THE SURGICAL ANATOMY OF THE SYNOVIAL MEMBRANE OF THE KNEE-JOINT.

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One of the most anxious of the various problems that present themselves for the consideration of the surgeon dealing with wounds in war is that of injuries involving the knee-joint. An apparently trivial penetrating wound may result in a stiff joint, amputation of the limb, or even death, notwithstanding great care, and in some cases, vigorous and radical treatment.

A movable joint after an infected wound of the knee is something to be proud of. The reason for this is not far to seek. The knee-joint has the largest and most complex synovial membrane in the body. Its size is not a matter of much consequence, except that a large surface is exposed for absorption of bacterial poisons, should infection occur. It is the complexity of the joint that renders treatment so difficult. Diverticula, folds, recesses, and communications with bursa, render it impossible thoroughly to drain; and irrigation, unless perhaps by a powerful force pump, is quite inadequate to reach and wash out the various culs-de-sac connected with the main cavity.

The question of foreign bodies in the joint is another problem. Their exact location and the best methods of approach require skilled X-ray work, and a knowledge of applied anatomy. Since I have been with the forces in France I have found good stereoscopic X-ray pictures, studied in conjunction with drawings from sections hardened in formalin kindly made for me by Professor Symington, of Belfast, of inestimable value. I have added to these an X-ray photograph kindly supplied by Lieutenant-Colonel Robert Jones, of Liverpool, showing a joint inflated with oxygen, and also photographs showing joints injected with bismuth. The object of this paper is to illustrate the more important details of the synovial membrane from a surgical point of view, and to supply the shortest possible description compatible with clearness.

The articulation is composed of three parts, two femoro-tibial and a femoro-patellar (figs. 8 and 9). In some animals there are three separate synovial membranes. The arrangement in the
human subject indicates its composite nature. The cruciate ligaments are the lateral ligaments of the femoro-tibial joints (fig. 8). Thus the external condyle is held in its position on the superior articular surface of the tibia by the external lateral ligaments (fibular collateral) externally, and the anterior cruciate ligament, which represents an internal lateral ligament, internally. Similarly, the internal condyle is held in position by the internal lateral ligament (tibial collateral) internally, and the posterior cruciate ligament which represents an external lateral ligament, externally. The cruciate ligaments which cross each other like the letter X divide the intercondylar fossa into two lateral recesses, into which, as we shall see, pockets of synovial membrane extend (figs. 6 and 8).
infra-patellar pad of fat (figs. 7, 8 and 9) further tends to sub-divide the joint into its component parts. It consists of a wedge-shaped central portion (fig. 9) which extends backwards and upwards to the intercondylar fossa and two lateral wings which extend along the lateral borders of the lower part of the patella. Covered by synovial membrane, the central portion is attached above (proximally) to the anterior margin of the intercondylar fossa. It is known as the ligamentum mucosum (patellar synovial fold) (figs. 7 and 15). The lateral extensions similarly invested by synovial membrane, form the ligamenta alaria (plicae alares). These ligaments (more properly called folds) form a pad which fills up the irregular space between the patella, femoral condyles and tibia (fig. 7).

The semilunar cartilages (menisci) are shown in figs. 7 and 8, and their wedge-shaped appearance in section is well shown in figs. 10 and 11, in which the parts are represented as separated somewhat, to show how the synovial membrane invests the upper and under surfaces and free borders. It should be remembered that while the internal lateral ligament is adherent to the internal semilunar car-
tilage (medial meniscus) at its convex border, the external lateral ligaments are separated from the external semilunar cartilage (lateral meniscus) by the tendon of the popliteus (figs. 7, 8 and 11) which, covered by a pouch-like prolongation of synovial membrane is prolonged backwards and downwards and grooves the outer convex border of the meniscus. This cartilage has, therefore, a covering

![Diagram of knee joint](https://example.com/knee-joint-diagram.png)

**Fig. 5.** Horizontal section of knee-joint, dividing the femur and patella, viewed from above (see fig. 3, Slab B). (1) Patella; (2) joint cavity; (3) fascia lata; (4) femur; (5) oblique popliteal ligament; (6) gastrocnemius muscle; (7) popliteal artery; (8) biceps muscle; (9) popliteal vein; (10) tibial nerve; (11) great saphenous vein; (12) sartorius muscle; (13) gracilis muscle; (14) semimembranosus muscle; (15) semitendinosus muscle; (16) common peroneal nerve.

**Fig. 6.** Horizontal section of knee-joint, dividing femur and the lower end of the patella, viewed from above (see fig. 3, Slab C). (1) Patellar ligament; (2) patella; (3) joint cavity; (4) fascia lata; (5) femur; (6) anterior cruciate ligament; (7) posterior cruciate ligament; (8) joint cavity; (9) popliteal artery; (10) oblique popliteal ligament; (11) popliteal vein; (12) gastrocnemius muscle; (13) sartorius muscle; (14) great saphenous vein; (15) gracilis muscle; (16) semimembranosus muscle; (17) semitendinosus muscle; (18) tibial nerve; (19) biceps muscle; (20) common peroneal nerve; (21) bursa under semimembranosus and gastrocnemius.

of synovial membrane on its outer convex border for part of its extent (figs. 7, 8 and 11). See also figs. 13 and 14). The capsule of the knee-joint, together with the ligaments, tendons and fascia which strengthen it, forms a complete investment for the joint, except at those places where communications with bursae exist. It is very thin above the patella where it is represented merely by the layer of synovial membrane which invests the under surface of the quadriceps muscle and is reflected on to the femur (fig. 15).
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Here pus distending the joint may break through and burrow in the fascial planes of the thigh. In this connexion the possibility of the presence of Baker's cysts, which are hernial protrusions of the synovial membrane through defects in the capsule, ought to be borne in mind. These might, of course, become pockets of pus in septic infection of the joint and complicate the treatment.

Fig. 7.—Horizontal section through knee-joint, dividing the condyles of femur and ligamentum patellae, viewed from above (see fig. 3, slab D). The lower end of femur was removed to show the synovial cavity, cruciate ligaments, and semilunar fibrocartilages. (1) Patellar ligament; (2) infrapatellar fat; (3) capsule of joint; (4) internal semilunar cartilage; (5) ligamentum mucosum; (6) external semilunar cartilage; (7) anterior cruciate ligament; (8) capsule of joint; (9) external lateral ligament; (10) posterior cruciate ligament; (11) popliteus muscle; (12) sartorius muscle; (13) biceps muscle; (14) popliteal artery; (15) popliteal vein; (16) gastrocnemius muscle; (17) tibial nerve; (18) great saphenous vein; (19) gracilis muscle; (20) semimembranosus muscle; (21) semitendinosus muscle; (22) common peroneal nerve; (23) bursa under semimembranosus and gastrocnemius.

The joint cavity is bounded by the articular cartilage and synovial membrane. The articular cartilage forms a firm, unyielding, non-vascular wall, whereas the synovial membrane, as a rule, is thin, readily displaced and vascular, except over the semilunar cartilages where it becomes very thin and firmly adherent. In addition to lining the capsular ligament it covers the non-articular portions of the bones within the joint (fig. 8) and various pads of fat.

The joint cavity not only extends between the articular ends of the bones, but into numerous extensions of the synovial membrane.
Thus a pouch is pushed up under the quadriceps and invests this muscle on its under surface and the femur for a distance of about an inch above the upper border of the patella (fig. 15. See also, figs. 1, 2 and 9). In figs. 13 and 14 the joint has been over distended with bismuth emulsion to show the arrangement of the cavity and its diverticula. In fig. 9 its vertical extent is less than normal.

This is due to the hardening process in the specimen from which the drawing was made. This protrusion communicates with a bursa which extends for about another inch by an opening which may be quite small, but is generally so large that the sacs are practically continuous, as shown in figs. 13 and 14. The lateral extent of this upward protrusion is represented in figs. 4, 5 and 6, from slabs cut at the levels shown in the key (fig. 3; see also figs. 1, 2, 13 and 14). It will be apparent that a penetrating wound
involveding the anterior third of the circumference of the thigh within two inches of the upper margin of the patella or the condylar surface of the femur is almost certain to be a wound of the joint, except in those rare cases in which the suprapatellar bursa does not communicate with the cul-de-sac from the joint. We have lately dissected a joint in which the suprapatellar bursa was filled with pus, but did not communicate with the joint. It is important to remember that occasionally the opening between these two cavities is quite small and that movement may pump infective matter from one to the other, an accident which might have been avoided by immobilization on a splint. In the kneeling position the cul-de-sac is drawn down with the patella and may thus escape injury. The synovial membrane which extends from the margin of the articular surface of the patella (fig. 15), is continued on to the infrapatellar fat forming the ligamentum mucosum and the ligamenta alaria, as before described (figs. 7 and 9). Note the arrangement in figs. 1, 2, 13 and 14, in which the joint has been distended. In the non-distended or normal state it will be seen that a missile can traverse the infrapatellar

Fig. 9.—Vertical anteroposterior section, approximately through middle of knee-joint, lateral view. (1) Semimembranosus muscle; (2) suprapatellar bursa; (3) patella; (4) joint cavity; (5) prepatellar bursa; (6) popliteal vein; (7) peroneal nerve; (8) patellar ligament; (9) anterior cruciate ligament; (10) posterior cruciate ligament; (11) bursa over tubercle of tibia; (12) gastrocnemius muscle; (13) plantaris muscle; (14, 15) popliteal vessels; (16) tibial nerver; (17) soleus muscle; (18) popliteus muscle.
region, and even project a considerable distance backwards towards the joint without actually involving the latter (fig. 9). It is important to remember that there is a bursa between the ligamentum patellæ and the tubercle of the tibia which must not be mistaken for the joint itself. In fig. 9 I have made an addition to the original drawing, showing the position of the bursa. A knowledge of the anatomy of this angle may enable a careful operator to remove a missile lodged there without opening into the knee-joint. In the distended joint (figs. 1, 2 and 14) the relations of the structures in this angle are much altered. The synovial membrane is reflected on to the condyles of the femur and the tuberosities of the tibia as far as the articular cartilage, and is then, as it were, pushed into the intercondyloid fossa, lining it and its contained fat and partially investing the cruciate ligaments (figs. 7, 8 and 9). In this way two recesses are formed, one on either side of the cruciate ligaments as they pass up from the non-articular surface between the facets on the upper (proximal) surface of the tibia to the intercondyloid fossa. These recesses are partially shown in figs. 6, 7, 8 and 9. The cruciate ligaments form a septum dividing the

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**Fig. 10.** — Vertical antero-posterior section of right knee internal to and 1·8 centimetres from section fig. 9, lateral view. (1) Semimembranous muscle; (2) quadriceps muscle; (3) inner condyle of femur; (4) tendon of semitendinosus muscle; (5) bursa under gastrocnemius; (6) cavity of joint; (7) patellar ligament; (8) internal semilunar cartilage; (9) tibia; (10) insertion of semimembranosus muscle; (11) inner head of gastrocnemius muscle.
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synovial pouch in the intercondyloid notch into two cavities in either of which a foreign body may lodge (fig. 8). Pus is also likely to accumulate here, and in bad septic cases can only be efficiently dealt with by acute flexion after division of the lateral and cruciate ligaments and removal of the semilunar cartilages, or by excision of the joint. The posterior cruciate ligament (figs. 6 and 7) is devoid of synovial membrane at its posterior aspect where it is connected with the posterior ligament of the knee-joint. Missiles may be lodged in this cruciate ligament and yet be entirely outside the joint and capable of being reached by an incision on the inner side of the popliteal vessels (figs. 6 and 7) always remembering the presence of the bursa in that situation which frequently communicates with the joint. The synovial pouches which invest the condyles of the femur are well shown in cross section in fig. 6, and in vertical section in figs. 8, 10 and 11.

Referring to fig. 6 it will be seen that at this level there appear to be three pouches—two condylar and one behind the patella. Compare this fig. with figs. 1 and 2, in which the synovial
To illustrate "The Surgical Anatomy of the Synovial Membrane of the Knee Joint." By Temp. Colonel ANDRE-FULLER, M.D., M.Ch., F.R.C.S.I.
membrane has been distended, for an explanation of the appearances seen. The synovial pouch is prolonged up behind each condyle to invest the cartilaginous surfaces, the whole sac as seen laterally resembling the letter "J." The synovial membrane is reflected from the cartilaginous surfaces of the tibia to invest the semilunar cartilages as shown in figs. 10 and 11. In fig. 12 the joint has been distended with oxygen and the potential pockets, especially those between the cartilages and the tibia, are well shown. Compare also figs. 13 and 14. On the outer side, the tendon of the popliteus muscle (figs. 7, 8 and 11) receives a finger-shaped diverticulum of synovial membrane which partially invests it and generally accompanies it as far as the tibio-fibular articulation, occasionally communicating with the latter (fig. 2). This process of synovial membrane separates the tendon from the posterior part of the external surface of the external semilunar cartilage and from the tibia (see figs. 8, 11 and 14). It is a source

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of serious danger in an infected joint, as pus frequently tracks along it, and breaks through to form an abscess in the ham or calf. This diverticulum we have found involved in almost every case in which amputation has been performed for a badly infected joint. It will be seen from the foregoing description that the external semilunar cartilage is covered for part of its extent on the outer surface by synovial membrane (figs. 8 and 14), thus differing from internal cartilage (figs. 8 and 13).

**Bursae.**—There are many bursae in the neighbourhood of the knee, but only those that are likely to communicate with the joint need detain us here. The suprapatella bursa has already been mentioned. A large and important bursa is that between the inner head of the gastrocnemius and the internal condyle of the femur. This bursa sends a communication between the tendons of the gastrocnemius and semimembranosus, and frequently communicates with the joint. It is shown in figs. 7 and 10, and I have added it to the original drawing in fig. 6. We have found that this bursa frequently shares in the infection of the joint. Movement is liable to pump infective matter into it from the joint, hence the necessity for absolute rest by fixation on a suitable splint. It is interesting to remember from one's experience of civil surgery that when enlarged and tense this bursa is easily emptied into the joint during flexion, while in the extended position its contents cannot be readily returned on account of the valve-like communication which is made tense by placing the limb in the latter position. There is also a bursa between the outer head of the gastrocnemius and the external condyle, but this is inconstant and rarely communicates with the joint.

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