XXII, under surface.

PLATE XXIV.

Semilunars of right knee, showing effects of long-continued friction.

patellar ligament is stretched or torn. The damage is done as the patella slips from beneath the outer edge of the internal condyle, and occasionally a less degree of injury was found there. Usually only the edge of the patellar cartilage was worn off, but at times an area one centimetre across was found with the cartilage layer worn through and strips or short tabs of fibrous tissue in its place. It is probably one of the least disabling of all the injuries found.

3. DAMAGED AND DISPLACED SEMILUNAR CARTILAGES.—PLATES XXII, XXIII, and XXIV.

The most striking injuries in my 150 joints were found in connection with the semilunar fibrocartilages, and these were noted in all of the joints examined. They have been grouped as follows:

Joints with both semilunars damaged:

Both crushed and torn for most of their cartilaginous portion			6
Split or torn from capsule	4	Internal, fringe on external	2
		External, fringe on internal	1
		Both	1
Internal showing wear under posterior part up to lateral ligament with external slightly worn			4
Both showing fine fringes on edges			1
			15

Joints with damaged external and normal internal semilunars:

Strands and fringes projecting	4
Split or torn from capsule	3
Transverse break	3
Showing damage on under surface only	2
Adhesions above	1
	13

Joints with damaged internal and normal external semilunars:

Transverse fracture at attachment of internal lateral ligament	2
Transverse fracture with splitting or tearing from capsule	1
Transverse fracture with wear on under surface only	5
Wear on under surface without complete fracture	4
Split or torn from capsule	2
	14 = 42

Grouping all the damaged internal semilunars together there were:

Showing decided injury	24
Showing only fringes along the edges	5
	29

The same grouping of the damaged external semilunars gives:

Showing decided injury	18
Showing only fringes along the edges	10
	28

Of these forty-two joints, twenty-four were noted as showing some of the marks of inflammation or degeneration of articular cartilage, and doubtless more would have shown under a microscope the earlier changes which are associated with this condition. The important thing, so far as the semilunar cartilages are concerned, is the dryness and consequent friction which is almost always present in some stage of the condition.

The first noticeable effect of friction may be expected to show in the appearance of fine fringes or strands at the edges of the semilunars after the cartilage layer is worn away. Or, one or both of the semilunars may be caught between the moving femur and tibia and split longitudinally somewhere between their free edge and their capsular attachment as described by Barker [12] and others. If both remain attached to the capsule, they may be worn down to the fibrous core, which itself may be torn and irregular as shown in Plate XXIV.

These injuries may all take place as a result of friction while the ligaments retain their normal adjustment, but long-continued friction must ultimately result in ligamentous damage through the strains produced by catching the semilunars and wedging the bones apart.

In many of these joints it has been impossible to decide whether the dryness and friction preceded or followed the ligamentous injury. Injuries to the knee which are classed as acute synovitis or sprain, and are not seriously disabling at the time, occur frequently among young patients, who are less likely than the subjects from which these joints were taken to show degenerative changes. So it has seemed worth while to study the results of extreme movements on the ligaments, and the relation of ligamentous damage to the more obvious injuries seen on the semilunars.

Experimental work on the cadaver cannot reproduce the conditions during life, but some of the results are worth considering. First, do the ligaments of the knee tear off their bony attachments, or do they rupture in their continuity?

The results obtained by Segond,[13] Poirier,[1] Bonnet,[14] Pagenstecher,[15] Hoenigschmied,[16] Jersey,[17] and myself indicate that on the cadaver ligaments almost invariably tear from their bony attachments (usually from the femur), and usually with fragments of bone attached, Larsen[18] reports an operation for a loose osseous body in the knee attached to the femoral end of the anterior crucial ligament. Swan[19] and Fürbeck[20] both report similar operative cases. Pagenstecher reports three operative cases with rupture of the femoral attachment of the crucial ligaments, and Battle[21] and Robson,[22] one case each. So far as cadaveric experiment and the reported operative cases go, it seems most likely that the crucial ligaments at least, and probably the laterals as well, are torn from their bony attachments more often than in their course.

Hints[23] is evidently of the contrary opinion, but presents neither experiment nor operative case to confirm his opinion, and quotes one description of Dittel's which directly states the existence of such an injury.

Second, What ligaments rupture?

Hints has gathered reports of thirty-four cases of rupture of the lateral ligaments of the knee with and without other ruptured ligaments. None of these cases were complicated by dislocation of the bones. Thirty-one of these were cases of rupture of the internal lateral and three of the external.

The experiments of Segond on the cadaver show that abduction alone or abduction combined with either rotation will rupture the internal lateral ligament by itself, also that adduction alone or combined with either rotation will rupture the external. With rotation alone, he always fractured the bones below the knee before any damage was done to the ligaments, and he quotes Bonnet as having had the same experience.

As to hyperextension, the results of his experiments agree with those of Poirier, who found the internal lateral remaining intact until after rupture of both crucials. Hoenigschmied was able to rupture the internal lateral ligament by external rotation, and the anterior crucial and internal lateral by internal rotation, without producing bony fracture.

Pagenstecher was able to tear the anterior crucial ligament from the femur by strongly flexing cadaveric knees over a round stick in the popliteal space, and also by combining complete flexion with adduction and internal rotation.

The cases of ruptured crucial ligaments in the living reported by him and by Battle and Robson will be referred to later.

Practically, all of these observers agree in giving the immediate results of these ligamentous ruptures as we should expect, and they may be tabulated roughly as follows:

Ruptured.	Increased Movement.
Internal lateral.	Abduction and both rotations.
External lateral.	Adduction and external rotation.
Anterior crucial.	Internal rotation and forward slip of tibia on femur.
Posterior crucial.	Internal rotation, extension, and backward slip of tibia on femur.

The effects of these increased movements on the semilunar cartilages do not seem to have been studied except as the semilunars were damaged at the time of injury.

So long as the normal knee is kept in a position of internal rotation, the articular surfaces of femur and tibia are in such close contact that it is impossible to catch the semilunar fibrocartilages between the two articular surfaces. With external rotation and a dry joint it is possible to catch the internal semilunar if the joint be moved slowly, but it will not hold unless the internal lateral ligament gives way.

In twenty-four undissected joints one was found in which the internal semilunar caught and held under this manipulation. This joint had a noticeable increase of lateral movement, though no recent injury showed on dissection. In the other twenty-three joints the internal semilunars caught after section of the internal lateral ligament, at its femoral attachment, sufficient to allow an equal increase of lateral motion, which means, of course, an increase in external rotation.

If the femur be free to roll up on the posterior part of the internal semilunar, it may simply hold it for a moment and then squeeze it back as one " snaps" an apple seed. This may not damage the cartilage for some time, but when the ligaments have become stretched by repeated pulls or by some new and greater violence, the condyle can roll entirely over the semilunar and settle down behind it.

The joint is now locked in flexion, and must be unlocked by abduction combined with internal rotation and extension. Apparently the most common result of this anterior dislocation of the internal cartilage is that the posterior portion is pushed forward until stopped by its firm attachment to the internal lateral ligament, and opposite this attachment a bend or transverse fracture of the semilunar occurs. With repetition the cartilage layer underneath the semilunar is cracked off or worn through, and fibrous tabs appear at the point of fracture which may project over the uncovered tibial surface.

This has been the most common injury to the internal semilunars seen in these joints, appearing in twelve of the fourteen where the internal only was damaged, and to a less degree in four of the fifteen joints in which both showed injury. Plates XXII and XXIII show three internal semilunars with this injury.

One joint shown on Plate XXV shows another possible result of over-riding. In this joint the internal semilunar has been torn from its capsular attachments all the way around and turned wrong side up into the intercondylar space, where it lies against the crucial ligaments with no tendency to return to its natural position. Croft,[24] Barker,[12] and Logan-Turner [25] have found this condition in the living.

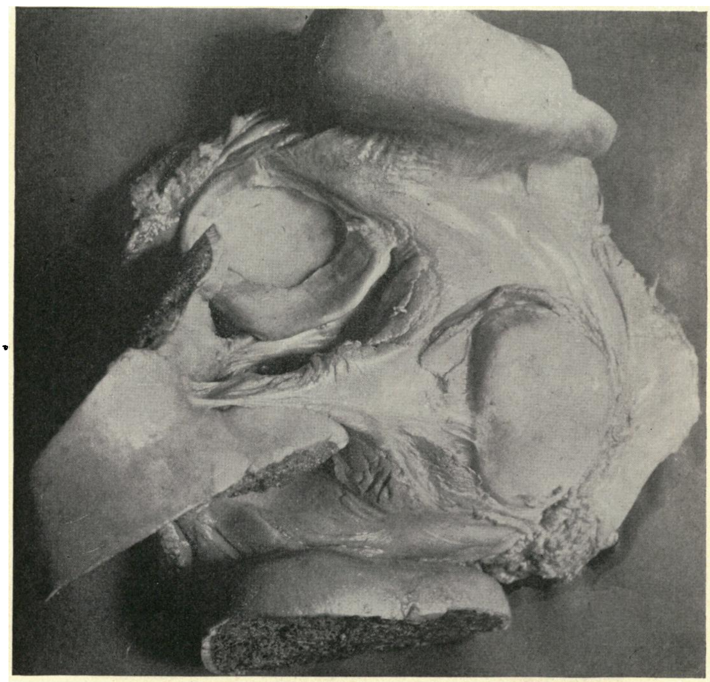
Several examples of another condition appear in the literature, though it is not the most frequent injury, as stated by Hoffa.[9] The internal semilunar is torn from its anterior tibial attachment and the free end may or may not be turned up or folded back on itself. As a possible way in which it is produced, external rotation of the leg while the knee is flexed to a little less than a right angle and is bearing a heavy weight seems to me the most reasonable. At the same time, the internal lateral ligament must be partially torn from its tibial attachment to allow of any tension on the anterior attachment of the semilunar. No instance of this injury appears in my collection.

For the femur to over-ride the external semilunar cartilage greater looseness of ligaments is necessary, because, unlike the internal, the external semilunar has much freedom of movement and has the shape of a blunt wedge on cross-section. Considering a tear from the capsular attachment as evidence, there are three joints in which anterior dislocation of the external semilunar may have occurred.

4. RUPTURED LIGAMENTS.

"Sprains" and "acute traumatic synovitis of the knee due to strain" are scarcely to be found in recent literature outside the text-books. Ruptured ligaments, as such, appear but rarely, while dislocations are reported with some frequency, and the subject of "hæmarthrosis" of the knee-joint

PLATE XXV.



Complete dislocation of internal semilunar fibrocartilage, right knee. Both condyles sawn through vertically, and peripheral pieces turned out.

PLATE XXVI.

Left knee, showing results of rupture of anterior crucial ligament, and fringing of the upper portion of the infrapatellar pad.

has quite an extensive literature. Yet all of these are diagnostic names which cover varying degrees of ligamentous injury.

Hints's [23] collection of ruptured lateral ligaments has been referred to. Pagenstecher [15] has recently reported three cases of suture of the crucial ligaments in which the joint was opened three months, four days, and four months after the injury. In the first case, the posterior crucial ligament was found torn from the femur, and was sewn to the near-by periosteum with good result.

The second case showed an anterior crucial torn from the femur, which was also sutured with good result.

In the third case the anterior crucial was torn "near its insertion, atrophied," and was removed. Later, a free body was removed from this joint, and it became stiff as a result of some rheumatoid process. Robson [22] sutured both crucials to the femur eight months after injury with good result. Plate XXVI shows a joint with a complete rupture of the anterior crucial ligament.

Anterior dislocation of the external semilunar will not be so likely to result in damage to the cartilage itself as the same dislocation of the internal, because there is no fixed point behind which it will bend or break; but the "snap" with which the dislocation is reduced will be sharper than that on the inner side, owing to the different shape of the two semilunars on cross-section as shown on Plates XI and XII.

An extreme form of this injury appears in a museum specimen described by Godlee,[26] and has once been found at operation by Logan-Turner.[25] It corresponds to the dislocation of the internal cartilage shown in Plate XXV.

To allow anterior dislocation of the external semilunar, both the anterior crucial and the external lateral ligaments must be looser than normal. These two may be ruptured by extreme internal rotation combined with adduction, according to Segond.

If the femoral condyle overrides and settles down behind its semilunar, and extension occurs while the joint is loaded heavily enough, the cartilage may be torn from its peripheral attachment and folded over into the notch. Otherwise, the dislocation will be reduced with the "snap," which accounts for the name "jerking" or "trigger" knee.[27]

It is possible that looseness of the external lateral ligaments may permit of sufficient external rotation to allow of a backward dislocation of the anterior portion of the external semilunar during extension, but no evidence of such a condition was recognized in these joints, and no such joint is described in the recent literature.

The only injury found exclusively on the external semilunar cartilages was a transverse tear at the junction of the anterior and middle thirds. This was seen in three joints of the four in which the tough fibrous tabs were found external to the ligamentum mucosum. It is possible that these tears may have resulted from the inclusion of such a mass within the well-fitting semilunar ring during extension, or when landing on the feet after a fall from some height. This connection was not noticed until the notes were tabulated and the joints thrown aside.

One hundred and twenty-eight operations on the semilunar fibrocartilages have been gathered from the reports of forty-seven different operators.

The pathological descriptions are so unlike that an accurate grouping of the conditions is almost impossible. The following is presented as approximately correct:

	Internal.	External.
Torn from or near anterior attachment	23	3
Transverse tear at or near lateral ligament	38	..
Longitudinal split, incomplete	16	1
Longitudinal split, complete	8	..
Turned into intercondylar notch	3	1
Loose and sewn to tibia	23	3
Cystic	1	1
Ossified	..	1
Doubtful	1	5
	113	15

The "loose cartilage" is the most difficult to understand, for the anterior portions of both semilunars are normally loose in certain positions of the joint, and an increase in this would seem to involve a tear. Possibly such a tear might show on the under side of the semilunar, as in the cases seen by Barker [12] and in certain of my specimens.

Schaeffer [28] and others have treated mechanically disabled knees with an apparatus which permitted flexion while preventing external rotation and limiting extension and lateral mobility. If the disability be in the early stage before damage to the semilunar has occurred, this treatment has much in its favor; but if the semilunar has been fractured or torn off its anterior insertion, it is not easy to see how any apparatus can bring about a permanent cure even in function.

The exact diagnosis of semilunar injuries is as yet seldom attempted before opening the joint, and has often been uncertain even then. There is hope that by a careful study of the exaggerated movements, we may learn to locate the damaged ligaments, and thereby to reason out the semilunar injury resulting.

Suture of damaged cartilages has often been attempted, but it is worth attention that in later operations by the same men the damaged portions were removed. The opinion that removal is preferable to suture is now practically unanimous.

Thirteen days after injury, Battle [21] sutured both crucials to the femur and the internal lateral at some point, with good result. Two joints in my collection showed the results of rupture of the anterior crucial ligament.

On the other hand, cases of dislocation like Bergman's,[29] where the internal lateral and both crucials must have torn, and like Eames's,[30] five miners with the same injury, show that there are two sides to the question of repair. These six were all treated without opening the joint, and all recovered with useful knees.

Ligamentous damage of any degree must be followed by swelling. With a certain grade of injury the swelling takes the form of an effusion within the joint. The more slowly the joint fills, the smaller will be the proportion of blood in the fluid. Pure blood has been aspirated from joints which filled within an hour after injury.

Lübbe [5] concludes, from a case reported by Kocher and one of his own, that blood may remain fluid in a knee for twenty-one days, or it may show clots after one day. He thinks the rapidity of clotting is directly proportional to the area of injured synovial membrane. He quotes Volkman as finding large masses of blood-clot as well as strong adhesions fourteen weeks after a contusion, while Delbastaille found that fluid blood in a very slightly injured knee was absorbed, except some pigment, within twenty-eight days. He believes that the rapidity of absorption is in inverse proportion to the synovial injury.

Three methods of treatment for these acutely distended joints are in use:

1. Rest followed by massage and movements. Lübbe [5] reports an average hospital stay of 34.6 days for twenty-two patients at the Seaman's Hospital in Hamburg, and thirty-eight days at a Copenhagen Hospital under this treatment.

2. Aspiration, repeated, if necessary, to relieve the distention and remove a material which would discourage movement and encourage the formation of adhesions.

From the Hamburg Hospital, Lübbe [5] reports an average stay of 25.5 days for thirty-two patients aspirated, and 22.4 days for the aspirated cases under Bondeson at Copenhagen. The great majority of writers [31] on this part of the subject favor aspiration, regarding it as safe if carried out with the most perfect asepsis, as shortening the time for recovery, and as giving better functional results.

3. Incision with drainage. O'Conor [32] is the most vigorous advocate of this procedure, and his conclusions after twenty-two successful consecutive arthrotomies are worth repeating.

"The question of draining gonorrhœal joints is settled."

"Washing out blood-clots from an injured joint is a surgical obligation." "Traumatic 'water on the knee' is best treated by arthrotomy and drainage."

He irrigates all his open joints with 1 to 1000 sublimate solution, and drains them until nothing but normal synovial fluid comes from the wound.

Whichever of these three methods be employed, the great probability of ligamentous injury ought to be kept in mind, an accurate diagnosis of the location and extent of the damage should be sought for by testing the joint for exaggerated movements, and the treatment should be directed not only towards an immediate recovery of function, but to the end that the ligaments may preserve the joint against further disability in connection with the semilunar fibrocartilages.

It may be that within a few years the early opening of these joints with immediate repair or removal of damaged structures will be the definite rule of procedure.

The writer believes that early or late repair of the internal lateral ligament, which is certainly the most accessible and probably the most frequently injured, will prevent some of the disability now caused by dislocation of its semilunar, and that in some cases it will be found to be a "surgical obligation."

5. FREE AND LOOSE BODIES.

Among my specimens there were but two which showed free bodies in the joint. In both they were small and numerous, and in both there was decided "lipping" of the margins of articular cartilage. Berry [33] removed 1047 free bodies from a joint which four years earlier had furnished him fifty. These consisted of a nucleus of cartilage surrounded by fibrous tissue and varied in size from a fine bead to a pea.

Thompson [34] removed several hundred from another joint, of the same structure with scattered areas of calcification.

Bazy [35] argues from his study of a similar case that these multiple bodies are the result of a dry arthritis with overgrowth of the articular cartilage at the margins.

Fowler [36] regards these as arising from embryonic cartilage cells in the synovial membrane.

The bony and cartilaginous masses found by Fredet,[37] Jaboulay,[38] Codman,[39] and many others are apparently of a different origin, and represent pieces of articular cartilage knocked off by direct violence, or pulled off with some ligament with or without bone tissue.

While these may consist of one, two, or even more fragments, they are not multiple to the extent found with the other type, and of course do not reappear as do the others.

Operations for removal of these bodies was successfully performed previous to 1803, according to William Hey.

Woodward [40] says that in 1860 Larry collected 131 operations for simple removal of free bodies. Where attempt was made to remove the body by direct incision 74 per cent. were cured, 4 per cent. were unsuccessful, and 21 per cent. died. The subcutaneous operation in two stages gave 49 per cent. cured, 38 per cent. unsuccessful, and 13 per cent. of deaths. Woodward collected 104 cases up to 1889 with six poor results, two amputations of the thigh, and one death.

Marsh [41] found seventy-two cases between 1885 and 1895, with no deaths, and sixty-two perfect recoveries.

I have tabulated 297 cases, all reported since 1895, including all sorts of operations on non-purulent knee-joints, with six resulting in ankylosis, no amputations, and no deaths. Operative removal of these free bodies is the only treatment to be considered to-day.

INCISIONS.

The uncertainty of our present methods of disinfecting the skin makes it desirable to arrange that the skin sutures shall not follow the lines of the incision in the capsule. This is accomplished by making a U-shaped flap of skin and turning it up or down to expose as much of the deep fascia as is necessary.

Incision 1. Beginning at the inner border of the patella, a finger's-breadth below its upper border, the incision runs downward nearly to the tibia, and then backward above the internal semilunar to the internal lateral ligament. It can be extended above at the expense of the internal lateral ligament of the patella and back into the lateral ligament of the joint if necessary. This will expose the anterior two-thirds of the internal condyle, the anterior half of the internal semilunar, the lower portion of the anterior crucial ligament, the mucosum, and the inner half of the infrapatellar pad in its natural relations.

Incision 2. This begins with extended knee at the upper end of the outer border of the patella, passes downward to the upper border of the external semilunar, then backward along this upper border to the external lateral ligament. If this incision be carried up a little through the extensor fibres, it will expose the suprapatellar synovial pad. Otherwise, it will expose the anterior two-thirds of the external condyle, the anterior half of the external semilunar, the mucosum, and the outer half of the infrapatellar synovial paid in its natural position. The patella can also be tipped up so that practically the whole of its posterior surface can be examined.

Incision 3. This is made along the anterior border of the biceps, with extended knee, down to the capsule. Flexing the knee allows the biceps to pull back out of the way and the iliotibial band to partially cover the field. This latter can be nicked and drawn out of the way. The capsule is now lax and can be opened either above or below the popliteus tendon. Below the tendon, the incision opens into the pocket under the popliteus, which in the ordinary bed position is the lowest portion of the joint cavity. Through Incisions 2 and 3 the whole or any portion of the external semilunar can be removed.

Incision 4. With extended knee this follows the anterior border of the sartorius down to the capsule. The muscle draws back as the joint is flexed, and the capsule may be opened behind the main part of the internal lateral ligament, either above or below the semilunar. Through Incisions 1 and 4 the whole or any part of the internal semilunar can be removed.

The two posterior incisions in the capsule are short and give a small field for operation, but are sufficient for the purposes above mentioned, and will allow gauze drainage from the dependent part of the cavity, provided the joint is allowed to rest partially flexed. Otherwise, the two posterior hoods are in close contact with the femoral condyles.

A possible form of drainage is continuous irrigation, in through one posterior incision and out through the other. The fluid in this case would wash practically every portion of the synovial membrane, except, perhaps, the bursa, under the quadriceps.

The joint has often been opened by one of three transverse incisions which pass either above, below, or through the patella. Niehans [42] has suggested a long vertical cut internal to the patella which turns out at a right angle below the tibial tubercle. The patellar tendon is then chiselled from the tibia and turned up with the patella and front of the capsule.

These extensive incisions are not necessary for complete examination of the joint. The large openings increase the possibility of infection from the air, the operator, or assistant's mouth, and other sources. They prolong the period of immobility, and without exception they give a distorted view of the relations of the fatty pads to the articular surfaces.

A transverse incision may be found necessary to complete the operation in some cases. Under these conditions, the writer believes that sawing of the patella just below its middle, or preferably the section of the patellar tendon immediately below the bone, avoiding injury to the infrapatellar pad, will give the maximum of working-room with the minimum of later inconvenience in the use of the joint.

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