

TREATMENT OF "GUNSHOT WOUNDS" OF THE KNEE-JOINT.

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THIS paper is written in order to draw attention to certain points which have been demonstrated by the surgeons of the British base hospitals in my area—that is, all south of Abbeville—to be of immense importance. In the earlier part of the war the results of the treatment of such injuries left a great deal to be desired. The great majority of such cases as recovered did so with ankylosis. The period of convalescence was usually most painful and precarious.

Such infected injuries were approached with ideas regarding their treatment which, as our experience has shown, are erroneous. The chief of these were: (1) That suppurative infections of the joint demand free and prolonged drainage; (2) that drainage tubes are the best means of procuring this; (3) that these tubes must be large, and must be inserted deeply into the various recesses of the joint, and (4) that strong antiseptic treatment is necessary in order to overcome the infection. These remedies are inimical to a "restitutio ad integrum," because, by their deleterious action, the synovial membrane and cartilages are more or less destroyed, and in most cases the best result that can be hoped for is ankylosis. On the other hand, the importance of certain factors in successful treatment were not grasped sufficiently: (1) That wounds of the knee-joint which are liable to become septic demand immobilization of that joint. Few of such cases arrived at our base hospitals with an efficiently applied splint. Movement of such a knee may turn the scale in favour of sepsis, in two ways—(a) it may favour the entrance of sepsis to a knee previously uninfected, and (b) it may stimulate a virulent, diffuse inflammation instead of a mild, localized one. During after-treatment the splint must be retained for two to three weeks at least. During the later stages gentle passive movement may be made daily. (2) There existed quite a widespread notion that foreign bodies in the joint should be removed "only if they lead to trouble." Fortunately, the fallacy of this view has been demonstrated, and now only those which are imbedded in the bone outside the joint are left alone, if they are not causing trouble. (3) The good effect of excision of the wound of the skin and superficial tissues, or of the whole wound where possible, was not appreciated. This good effect has been well demonstrated in our base hospitals, and, to my mind, the procedure has a profound influence on the subsequent favourable course of the case.

A few amplifying remarks on some of the foregoing points will be allowed.

Foreign Bodies.

The undistorted rifle bullet may perforate the joint without introducing infective material in sufficient amount to overcome the natural resistance of the part, and no inflammation may result. This does not justify neglect to apply a proper splint to the limb in these cases. The broader and more irregular the surface of impact of the foreign body the more likelihood is there of infective material (clothing or skin) being carried in to the depth. Shrapnel bullets, splinters of shell, or distorted rifle bullets may carry distinct "wads" of such material in front of them. The urgency for immediate removal of these foreign bodies increases with their potentiality for carrying in infective material. The size of the foreign body should not be allowed to influence the decision unless in very exceptional cases.

Drainage Tubes.

Since it is so important to remove foreign bodies from the interior of the joint, it seemed a futile proceeding to introduce others, especially when these establish free communication with septic surfaces either of the wound or of the skin, as tubes do. The presence of a tube in the joint, besides exerting a mechanical evil effect on the synovial membrane or cartilages, provides a haven of refuge and a reservoir of pabulum in which organisms can multiply. "Hypertones" (for example, tablets of sodium chloride and sodium citrate) placed in the tube,

continuous irrigation, or continuous baths, only mitigate—they do not remove—these drawbacks. The tubes should lead down to, but not through, the wound in the synovial membrane, unless the inflammation is so acute that all thought of saving the function of the joint is hopeless. If sepsis in the joint has been acute, it is better to leave the synovial membrane unsutured. This attitude towards the insertion of drainage tubes was stimulated on seeing the results in a few cases of this procedure when carried out at the front, with the object, no doubt, of preventing acute sepsis. In these cases the drains had been inserted with perfect attention to the principles which have been laid down for procuring efficient drainage of the joint, but the results were certainly not satisfactory.

A comparison of the condition in which cases arrived with apparently similar wounds, but which had simply been dressed, made us feel that, if possible, wounds of the knee-joint should not be operated on until they reached a hospital where they could be kept in bed for ten to fourteen days at least after operation.

The Use of Antiseptics.

The opinion is obtaining very firm hold amongst us that any beneficial action which any antiseptic may show in the interior of wounds or of joints is due entirely to its power of inducing "lymph lavage" or "chemiotaxis" or both. The opinion that antiseptics applied to the skin around a wound are of the greatest prophylactic value remains, of course, unshaken. Strong antiseptics in a joint have a deleterious effect on the delicate synovial membrane and on cartilages, which interferes with the resistance and recuperative power of these structures. It is therefore the exception to find that antiseptic dressings or applications in the depths of wounds are used in our base hospitals.

Hypertonic Salt Dressings.

Better and quicker results are found to follow the use of "hypertonic" dressings (see my letter of last week, p. 32). The mode of application varies in different cases. Even hydrogen peroxide is now used practically only to remove very adherent dressings. Regarding the use of injections of formalin-glycerin, iodoform-ether, or ether into the joints, it cannot be said that any one of these agents is better than the other. They do no harm apparently, and they appear to do good, but hypertonic saline solution seems equally efficient.

It would seem desirable that this well-tried and satisfactory "hypertonic" treatment should be more widely employed. If it were, the provision and transport of medical stores would be simplified enormously.

Excision of Wounds.

The excision of the soiled superficial part of deep wounds or of the whole wound, when possible, cannot be too strongly advocated. In other parts of the body *excisio in toto*, no matter at what stage, followed by immediate suture, has, when technique is perfect, resulted in healing by first intention. The advantages of this are obvious. Contraindications need not be discussed here. I look upon results obtained from this procedure as a measure of the claim which any surgeon can make that his technique is perfect! Primary suture is, of course, out of the question in the wounds we are at present considering—free drainage must be provided, therefore the wounds are left open—but secondary suture, when advisable, can certainly be performed at an earlier stage after excision has been made. Aponeurotic structures especially, unless their removal entails disablement, should be cut away. Their superficial parts at least will slough, and such sloughs take a long time to separate. The ragged, possibly soiled, edges of the wound in the synovial membrane should always be snipped away.

Frequency with which Deep Dressings should be Changed.

As I have pointed out in the letter referred to, the first dressing may frequently be left *in situ* for days. If the joint is "quiet" and the dressing free from pus, there is absolutely no necessity to remove it. The wound in the synovial membrane will thus get a chance to heal. In removing the dressing early it is likely to be torn open.

The feeling is gaining ground that the knee-joint, if given a fair chance, has more recuperative power than it has hitherto received credit for. One cannot, however, while giving it a chance to take care of itself, forget the dire results which may follow if septic infection gains the upper hand. Therefore the cases must be watched with the utmost care, and any untoward symptom be fully investigated. It is rare that a quiet-looking knee is going wrong inside unless a wound exists which communicates directly or indirectly with the joint. In that case there will probably be an amount of discharge in excess of what would be expected from the surface wound. If the knee is at fault, prompt and energetic suitable measures must be taken.

Results.

The recent application of the principles which I have discussed has been followed by a great improvement in results, which must be very gratifying to the surgeons concerned. For purposes of comparison I give the results in 10 cases which were admitted from the Neuve Chapelle fight, and treated by what one might call transition methods—that is, the more recent methods were already being tried in some cases. These cases were unselected, and were similar in severity to those which were admitted to all the hospitals in Rouen during the month previous to May 19th, for which period the surgeons furnished me with returns. I append also a *précis* of the treatment employed.

Cases from Neuve Chapelle (March). Newer Methods Applied in Successful Cases.

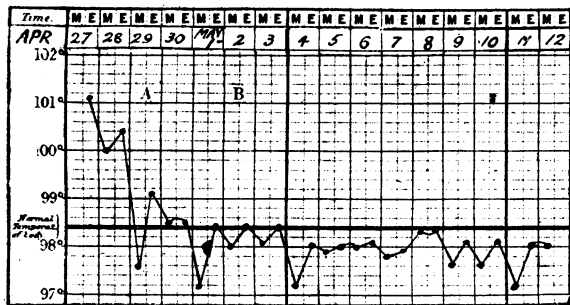
| | |
|-------------------------------------|----|
| Deaths (in spite of amputation) ... | 2 |
| Amputations... .. | 3 |
| Ankylosis | 1 |
| Doubtful | 1 |
| Free movement when discharged ... | 3 |
| | — |
| | 10 |

Cases During Four Weeks Previous to May 19th.

| | |
|-------------------------------------|----|
| Deaths (in spite of amputation) ... | 0 |
| Amputations... .. | 3 |
| Ankylosis | 3 |
| Doubtful | 2 |
| Free movement when discharged ... | 28 |
| | — |
| | 36 |

Synopsis of Treatment.—Excise wound of skin and superficial soiled or necrotic muscle and fascia. Enlarge wound freely if necessary. Remove foreign bodies (previously localized by x rays) after possible enlargement of wound in synovial membrane. Flush synovial cavity with 5 per cent. saline solution. Thoroughly remove blood clot. In very acute cases make fresh incision. Trim edges of wound in synovial membrane, suture if sepsis not acute. Insert drainage tube down to but not through wound in synovial membrane. Fill rest of wound fairly firmly with "tablet and gauze" dressing. Inject formalin-glycerin or ether, etc., through fresh puncture. Clean and disinfect surrounding skin. Superficial dressings, light bandage. Immobilize in suitable splint. If this fails, free arthrotony, possibly amputation.

Case I.—Second Lieutenant J. Wounded April 25th; admitted April 27th. Temperature 101° F. Lacerated wound 1½ in. on the antero-internal aspect of the right knee. Opening in synovial



A, Superficial dressing changed; B, deep dressing changed.

membrane 1 in. Inner condyle split off. Flattened distorted bullet and clothing lying in fissure, which extended up into the medullary cavity of the femur. Sanguinolent pus discharged

from joint, containing staphylococci and streptococci. Operation April 27th: Synovial membrane not sutured; ether injected. First change of deep dressing on May 2nd. Temperature normal on April 30th and subsequently (see chart). *Result:* Movable joint. Wound practically healed when sent to England on May 12th.

Case 2.—Private P. W., 1st Argyle and Sutherland Highlanders. Wounded April 18th; admitted April 20th. Left knee. "Transverse" shrapnel wound, shattering patella; shrapnel bullet lodged to inside of patella. Local severe inflammation and effusion (blood and pus; staphylococci). Temperature 100°. Operation April 20th: Fragments of patella left (a mistake in presence of sepsis); synovial membrane sutured; formalin-glycerin injected. Temperature 98.4°-99° till May 8th, when the patient complained of pain and the temperature rose to 101°, and smelly pus exuded from the wound in the synovial membrane. Decided to operate on May 12th. Patella excised; joint washed out; synovial membrane again sutured and formalin-glycerin injected—without success. Joint opened up freely on May 17th. *Prognosis:* Ankylosis.

Case 3.—Private L., 1st Somerset Light Infantry. Wounded April 28th; admitted May 1st. Right knee. Temperature 99°. Transverse shrapnel wound, suprapatellar pouch; fracture (splintering) of lower end of femur; blood and pus (staphylococci) in joint. Operation May 1st. Synovial membrane sutured; injection of formalin-glycerin. Next day temperature 100.4°; since then normal. *Result:* Movable joint.

Case 4.—Private C., London Rifle Brigade. Wounded May 2nd; admitted May 8th. Had lain out in the open for five days after being wounded. Right knee. X rays showed a piece of shell casing in intercondylar notch. Small wound covered by scab on outer side above patella. Local signs of intense inflammation; effusion; very painful on movement. Temperature 103.6°. Operation May 9th: Wound excised; joint washed out (full of greyish clotted material, smelling; a Gram-positive bacillus found); foreign body removed; synovial membrane sutured; formalin-glycerin injected. The morning and evening temperatures from May 10th to May 14th were as follows:

| | Morning. | Evening. |
|-----------------|----------|----------|
| May 10th | 100.2° | 100.8° |
| May 11th | 99.4° | 99.6° |
| May 12th | 98.4° | 99.6° |
| May 13th | 98.6° | 99.0° |
| May 14th | 93.0° | 99.0° |

On May 17th the wound was painful, and the temperature went up to 102°; there was purulent effusion. Lateral incisions were made, anteriorly and posteriorly. On May 20th the condition was steadily subsiding. *Result:* Probable ankylosis.

Case 5.—Private K. A large lacerated wound over the outer tuberosity of the tibia; a smaller one over the outer condyle of the femur. Extensive comminution of condyles. Very septic. Pulse 140, temperature 97°. Operation: Knee laid open by transverse subpatellar incision. No improvement. Three days later amputation.

Case 6.—Private B. Shrapnel wound on outer side of patella; very septic; purulent fluid exuding. Knee much swollen, very painful. X rays showed a bullet in the joint near the spine of the tibia. Operation: Wound enlarged after excision; counter opening on inner side of patella. Foreign body removed; joint washed out—iodoform ether. Tube from wound to wound for two days. *Result:* Movable joint.

Case 7.—Private S. Left leg amputated at clearing hospital. Small septic wound in right knee, foul pus exuding. Much swelling and pain. Temperature 102°. Operation: Shrapnel bullet deeply imbedded in articular surface of tibia. Cartilage much eroded. Joint laid open by transverse subpatellar incision. May 16th, patient doing well; temperature normal. *Prognosis:* Ankylosis.

Case 8.—Private McG. Transverse (? shrapnel) wound. X rays showed grooving of head of tibia. Much swelling and tenderness. Temperature 102°. Syringe removed turbid flaky blood-stained fluid. May 16th, patient doing well; temperature normal. *Result:* Movable joint.

Case 9.—Private W. Two wounds (machine gun): one perforated condyle of femur and passed out; the other chipped upper surface of tibia and lodged in the tibialis anticus muscle (x rays corroborated). Much swelling and tenderness. Temperature 102°. Exploring syringe revealed pus. May 16th, patient doing well; temperature normal. *Result:* Movable joint.

Case 10.—Private E. C., 3rd Middlesex. Admitted April 27th. Severe, very septic flesh wound in upper third of right thigh (streptococci; thigh wound also contained *B. perfringens*). Conservative measures no use. May 4th, knee-joint and extensive abscess along thigh laid open—transverse subpatellar incision. May 13th, wound clean, covered with healthy granulations. *Prognosis:* Ankylosis.

Case 11.—Shrapnel wound; blood and pus in joint (micro-organisms found, ? nature). Shrapnel in joint. Tube left in wound for two days after operation; fourteen days after discharged to England. *Result:* Movable joint.

Case 12.—Sergeant W. Wounded April 23rd; admitted April 27th. Shrapnel wound; comminution of patella. Operation April 27th: Excision of wound; removal of foreign bodies (bullet and clothing) and fragments of patella; anterior drainage. May 12th, joint gradually settled down; condition very good. *Prognosis:* Ankylosis.

Case 13.—Private S., King's Own Royal Lancashire. Admitted April 22nd. Shrapnel bullet imbedded in inner condyle of femur—left knee—split through articular surface; joint full of blood and pus. Bullet extracted; bone cavity scraped out. Joint washed out with hypertonic saline. Formalin-glycerin. May 13th, patient doing well. *Result:* Movable joint.

Case 14.—Sergeant T., 1st East Surrey. Shrapnel wound in right knee. Synovial membrane torn; bloody pus exuding. Usual operation on April 22nd. On May 7th the patient left for England; wounds clean; no effusion. *Result:* Movable joint.

Cases 15 and 16.—Private R., 1st East Surrey. Shrapnel wounds in both knees; also depressed fracture of skull. Synovial membrane found torn in both knees. April 22nd, usual operation on both knees. May 13th, patient doing well; wounds clean. *Result:* Movable joints.

Case 17.—Private E. G. H., 1st Monmouth (T.F.) Shrapnel wound of left knee. Capsule badly torn. April 24th, usual operation. May 13th, patient doing well; wound clean. *Result:* Movable joint.

Case 18.—Corporal R., Canadian Field Artillery. Shrapnel wound of left knee. Bullet pierced internal condyle and lodged in external. Capsule full of blood clots and pus. April 29th, usual operation; bullet left *in situ*. May 9th, patient left for England; wound nearly healed. *Result:* Movable joint.

Case 19.—Wheeler H., Canadian Field Artillery. Shrapnel wound of right knee.

Case 20.—Private W. S., 4th Yorks. Shrapnel wound of right knee; fragment lodged in head of tibia (? fracture into joint).

Case 21.—Bombardier E., Royal Garrison Artillery. Multiple shrapnel in left knee.

Case 22.—Private M., Honourable Artillery Company. Bullet wound of right knee; bullet imbedded in lower end of femur.

In the last four cases it is doubtful if the knee was actually opened. All had much effusion of bloody purulent fluid. All had movable joints when sent to England.

Case 23.—Lance-Corporal D., Canadian Artillery. Gunshot wound of left knee, perforating upper part of joint; no fracture; bloody purulent effusion (Gram-positive coccus). Usual procedure; 10 c.cm. ether injected. *Result:* Movable joint.

Case 24.—Private C., 12th County of London. Shrapnel perforating wound of knee-joint; purulent effusion (Gram-positive coccus). Usual procedure; 10 c.cm. ether injected. *Result:* Movable joint.

Case 25.—Private W., 48th Canadian Highlanders. Perforating gunshot wound of knee-joint; very great effusion; no fracture. Usual procedure; 10 c.cm. ether injected. *Result:* Movable joint.

Case 26.—Corporal L., 2nd D.C. Light Infantry. Perforating gunshot wound of knee-joint; much distension; no fracture. Usual procedure; 10 c.cm. ether injected. *Result:* Movable joint.

Case 27.—Private M., 2nd West Riding. Perforating gunshot wound of knee; no fracture; much distension and severe inflammation around joint; purulent effusion (Gram-positive coccus). Usual procedure; 10 c.cm. ether injected. *Result:* Movable joint.

Note.—In Cases 13-27 I had asked the surgeons of the hospitals concerned to report only those cases which showed signs of acute local inflammation with decided rise of temperature, and which in their opinion would go wrong if not treated according to the method we had worked out. Hence the short notes.

Case 28.—Corporal J. H., 12th London. Admitted May 6th. Shrapnel wound of left knee through ligamentum patellae, with comminuted fracture (T) of head of tibia, communicating with joint; cellulitis in calf. Temperature 104.4°. Much distension. Operation May 6th: Aspiration of bloody pus; injection of formalin-glycerin. Abscess in calf opened, and piece of shell $\frac{3}{4}$ in. by $\frac{1}{2}$ in. removed; tube drain to hole in back of tibia. Anterior wound excised; tube down to hole in tibia; wounds "filled" with hypertoner and gauze. Inflammation gradually subsided. Report on May 14th: Patient looks, eats, and sleeps well; practically no pain; wounds clean; no swelling, no fluid in joint. Knee-joint movable. A similar report was made on May 19th.

Case 29.—Private McL., 1st Royal Scots Fusiliers. Wounded May 4th; admitted May 6th. Shrapnel wound of right knee just above patella on antero-external aspect. Temperature 101°. Much effusion, purulent. Operation May 7th: Fragments of shrapnel removed from joint; usual procedure otherwise; formalin-glycerin injected. Temperature next day 99°. His condition gradually improved, and on May 14th there was no effusion, the wound was clean, and the joint movable. May 19th, similar report.

Case 30.—Private M. Admitted May 7th. Fragment of shell (size of hazel nut) removed from above patella. Purulent effusion. Formalin-glycerin injected. May 10th, aspiration, 1 oz. purulent fluid removed. May 14th, no fresh effusion; wound still discharging, but cleaner. May 19th, no recurrence of effusion. (This patient, a few days after the last report, developed purulent effusion again, which ultimately led to free incision treatment, and later amputation. Possibly another injection of formalin-glycerin might have saved the joint.) *Result:* Amputation.

Case 31.—Private L. Piece of shell removed from inner side of left knee—subcrureus bursa. Purulent effusion. Formalin-glycerin injected. Fluid did not collect again. *Result:* Movable joint.

The following four cases were treated: (a) Directly in track of wound, by excision of superficial wounds and superficial part of track; removal of foreign body; free incision on each side of patella and suprapatellar pouch. No tubing inserted; no sutures. Spirit dressing, after swabbing out wounds with 10 per cent. iodine. Posterior knee splint and footpiece. (b) Indirectly when infection occurred after fracture of tibia or condyles of femur. Joint opened and effusion removed at point most remote from surface wounds—along lines laid down.

Case 32.—Lance-Corporal H., 2nd King's Own Yorkshire Light Infantry. Admitted May 2nd, and operated on the same day. Temperature 99°. Shrapnel ball in joint; wound on inner side of patella. Great effusion; much clot; condyle fractured (?). Incision on outer side of patella. May 15th, no reaccumulation of fluid; both wounds cleaned well. For the last four days the temperature had not passed 99°. Condition of joint seems most satisfactory. May 19th, similar report. *Result:* Movable joint.

Case 33.—Gunner W., 3rd Canadians. Gunshot wound; (shrapnel) wound of right knee; wound to outer side of patellar ligament. Ball removed. Much muco-purulent effusion. Two lateral incisions besides excision of wound. Whole knee swathed in dressing, wet with spirit. May 15th: For ten days temperature varied between 99.8° and 102°; patient very ill; locally the knee kept remarkably well; for past three days temperature never above 99°. "Looks like making a first-class recovery." May 19th, continued improvement. *Result:* Movable joint. (A periarticular abscess, with stinking pus, developed about June 1st, but caused no trouble in the knee.)

Case 34.—Private M., 2nd Buffs. Admitted May 2nd, with gunshot wound through condyles of left knee. Bone shattered; not marked effusion into joint. Excision of septic wounds—tubes down to site of fractures. Temperature fell gradually. Tubes out on fifth day, when no apparent inflammation in knee-joint. May 19th, condition reported excellent. *Result:* Movable joint.

Case 35.—Lance-Corporal W., Royal Engineers. Gunshot wound (shrapnel) of right knee; septic wound at outer side over head of fibula. Much effusion. Bullet had gone on after opening joint and lodged over external condyle. Usual operation. Bullet not removed at first operation. Tube along track removed on fourth day. Bullet removed on May 14th. May 19th, "Perfect recovery seems assured." *Result:* Movable joint.

Case 36.—Sergeant —. This case, which was not fully reported to me, required amputation; hopelessly shattered femur, patella, and tibia—truly an injury of the knee-joint!

There were many other cases of wounds of this joint in the various hospitals in which the effusion gradually subsided without other treatment than rest, with occasionally simple aspiration.

CHALMERS AND O'CONNOR (*Journal of Tropical Medicine and Hygiene*, April 1st, 1915) have described under the name "Pyosis Corletti" a small epidemic of a bullous eruption occurring amongst soldiers at Khartoum. They define the disease as an acute, contagious, bullous pyosis beginning in any region of the body (but not specially affecting the axillary and scroto-crural regions), characterized by the presence of medium-sized and large bullae arising on seemingly healthy skin, and apparently caused by *Aurococcus mollis* (Dyar, 1895). A differential diagnosis must be made between this condition and impetigo contagiosa, dermatitis bullosa plantaris, pemphigus acutus, pyosis mansonii, and Corlett's impetigo contagiosa bullosa. The prognosis is very good, for the disease yields rapidly to vaccine treatment. The authors prepared a vaccine, which was administered in 200 and 450 million doses, with intervals of two to three days between each dose. At the same time local treatment was found useful in expediting the cure. Each blister was pricked, and the exuding fluid caught on swabs dipped in 1 in 1,000 lotio hydrargyri perchloridi. After pricking, the blister should be dusted with some antiseptic powder.