GUNSHOT WOUNDS OF THE KNEE-JOINT:

THE CONSERVATIVE OPERATION AT THE CASUALTY CLEARING STATION.

BY

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WHEN Colonel Gray published his first article on the conservative treatment of gunshot wounds of the knee-joint as carried out by him at the base,¹ it was decided to adapt his principles to treatment at the casualty clearing station. It soon became apparent that this procedure was justified, and as time went on and technique improved conservatism became more and more the routine practice. It is now matter for regret that any case requiring operative treatment is ever transferred to the base before operation; results are so much better when operation can be performed within twenty-four hours of the patient being wounded.

It is not proposed to repeat in this article what has already been written on the classification of cases according to the respective indications for amputation, resection of the knee-joint, conservative operation, or expectant treatment, but to confine it to a description of the technique of the conservative operations.

X RAYS.

Operations should never be attempted without the evidence of radiography when this is available. Accurate knowledge of the position of the foreign body and the extent of bone injury is invaluable in determining the procedure to be adopted in any case. The most useful examination is one yielding a stereoscopic radiograph combined with the cutaneous marking of the position and depth of any foreign body present. Such an examination can usually be carried out with the patient in the dorsal decubitus throughout.

OPERATION.

1. Bloodless Field.

Our primary object is the scrupulous excision of infected material from the joint and its surroundings without spreading sepsis in so doing. To obtain this object I consider it absolutely necessary to secure a bloodless field throughout the operation. The first step, therefore, is to apply an Esmarch's bandage from the foot upwards to a point above the knee-joint where the tourniquet is fixed.

2. Sterilization of Skin.

The skin all round the knee is thoroughly washed, shaved, cleansed with spirit, and painted with a solution of picric acid (5 per cent.) in spirit. The wound or wounds must then be gently packed with gauze to prevent leakage of infected fluid on to the skin.

3. Excision of the Track and Wound.

The whole success of the case depends upon attention to every detail which can contribute to the removal of soiled tissue without carrying infection into fresh tissue. In nearly all cases it is possible to remove the entire track of the missile intact down to the joint cavity without permitting the knife or other instrument to touch the track or the infected surface of the wound. Should such an accident occur, the soiled instrument or glove is immediately discarded. As the field of operation is bloodless every cut of the knife can be followed by the eye, and one is not hampered by the presence of artery forceps or swabs, which, moreover, so often contribute to the spreading of infection. The incision employed for excising the wound varies according to the size and position of the wound, and should always be made with a view to extending it so as to give free access to the joint. Having isolated the wound by an elliptical skin incision, the skin surrounding the ellipse is freely undermined all round; its edges are then protected by oiled silk and retracted. In excising the track the deep tissues are not usually removed

to an extent corresponding to the area of the skin incision. The next step, therefore, is to undermine this elliptical area of skin and get close up to the track. So far as the outer portion is concerned the track and wound are now ready for excision, but it is first necessary to carry the incision on one side down through all layers into the joint cavity to permit a view of the deep end of the track. With these landmarks established the tissues enclosing the whole length of the track are excised in one piece. This stage calls for a most patient dissection under severely aseptic conditions, and, being carried out with both ends of the track in view, it entails a minimum loss of valuable fibrous structure.

4. Investigation of Joint.

All used instruments and gloves are exchanged for clean ones. The original opening is then enlarged and the state of the joint investigated. Most of the conditions encountered are dealt with below.

5. Removal of Foreign Body and other Infective Matter.

The missile may be found loose in the joint cavity. In this case it is removed, and, if no injury is present within the joint, the cavity is

thoroughly irrigated, and the joint closed in layers with a view to healing by first intention.

If the missile is found impacted in the bone, and access can be got to it by enlarging the incision, this is done even if it entails division of the tendo patellae. Free access to the joint is essential, and I frequently sever the tendon for this purpose. The site of the foreign body is then isolated from the rest of the joint by gauze wrung out of saline, and the foreign body, together with the portion of bone surrounding it, is cut clean out in one piece. A sharp osteotome and hammer are used for this purpose, and it is important to go deep enough to ensure that no surface of bone is left that has been in contact with the foreign body. The joint is then irrigated and closed.

FIG. 2.—Specimen of large foreign body with surrounding bone cut out *en masse* (Case XII). A, Cartilage found lying loose in joint. B, Tip of foreign body. C, External condyle. D, The foreign body in cancellous tissue.

When the missile is situated on the side opposite to the wound, and if there is no injury to the intervening tissues, the original opening is closed and a fresh incision made directly over the missile.

Injuries to the Bone.—Grooved injuries are always treated as foreign bodies and excised *en masse*. Small comminuted fractures and chipping of the bone are dealt with in the same careful and thorough manner, the fractured surface being chiselled away along with the adherent fragments.

With regard to the excision of bone, as above described, though applicable to the greater part of the joint surface, there are cases in which it is difficult to apply it to the neighbourhood of the mid-line of either bone in the centre of the joint. Severe lesions in this region often penetrate further into the bone than examination reveals or the surgeon can excise, and in these cases one may feel compelled to resect the joint. However, even in such cases, by reflecting the patella and employing Carrel-Dakin treatment from the start, one can often save the joint. When the bone lesion is small and the conditions

FIG. 3.—Specimen of comminuted patella, with wound and track excised *en masse* (Case IV). A, Lower portion of patella. B, Upper portion of patella. C, Quadriceps tendon. D, Fat and subcutaneous tissue. E, Skin. F, Patella end.

otherwise favourable, the infected area may be curetted and the joint closed after thorough irrigation. Another type of wound presenting difficulty and necessitating a departure from the principles above detailed is comminution, or chipping of the head of the tibia on either side, associated with a wound of entrance through the joint. Excision must then be practised in stages. It is necessary to excise first the skin wound and track in the soft tissues, then reflect the patella and excise the infected ligamentous tissue—usually the meniscus; and, finally, by a vertical incision down the lateral aspect of the head of the tibia, fully expose and chisel away the damaged portion of bone. This done the wound is completely closed in favourable cases, otherwise the bone cavity is dressed with bipp and packed with gauze, the end of the gauze being brought out and the rest of the wound closed in layers (see Case xx).

FIG. 4.—Comminuted patella, with wound and track excised *en masse* (Case v). A, Lower portion of patella. B, Fragment of patella. C, Upper portion of patella, completely detached. D, Fat. E, Capsule. F, Skin, including wound. G, Patellar tendon.

When the patella is fractured the comminution is often so extensive as to call for complete removal along with the neighbouring infected tissue. The transverse incision employed for this operation should be made to include the external wound or wounds, so that such may be included in the excised mass. Obviously precaution must be taken to avoid cutting away any serous membrane or ligament beyond the margin of necessity; and even after exercising great care it is often found necessary to lengthen the quadriceps tendon when bringing the parts together again.

In minor fractures of the patella involving the articular surface, such as gutter wounds, or chipping or comminution limited to one side or end of the bone, the portion involved is excised *en masse* by means of a metacarpal saw. Occasionally a transverse fracture is met with and is treated in the same way, both fractured surfaces being sawn away. The fresh ends are then approximated by a purse-string suture of chromic gut round the circumference (see Case vi).

6. Irrigation of the Joint.

I invariably use normal saline, and prolong the process for several minutes so as to ensure a thorough mechanical cleansing of the joint.

7. Transplantation of Fat.

It has been proved that adipose tissue, when transplanted on to any raw surface, has the property of becoming adherent to it, with little reaction or alteration in its original size.² I have applied this practice to the knee-joint in the cleaner cases for filling up a hole in the articular surface. The infrapatellar pad of fat with the attached portion of synovial membrane is usually convenient, and I have found that such a pad inserted into the bony cavity acts also as a plug in arresting the oozing of blood.

8. Synovial Membrane.

It is now a recognized fact that when the knee-joint is given a fair chance it can deal with a mild infection, but not so the surrounding soft tissues; therefore it is important to close the joint completely and without tension. In order to do this, the lateral reflection of the synovial membrane has often to be loosened. Frequently, in dealing with a punched-out hole in the condyle, and particularly in case of doubtful asepsis, I have resorted to the following simple expedient for converting it into an extra-articular lesion: Beginning at the edge of the wound, the redundant synovial membrane is undermined from its attachments to the soft tissues and to the condyle all round the hole; it is then closed by suture, so as to exclude the bone lesion from the joint cavity. This is also done with wounds in the suprapatellar region.

Again, in rare cases, where the patella has been removed and the severely lacerated condition of the adjoining soft parts renders it absolutely necessary to close the true joint cavity, the whole of the synovial membrane from the suprapatellar pouch may be brought down and sutured to the synovialis below. A further lateral incision may be required to give access for this dissection.

9. Closure of Wound.

The wound is sutured in layers—the synovial membrane by a continuous suture of fine catgut, the capsule brought together by interrupted sutures, and the rest of the wound closed without drainage. In any case in which there is doubt as to complete absence of infected tissue, one or two Carrel's tubes are placed under the skin, in the hope of preventing sepsis. This, however, is seldom necessary.

The dressing is applied with a firm bandage and the tourniquet is then released. Finally the leg is put up in a Thomas splint.

ILLUSTRATIVE CASES.

The following series of twenty consecutive operations has been chosen because, thanks to the courtesy of medical officers at the base, I am able to give some account of the subsequent progress of all of them. In looking over the records of 50 consecutive cases (including this series of 20), I find that there were three deaths. Case xi was one of these; a second was due to septicaemia on the third day, and the third resulted from general sepsis due to multiple wounds. In only one case to my knowledge was a subsequent amputation necessary.

Many of these cases were operated on during periods of high pressure in the casualty clearing station and were transferred to the base within twenty-four hours with apparently no harmful results.

CASE I.

Pte. W., Canadian Infantry; rifle bullet wound, January 2nd, 1917, 11 p.m.

On admission there was a gutter wound across the middle of the patella with fracture; no effusion into the joint. I decided that it was a case to leave alone; the wound was cleansed and dressed, and the leg placed on a back splint.

Operation.

On January 3rd the wound was very septic, and the joint painful and tender. At 10 p.m. the patella was removed *en masse*; the joint, which contained semi-purulent fluid, was washed out with saline; the suprapatellar pouch was undermined, brought down and sutured to the synovialis below, thereby closing the true joint cavity; the quadriceps tendon was brought down and sutured, and the operation completed by closure of the capsule, and the wound without drainage. On the following day the area of the skin incision was red and inflamed; the stitches were removed and the parts treated by the Carrel-Dakin method. On January 8th there was slight superficial sepsis only, and on January 25th he was transferred to the base, the wound looking clean and healthy.

Base Report (a General Hospital).

Temperature normal since admission; wound healing rapidly; no joint infection. Transferred to England February 5th, 1917.

CASE II.

Cpl. B., Highlanders; wounded by shell fragment on January 6th, 1917, at 12.30 p.m.

On admission there was a small wound of entrance on the antero-internal aspect of the knee, with a large effusion into the joint. X rays showed two foreign bodies impacted in the inner head of the tibia. Multiple wounds of the leg were also present.

Operation.

The wound was excised and enlarged, the joint laid freely open, and the patellar tendon divided; both foreign bodies were removed, and the joint washed out with saline and completely closed without drainage. The wounds of the calf were laid open, infected and destroyed tissue was removed, and the post-tibial artery ligated; Carrel-Dakin treatment. He was transferred to the base on January 21st.

Base Report (a Canadian General Hospital).

Knee-joint looks well. Operation wound over front and internal part of knee-joint healed. Leg, large granulating wound, perfectly healthy. Transferred to England February 26th, 1917.

CASE III.

Pte. H., Cyclists Corps; wounded by shell fragment on January 8th, 1917, 9 p.m.

On admission it was seen that the missile had entered over the external condyle and traversed the suprapatellar pouch; x rays showed it lodged in the vastus internus muscle. There was a severe compound fracture of the middle third of the tibia of the same leg.

Operation.

At 10 p.m. the wound of entrance was excised and enlarged in the direction of the missile obliquely across the suprapatellar pouch and the joint laid widely open. No bony injury was found; the position of the wound of exit from the joint was noted to be at the top of the pouch; the skin incision was continued in this direction, and the wound in the synovialis along with the adjoining track and missile in the vastus internus excised *en masse*. The joint was washed out with saline, and the wound closed without drainage. The compound fracture of the tibia was treated by the Carrel-Dakin method.

On January 18th the knee-joint wound had healed by first intention; the stitches were removed, and he was transferred to the base.

Report from Base (a General Hospital).

Knee wound healed by first intention; no fluid in joint; result perfect. Leg wounds healing rapidly; a shell fragment found in subcutaneous pus pocket. Marked for England, February 5th, 1917.

CASE IV.

Pte. B.; wounded by shell fragment on February 5th, 1917.

On admission next day, through-and-through wounds on each side of the patella were found; both were dirty; x rays showed comminuted fracture of the patella.

Operation.

On February 6th a transverse elliptical incision was made and the patella removed completely, including the wounds of

from the suprapatellar pouch. The wound healed by first intention, and the stitches were removed on February 25th. When he was evacuated there was no joint infection.

No report was received from the base, but I heard from the patient that the wound was doing well.

CASE VI.

Lce.-Cpl. M., Canadian Infantry; wounded February 22nd at 7 p.m. by a bomb.

On admission he presented multiple wounds of the knee-joint, and there was considerable loss of skin, with a large exposure of the antero-external surface of the joint. X rays showed a piece of metal impacted in a complete transverse fracture of the patella, also local injury to the external condyle and metal fragment higher up in the thigh.

Operation.

At 11.30 p.m. an oval incision including both wounds was made; infected tissue was excised with considerable difficulty in avoiding reinfection of the wound. The fractured patella was exposed, and by means of a metacarpal saw the upper and lower fractured surfaces were resected, leaving both ends with an even surface; the two portions were approximated by a purse-string suture. The injury to the condyle was next investigated, and a punched-out hole found communicating with the joint by a fissure through the articular surface; this injury had been produced by the foreign body seen by the x rays higher up in the thigh; the hole in the bone was

FIG. 5.—Case VI, before operation. A foreign body is impacted in the lower half of the fractured patella. The missile higher up produced a punched-out hole in the external condyle with a fissured fracture into the joint.

FIG. 6.—Case VI, after operation; shows also the fracture of internal condyle. This photograph, taken on the twelfth day, shows some separation of the patellar fragments.

FIG. 7.—Case VII: comminution of upper third of patella. Damaged bone excised, sawing from within outwards and well below infected tissue.

FIG. 8.—Case VIII: radiograph showing foreign body in internal condyle.

entrance and exit, *en masse*. Pieces of clothing were removed from the joint, and it was washed out with saline; the synovial membrane of the pouch was undermined, brought down, and sutured to the synovialis below; a flap of quadriceps tendon and vastus internus muscle was reflected downwards to close the gap completely, and finally the skin sutured without drainage.

On February 11th there was slight superficial skin sepsis; a few stitches were removed, and Carrel tubes placed underneath the skin. When transferred to the base on February 25th there was no joint infection.

Base Report (a Canadian General Hospital).

March 5th, 1917. Some pus from the wound in front of the joint. Carrel's tubes placed *in situ*. March 9th, 1917. Lateral incision inner side of joint; large cavity communicating with the wound in front; salt-packed. April 5th, 1917. Joint looks well, no pain, wound nearly healed. Transferred to England.

This pus pocket was apparently deep to the quadriceps, and was no doubt due to infection during the primary operation.

CASE V.

Pte. G., Canadian Infantry; wounded by shell fragment on February 13th, 1917, at 9.30 a.m.

On admission there was a wound of entrance only, on the top of the patella; the joint was very distended. X rays showed a foreign body in the joint, with fractured patella.

Operation.

At 4.30 p.m. on the same day a transverse incision was made, and the patella and wound removed *en masse*; the foreign body was lying loose in the joint; the quadriceps tendon and the capsule sutured. The wound was closed without drainage. In this instance the synovial membrane was not brought down

chiselled out, the joint washed out with saline, the synovialis was reflected laterally, loosened, and sutured, leaving the resulting cavity in the condyle extra-articular; finally, a plastic operation on the skin was done to effect closure of the wound.

On March 12th, when he was transferred to the base, the wound was healed by primary union; no joint infection.

Report from Base (a Canadian General Hospital).

Wound healed and looking clean; patient in good condition. Transferred to England March 26th, 1917.

CASE VII.

Pte. P., Canadian Infantry; wounded on March 1st, 1917, at 4.30 a.m., by a bomb.

On admission there was a through-and-through wound, the entrance over the external condyle, the exit above the patella. X rays showed the upper portion of the patella comminuted.

Operation.

At 2 p.m. an oval incision was made, including both wounds, which were excised in one piece with a portion of the quadriceps tendon; the upper third of the patella was resected, the joint washed out with saline, and the wound closed in layers.

He was transferred to the base on March 12th, the wound being healed by first intention.

Base Report (a Canadian General Hospital).

Treatment: Dry dressing; stitches removed. March 29th. Transferred to England in good condition, "for special orthopaedic treatment."

CASE VIII.

Pte. E., Fusiliers; wounded on March 8th, 1917, by shell fragment. Both knee-joints were penetrated; on the right there

was a through-and-through wound across the anterior surface of the knee; track running deep to the patellar tendon; the joint was very distended. On the left there was a wound of entrance only; X rays showed a large piece of metal impacted in the external condyle.

Operation.

On the same day both wounds on the right were excised, including a portion of the patellar tendon, in one mass; no bone injury was noted; the joint was washed out with saline, and completely closed. In the left knee the wound was excised and enlarged; the missile was located in the cancellous tissue, and cut clean out with a portion of the surrounding bone; the cavity was smeared with bipp, filled with a fat graft, and the joint completely closed.

Both wounds healed by first intention, and he was transferred to the base on March 18th.

Base Report.

Heard from the patient that he was doing well some weeks later.

CASE IX.

Pte. M., Field Coy. R.E.; wounded March 10th, 1917, by a rifle bullet.

On admission it was found that the bullet had entered the back of the calf, passing up through the head of the tibia; it could be felt underneath the skin just above and external to the patella; joint very distended.

Operation.

Arthrotomy was performed and the bullet removed; a fissured fracture of the head of the tibia was noted; the joint was washed out with saline and closed without drainage.

Base Report (Red Cross Hospital, Perth).

March 24th, 1917. Stitches removed. Wound healed and patient up on crutches. Transferred to Canadian General Hospital, London, April 26th, 1917.

CASE X.

Pte. A., Highlanders; wounded April 2nd, 1917, by bomb.

He presented on admission a through-and-through wound, passing under the patella. Synovial fluid was escaping from the wound.

Operation.

A crescent-shaped incision, convexity downwards, including the wound of exit and entrance in either horn, was made, the patella reflected upwards, and a transverse gutter fracture just above the articular surface of the femur excised; the synovial membrane was sutured over it, the joint irrigated with saline and closed. He was transferred to the base on April 3rd.

Base Report (a Canadian General Hospital).

A slight skin infection at one end of the wound, which cleared up in a few days. Sent to England.

CASE XI.

Pte. R., Highlanders, wounded on March 13th, 1917, by shell fragment, presented on admission a severe compound fracture of the right femur, and a large flesh wound over the antero-internal aspect of the left knee-joint; extensive destruction of skin and deep tissues exposed widely; this surface of the joint; both wounds were very dirty.

Operation.

On March 14th the infected and damaged tissue of the knee-joint was freely excised. Bone was not injured; the joint was irrigated with saline. bipp was smeared into the joint, and rubbed into the surrounding tissue; the synovial membrane alone was sutured. The fracture of the femur was treated by the Carrel-Dakin method. He was transferred to the base on March 16th.

Base Report (a General Hospital).

March 31st, 1917. Amputation of left leg. Sequestrotomy of femur.

April 6th, 1917. Died from sepsis. Post-mortem examination: fatty degeneration of kidney and liver.

Fig. 9.—Case xv.

CASE XII.

Pte. F. D., R.F.A.; wounded on April 2nd, 1917, by shell fragment.

There was a large wound of entrance only, situated over the external condyle; the joint cavity was freely exposed. X rays showed a large piece of metal impacted in the articular surface of the external condyle of the femur.

Operation.

The wound was excised and enlarged, the patella and tendon divided; the metal, with a portion of the surrounding bone, was cut clean out *en masse*; the joint was irrigated with saline and the cavity packed with gauze soaked in bipp; the end of the gauze was brought out and the rest of the wound closed in layers. He was transferred to the base on April 3rd.

Base Report (a Canadian General Hospital).

Gauze left in knee-joint for nine days before removing it. He had an infection localized to the track where the gauze was, but no general infection of the joint. His condition is good and the result should be a useful knee-joint.

CASE XIII.

Lieutenant M., Canadian Infantry; wounded on April 20th, 1917, by a shell fragment. The wound of entrance was on the top of the patella; there was no exit wound; there was a large effusion of blood into the joint. X rays showed a foreign body lying between the fragments of the patella, which was severely comminuted.

Operation.

On April 21st a transverse incision was made, the patella removed, and the joint irrigated with saline; the quadriceps tendon was lengthened and sutured, and the capsule and wound closed; a Carrel tube was placed underneath the skin; Dakin's solution was used every two hours. He was transferred to the base on April 23rd.

Base Report (a Red Cross Hospital).

This patient has done most awfully well; Carrel tube removed. Has never had any rise in temperature. Wound healed. Transferred to England.

CASE XIV.

Cpl. F.; wounded May 6th, 1917, by a bomb.

There was a wound of entrance only, internal to the patellar tendon. X rays showed a metal fragment in the joint cavity. There were multiple wounds also of legs, arms, and face.

Operation.

A crescent-shaped incision including the wound of entrance was made, and the patellar tendon partially divided. A foreign body lying loose in the joint was removed, and a gutter fracture of the inner border of the patella resected. The joint was washed out with saline, and the wound closed in layers. He was transferred to the base on May 7th, 1917.

Base Report (a Canadian General Hospital).

Treatment to knee nil. Patient sent to England, May 30th; no sign of joint infection.

CASE XV.

Pte. S., wounded by a bomb on May 9th, 1917, presented on admission a wound of entrance only through the patellar tendon. X rays showed a large piece of metal in the joint; there was no effusion.

Operation.

A crescent-shaped skin incision was made and the wound and track excised, including a portion of the patellar tendon; the metal, which was lodged in the infrapatellar pad of fat, was removed and the site smeared with bipp. The tendon was sutured, and the capsule and wound closed. He was transferred to the base on June 10th.

Base Report (a Canadian General Hospital).

Progressing satisfactorily.

Fig. 11.—Thomas splint outfit for transport, with outer bandage removed to show method of application. Support is afforded to the limb by a ham splint, firmly padded under the popliteal space, and slung by a bandage at three points with two additional slings of adhesive plaster to prevent it shifting. Rotation of the leg is prevented by two lateral extension strips of gauze applied with glue solution and bound by a roller bandage. Only slight traction is necessary. Foot-drop is avoided by a third adhesive gauze applied from behind the heel, up the sole of the foot, and hitched to the crossbar of the foot-piece. General fixation of the limb is completed by a figure of eight bandage around the foot, which is continued upwards over all, including the anterior thigh splint.

CASE XVI.

Pte. S.; wounded by a bomb on May 13th, 1917. There was a wound of entrance on a level with the lower margin of the patella and internal to the tendon. X rays showed metal impacted in the inner head of the tibia.

Operation.

The wound and track were excised in a crescent-shaped skin incision; the patella was reflected upwards, and the comminuted lower tip resected; the foreign body was removed with a portion of the surrounding bone; the joint was irrigated with saline and completely closed. He was transferred to the base on May 16th, 1917.

Report from Base (a Red Cross Hospital).

Wound healed by primary union; most successful knee-joint operation. Evacuated May 30th.

CASE XVII.

Pte. C.; wounded on May 21st, 1917, by a bomb. On admission there was a large flesh wound involving the antero-internal aspect of the knee, with considerable loss of skin and deep tissue, exposing the joint cavity from the top of the suprapatellar pouch to the head of the tibia. X rays showed that a portion of the inner head of the tibia and internal condyle had been chipped off.

Operation.

The wound and infected tissue were excised, the internal meniscus removed, the cavity in the condyle and in the inner head of the tibia was cut clean out with a portion of the surrounding bone, and the joint irrigated with saline; the lateral attachment of the synovial membrane was loosened, rendering it possible to close the joint more or less; the hole in the tibia was dressed with bipp. The operation was completed by making a skin flap from the popliteal space and suturing it in position. He was transferred to the base on May 22nd, 1917.

Base Report (St. John Ambulance Brigade Hospital).

Wound healed by first intention. Raw surface at back has closed to such an extent as to render grafting needless; excellent result so far. To England June 28th.

CASE XVIII.

Second Lieut. H., Fusiliers, wounded June 6th, 1917, by shell fragment, was admitted with a large wound of entry over the external condyle. X rays showed a large piece of metal impacted in the condyle close to the anterior border.

Operation.

On June 7th the wound was excised and further enlarged; the foreign body, found impacted at a depth of half an inch in the condyle, was removed in the usual way; the joint was irrigated, the bone cavity smeared with bipp and filled with fat graft, and the wound closed in layers. He was transferred to base on the same day.

Base Reports.

From a General Hospital: Wound healed by first intention. Transferred to England June 14th. From 2nd Southern General Hospital, Bristol:—June 27th, 1917: Stitches removed; wound healed. Without a splint and doing well. (From the patient.)

CASE XIX.

Cpl. W. B.; wounded September 7th, 1917, by a bomb. There was a large through-and-through wound on the antero-external aspect of the knee-joint. Synovial fluid was escaping from the wound.

Operation.

The wounds of entrance and exit were excised in one piece; no injury to bone; the joint was washed out with saline and closed. He was transferred to the base on September 17th.

Base Report (a General Hospital).

October 6th. Wound healed by first intention. Transferred to England.

CASE XX.

Pte. J. T. A.; wounded October 5th, 1917, by shell fragment. The entrance was to the inner side of the patellar tendon and there was a large exit wound over the outer side of the head of the tibia; the wounds were very dirty. X rays showed severe comminution of the head of the tibia on its outer side.

Operation.

On June 6th the wound of entrance and the track in the soft tissues were excised by a crescent-shaped skin incision, the patella was reflected, the external semilunar cartilage and infrapatellar pad of fat removed, and the head of the tibia then exposed by prolonging the excised exit wound vertically downwards; the damaged bone was removed *en masse*; the bone cavity was packed with bipp gauze, the joint washed out with saline, and the wound closed. He was transferred to the base on October 12th.

Report from Base (a Stationary Hospital).

October 18th, 1917. Knee-joint distended; purulent fluid withdrawn by needle; joint opened and Carrel tubes inserted.

Bipp plug to tibia. October 31st. Has cleared up, and there is now no discharge from the joint, though there is still a good deal from the hole in the tibia. Transferred to England.

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THE KNEE-JOINT CAPSULE:

A RADIOGRAPHIC STUDY.

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It is not the purpose of this paper to refer to any of the points raised in recent articles by Colonel Sir A. W. Mayo-Robson and Major Keith Monsarrat on knee-joint injuries, but rather to show at a glance the salient and more obvious features of an injected normal knee-joint capsule, representing as it does an acutely inflamed, distended, synovial membrane which from a surgical point of view requires immediate interference. The minute anatomical detail has already been thoroughly dealt with by Colonel Andrew Fullerton, C.M.G.¹ Knowing, however, the difficulty of reproducing shadow contrasts in many x-ray photographs, it is hoped that these simple graphic drawings, made for me from the original skiagrams by Mr. Noel Leaver, A.R.C.A.Lond., will facilitate the grasping of the points at issue in discussions relating to the surgical treatment of knee-joint affections.

A direct antero-posterior view is shown in Fig. 1. In the first place there is to be noted the marked tendency to displacement well over to the outer side of the femur, and not to the inner, where it barely reaches the border of the bone; it shows also the distance it extends above the joint line, nearly five inches, and three inches above the patella; almost the entire outer condyle is covered by the overlapping capsule in front, whereas the inner condyle is very nearly free. The patella is seen in its normal position,

FIG. 1.

much more over the outer than the inner condyle.

In Fig. 2 is shown a direct lateral view with the leg straight and lying on its outer side, thus bringing the inner side uppermost and nearest the plate. Here again it is manifest that the inner condyle is comparatively free from covering; the upward extension of the capsule three inches above the patella is shown, and also that it is slightly off the actual surface of the bone. The square-like upper border of the capsule is very marked, though this, of course, changes its shape on flexion.

The pouch underneath the patella averages about one fingerbreadth in thickness from the surface of the femur; but the most marked feature of this view is the extent to which the capsule is seen overlapping the inner surface of the shaft to nearly half the thickness of the bone. It is seen that in the popliteal space little more than the deepest part of the intercondylar notch is filled, and this only to the level of the upper intercondylar line; along the