

# **SURGERY OF MODERN WARFARE**

EDITED BY  
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*PART FOUR*

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**THIRD EDITION**



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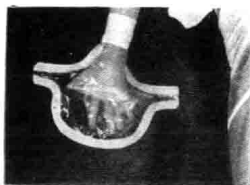
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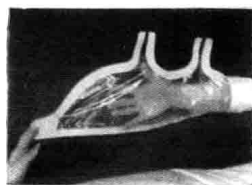
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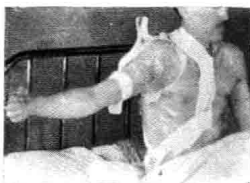
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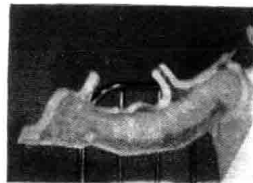
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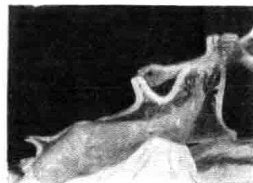
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## SECTION XI

# WOUNDS OF BONES AND JOINTS

### CHAPTER L

#### WOUNDS OF BONE

**W**OUNDS of bone cannot occur alone. We are concerned here, not with the treatment of war wounds in general, but with those of a particular tissue of comparatively low vitality and absorptive power.

The problem before us is largely the problem of the compound fracture, upon which surgical attention has been focused, both in times of peace and war. In May 1866 Lister treated successfully a compound fracture of the leg by swabbing the wound with crude creosote and covering it with plaster of Paris impregnated with the same chemical. The day of conservative surgery in compound fractures had dawned.

Remarkable progress has been made in this field, and it is probable that finality has not yet been reached. Perhaps even more than with other problems connected with war surgery, it must be realized that sound judgment—when to operate, when to amputate, when to excise the wound meticulously and when to perform rapid but purposeful débridement—is far more important than blowing sulphanilamide powder around the broken bone and encasing the limb in plaster, excellent as these procedures may be in their proper sphere.

**The time factor** is the very crux of the situation. The earlier a compound fracture can receive attention in the operating theatre, the better the prognosis. Every half-hour counts. In compound fractures of peace, a limit of eight hours was generally conceded the maximum in which it was permissible, after adequate cleansing, to suture the wound; in other words, to convert an open fracture into a closed one. It is doubtful if it is ever advisable to carry out this ideal in its entirety in war wounds, except in selected cases of bullet wounds.

**Resuscitation** is as important here as with other wounds. To determine the mean between the urge to transfer the patient to the theatre in order to treat his local condition, and the anxiety to retain him in the resuscitation ward

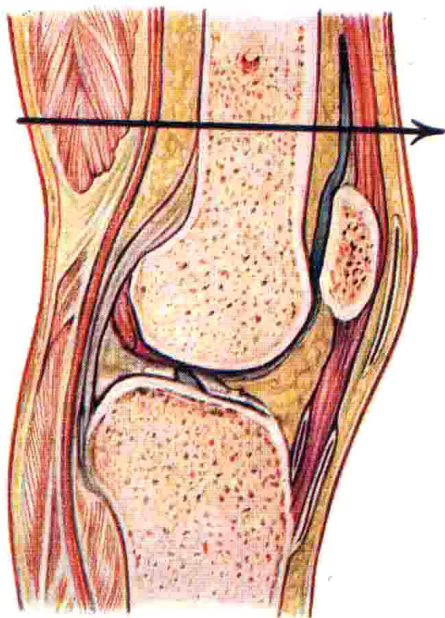


FIG. 624

A perforating wound of the lower end of the femur, if situated within a hand's-breadth of the superior surface of the patella, may involve the knee-joint.

for the improvement of his general condition, is an occasion where a colleague, with blood pressure and hæmatological records, can be most helpful.

**Preliminary consideration of the case**—Even when resuscitation is unnecessary there will be at least a quarter of an hour for the surgeon to ponder and plan. He should assemble his data, bearing in mind that in every case of bomb and shell wounds it is probable that clothing and dirt will have been carried within. What was the condition of that clothing and the patient's skin? Is it possible that the neighbouring joint is involved (Fig. 624)? These are among the many points which should be occupying his attention.

**Preliminary radiography**—Naturally it is of the utmost value to have before him radiographs showing the extent of the bone damage, and concrete evidence of retained foreign bodies (Fig. 625). Fissuring of the bone should be noted and special attention given to the possibility of a fissure entering a joint.

**Should amputation be performed?**—The whole trend of surgical progress is to save limbs, but it must be remembered that excessive conservatism may sacrifice a life. Decisions to perform amputation fall sharply into two categories:—

- (a) Those made in the resuscitation ward from data which are manifest.
- (b) Those which can only be arrived at after the wound has been explored.

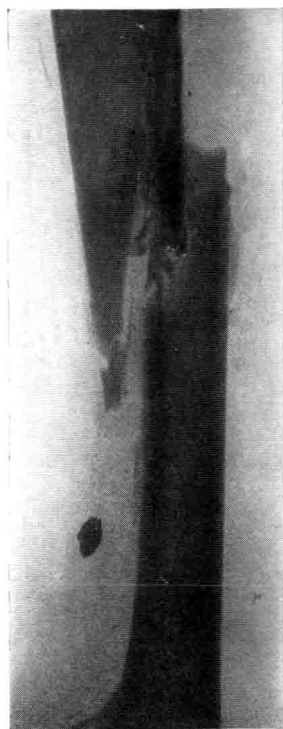


FIG. 625

Shell fragment causing compound comminuted fracture of the femur. (Anthony Green.)

the best course. It is, however, necessary for the surgeon always to remember that the problems presented by a compound fracture in the upper extremity are entirely different from those in the lower. This is particularly the case when a decision has to be taken regarding amputation.

It is clear that immediate amputation in the upper extremity is indicated only when the reasons are absolutely obvious. In early gross injuries excision, even drastic excision, of bone and joint can be undertaken. There is seldom a doubtful case in which the decision to amputate cannot be postponed for consultation with a colleague. Conversely, in the case of the lower limb, if there is no one available to share the responsibility and the surgeon is in real doubt, it is usually better for him to proceed with amputation. In the case of the lower third of the leg, for instance a badly comminuted, grossly soiled, compound Pott's fracture, the responsibility for amputation is not great and the decision is

It is not possible to embark upon the colossal task of enumerating the manifold combinations or circumstances which render amputation

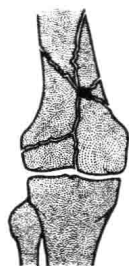


FIG. 626

Comminution of the condyles with fissuring into the knee-joint and gross contamination is a type of compound fracture much to be feared. (After Leriche.)

probably a wise one. In the case of projectile fractures of the femur, Sir Anthony Bowlby, after an immense experience, gave the following helpful indications for amputation :—

1. Wounding of the femoral or popliteal vessels, which is, unfortunately, a common complication.
2. Comminution of the condyles with involvement of the knee-joint (Fig. 626). In very few cases should any attempt be made to save the limb in these circumstances.
3. Extensive tearing and destruction of skin and muscle. When large portions of the front or back of the thigh are torn off, the limb would be useless, even if it could be preserved.

#### FACTORS WHICH INFLUENCE THE DECISION TO AMPUTATE

	Upper Extremity.	Lower Extremity.
Prosthesis . . . . .	Almost valueless	Usually most satisfactory.
Shock and poor general condition necessitating a rapid operation	Seldom enters the picture	Especially in the case of the femur, a matter of grave concern.
Clothing . . . . .	Coat and shirt sleeves usually comparatively clean	Trousers, pants, socks and boots often teeming with pathological bacteria.
Concomitant arterial wound	Even when there is no pulse at the wrist, limb can often be saved	Femoral or popliteal arterial injury a matter for most serious consideration.
Operative, reactionary and secondary hæmorrhage	Presents no difficult problem	All to be taken into consideration in compound fracture of the femur.
Gas gangrene . . . . .	Comparatively rare	Comparatively frequent.
Infected phlebitis and embolus	Extremely rare	Sufficiently common for serious consideration.
Considerable shortening .	Of minor importance	Great handicap.
Fracture involving joints .	If necessary joint can be included in the resection with excellent results	Amputation sometimes indicated.

#### THE PATIENT'S GENERAL CONDITION AND THE TIME FACTOR PERMIT WOUND EXCISION

**Instruments**—It is highly desirable to have instruments arranged in three completely separate sterile groups :—

- (a) Instruments for general wound excision (see Chapter XXIV).
- (b) Instruments for bone purification procedures.
- (c) Instruments for skeletal traction (see Chapter XLIV).

Set (b) must include a few special bone instruments ; nothing elaborate is required. A hammer, a few gouges and chisels, a Volkmann's spoon,

sequestrum forceps and perhaps a pair of bone-holding forceps are obviously the type of instruments the sister will put out. The only special instrument to which attention is drawn, for it is a real asset, is Ollier's cutting rugine (Fig. 627) or one of its modifications

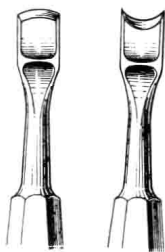


FIG. 627

Ollier's cutting rugines.



FIG. 628

Pierpont's modification of Ollier's rugine.

(Fig. 628). The instrument should be of razor-like sharpness, and two or three are a surgical luxury.

**The Operation**—The wound or wounds are covered with sterile gauze, while the large surrounding area of skin is washed, shaved and washed again; it is then painted with iodine or other skin antiseptic right up to the wound margin. In a few instances where it is known that skeletal traction will be required, it is an advantage to commence by inserting the nail, after which the surgeon can proceed to utilize set (a) of his instruments without changing his gloves. The wound is excised in the manner described in

Chapter XXIV. When a missile has perforated the bone, comminution is frequently more marked on the side opposite the wound of entrance, and the soft parts there are more likely to contain bone fragments (Fig. 629). Bone splinters must be searched for and removed from the muscles. Before proceeding to deal with the bone itself gloves should be changed and set (b) of instruments used. It is most necessary to realize that in these cases the medulla must be presumed to be contaminated, and in order to get at the medulla it is usually necessary to remove some bone. This brings us to the question: What should be done with fragments? All are agreed that completely detached fragments should be removed, and in the case of through-and-through wounds it is necessary to approach the bone from both sides. Fragments still attached by periosteum should also be removed if by their removal adequate access is afforded to the medulla. On no account should such fragments be picked up in forceps and twisted and torn from



FIG. 629

The side farthest away from the wound of entrance is more likely to contain fragmented bone and foreign bodies.  
(From a Radiograph.)

their moorings. Fragments to be removed in order to afford access to the interior must be cleanly excised. It is for this work that Ollier's cutting rugine is particularly suited. It enables the surgeon to cut away, with little injury, enough bone to expose the medulla adequately. Loose fragments and pulped medulla must be removed from the interior of the bone.

The question of how far to proceed in removing fragmented bone is debatable. Towards the close of the 1914-18 war there were many converts



to the school of Ollier, of which Leriche was, and still is, a great exponent. Members of this school remove subperiosteally most, if not all, fragmented bone, a process which they call *esquillectomy*. Their main argument, which is sound, is that unless splintered bone is removed, sooner or later foreign matter lodged in a crevice will be overlooked. Leriche believes that to perform esquillectomy neatly and thoroughly the Ollier type of instrument is essential, and he maintains that serious infection cannot be prevented regularly except by complete clearance of fragmented bone. He explains that early *subperiosteal* removal of fragments does not expose the fracture to the danger of pseudo-arthritis; it is not a resection of the entire circumference but rather a removal of everything which interferes with complete exploration of the interior. In more than two-thirds of cases the operation ultimately leaves the ends of the bone in continuity.

Employing these principles, this authority was able to report a consecutive series of over 250 cases of comminuted, compound shaft fractures sustained in Flanders at a time when gas gangrene and profound sepsis were rife, with the loss of only one case and without a single example of gas gangrene, proof indeed that his ideas should not be passed over lightly.

**Irrigation of the wound**—While many surgeons, particularly American industrial surgeons of wide experience, advocate and practise successfully irrigation of the wound with sterile saline at the conclusion of the surgical toilet, the general consensus of opinion in this country is that irrigation should be eschewed. In order to remove grit and fine debris moist swabs on holders are employed.

**Antiseptics**—The local application of sulphanilamide and proflavine powders is now a standard procedure (see Chapters XXIV and XXXII).

**Should the skin be sutured?**—As has been mentioned already, it is wise to be cautious about closing the skin in the compound fractures of war; indeed, this step is better avoided in every case. To pack the wound with vaseline gauze does not preclude the possibility of secondary suture.

**Prophylactic sera**—Before every operation for compound fracture antitetanic serum and antigas-gangrene serum should be administered in suitable doses, if this has not been done already.

**Immobilization**—That every fracture, including every compound fracture, must be immobilized completely goes without saying. As to how this immobilization is best effected depends upon circumstances. Not the least of these are the surgeon's experience and training, the apparatus and nursing facilities that are available, and whether the patient has to be evacuated or remain under his care. The closed plaster method has a great deal to recommend it, but we should not be blind to the fact that admirable results have been, and still are, obtained by other methods. In certain instances other methods are to be preferred. The best means of taking a broad view of the whole subject is to consider compound fractures of individual bones.

### COMPOUND FRACTURES OF INDIVIDUAL BONES

**Tibia**—Böhler's screw traction apparatus (p. 456) is rightly popular and is now widely available. It is a good practice to commence by inserting

a Steinmann's nail through the os calcis and then to attend to the necessary excision of the wound and the toilet of the fracture with the limb on the apparatus. Having covered the wound with strips of vaseline gauze, a plaster cast is applied (see p. 604). Stockinet is omitted, but bony prominences are well protected by best quality felt. Because of the danger of interference with the circulation consequent upon post-operative œdema, the plaster should be guttered (see p. 405).

Alternatively, the Böhler-Braun splint can be employed, especially—

- (a) When circumstances are favourable and there is sufficient skin to permit of closure of the wound without any tension.
- (b) In doubtful cases nearing the time limit where infection is feared. In this instance the question of suturing the wound does not arise.

Whether a plaster has been applied or not, elevation is desirable, and for this purpose a Böhler-Braun splint cannot be bettered. When circumstances permit, probably the best method for all cases is to defer applying a plaster for a few days, during which time the Böhler-Braun splint is employed. After approximately four days the danger of post-operative swelling has passed, and also the danger of spreading infection.

**Fibula**—When the fibula is involved alone there is hardly a more satisfactory bone to treat. Large portions of the shaft can be removed by subperiosteal resection without fear of loss of function. At the upper end the external popliteal nerve must be preserved; at the lower end the external malleolus should be preserved if possible. The immediate application of a plaster cast cannot be bettered.

**Patella**—Excision of the patella with suture of the capsule and the immediate application of a plaster cast is eminently satisfactory.

**Femur**—This, of course, is the most difficult problem connected with compound fractures. The main indications for amputation have been discussed on p. 508. When there is the slightest doubt concerning the vascular integrity of the limb, under no circumstances should plaster be employed until the danger of gangrene has passed. In grave cases, or compound fractures of the upper third, when the patient's general condition is poor in spite of resuscitative measures, the reader's attention is directed to the sleeve amputation (see p. 480).

We will assume that the patient's general condition is sufficiently good to withstand a fairly prolonged operation under gas-oxygen-ether anæsthesia; because of incipient shock, a spinal anæsthetic is to be deprecated in these cases. Suitable exposure is of major concern, and it may so happen that the wound is not the best avenue of approach. Fig. 630 emphasizes this point, and in certain cases, after the wounds have been excised, it is advisable to make a fresh incision with uncontaminated instruments.

The results of closed plaster treatment are most encouraging. If an orthopædic table, even the portable variety (p. 403), is available, there is a great deal to be said for commencing by inserting a Steinmann's nail through the crest of the tibia. To have the knee and, to a lesser extent, the hip flexed, together with suitable traction, definitely aids the necessary surgical attention to the bone ends, and helps to get them into alignment. When

an orthopædic table is not to hand, an assistant, with his hands clasped under the knee (Fig. 632), can be an efficient substitute. In grossly contaminated but early cases, drainage of the deep fascial planes, which



FIG. 630

The danger area through which intervention should not be undertaken. When necessary a fresh incision is made. (After Leriche.)

will be detailed on p. 516, must receive consideration. There is no serious objection to including a drainage tube within the plaster cast, providing its presence is notified in writing on the cast. The plaster is applied with the hip and knee still flexed and it extends from the lower ribs to the heads of the metatarsal bones,

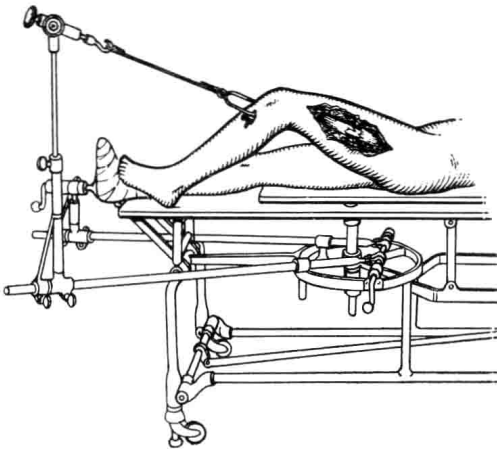


FIG. 631

When an orthopædic table is available it is an excellent practice to insert a Steinmann's nail through the crest of the tibia. The wound is then excised and the whole operation, including the application of the plaster cast, completed. Note the flexion of the knee and the hip. (After Trueta.)

the sole of the plaster extending beyond the tips of the toes to prevent pressure from the bedclothes (Fig. 633).

Even a patient in comparatively good condition is likely to show some recrudescence of shock after this formidable procedure. It should be understood that plaster, in setting, generates heat and for the time being serves a useful purpose in keeping the patient warm. It is, however, highly important when the patient is returned to the ward to ensure that the plaster is not dried at the expense of extracting heat from the patient. On the other hand, nurses must not be allowed to cover the patient with blankets, for this will

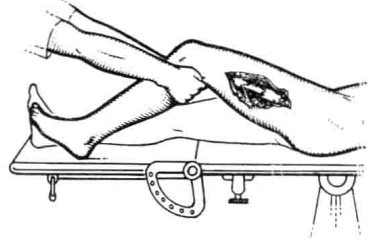


FIG. 632

In the absence of an orthopædic table an assistant can maintain the desired position. (After Trueta.)

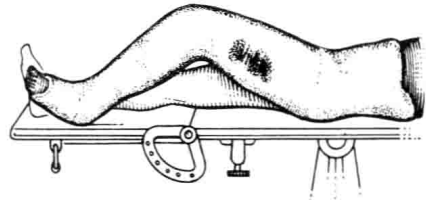


FIG. 633

The plaster cast for compound fracture of the femur completed. Note the position of the limb. (After Trueta.)

delay drying of the plaster. Air must be allowed to circulate, and the best method of both attending to the patient's needs and at the same time drying the plaster is to apply a radiant-heat cradle.

It should not be lost sight of that thousands of excellent results have been obtained by the use of Thomas' splint and Braun's splint. The latter has the serious disadvantage of being unsuitable if the patient is to be evacuated. For severely shocked patients, especially in cases of compound fractures near the upper end of the bone, Thomas' frame is without doubt the best expedient. Summarizing the position: the closed plaster is the best method to employ when the patient's general condition is satisfactory and the necessary facilities for its rapid application are to hand. Experience in plaster work is particularly desirable; to apply a hip spica properly requires as much training and experience as to perform a gastro-jejunostomy correctly.

**Humerus.**—These injuries are much more common in war than in peace. As pointed out already, in this instance the bone lesion *per se* is seldom, if ever, an indication for amputation; it is concomitant devastating injuries to vessels and particularly nerves which are the determining factors in deciding that the limb must be sacrificed. Compound fractures of the upper third (*i.e.*, above the musculospiral, syn. radial, nerve) are particularly favourable lesions to treat. In the middle third the musculo-spiral nerve is prone to be damaged, but this does not preclude the possibility of saving a useful limb. Unfortunately, in the middle third, main vessels are liable to be damaged almost irreparably. The same remarks apply even more forcibly to the lower third of the bone. As emphasized already in this chapter, if necessary a considerable area of contaminated bone, which may even include a joint, can be excised with every prospect of ultimately securing a limb with considerable function.

The closed plaster technique is eminently suitable for compound fractures of the humerus; the major deterrent to its use is the difficulty of applying a thoraco-brachial plaster cast to an unconscious patient. To apply it quickly and efficiently the patient must be in the sitting posture or on an orthopaedic table. The difficulty can be overcome thus: the wound is excised and the bone treated appropriately. The arm is then placed upon a temporary splint, and for this purpose there is no better splint than one constructed of Cramer wire (p. 466). These aeroplane splints, useful as they are, and however well constructed, are not sufficiently stable to ensure complete immobilization; a plaster cast is infinitely superior in this respect. As soon as the patient has recovered sufficiently, regional block brachial anæsthesia is induced after suitable premedication. With the patient in the sitting posture, the plaster is applied.

**BRACHIAL BLOCK ANÆSTHESIA**—As the brachial plexus passes beneath the clavicle it lies just external to the subclavian artery. The patient is seated with the face turned to the opposite side and, if possible, with the shoulder depressed. A cutaneous wheal of local anæsthesia is raised just above the mid-point of the clavicle immediately external to the (often palpable) subclavian artery. A long hollow needle is then introduced, pointing it towards the second dorsal vertebra until its point impinges upon the first rib. A syringe is then attached to the needle and aspiration

is attempted. If blood is not aspirated, about 10 c.c. of 1 per cent. solution of novocain is injected as the needle is withdrawn. The needle, without the syringe attached, is again inserted, this time about 5 mm. nearer the sternal end of the first rib. The process is repeated, *i.e.*, if no blood is aspirated, a further 5 to 10 c.c. of the solution is injected as the needle is withdrawn. Finally, in order to block the lower trunk of the brachial plexus, the third and last puncture is made with great caution. The needle is introduced still nearer the sternal end of the first rib, and the shaft of the needle should lie against the subclavian artery (Fig. 634), when transmitted pulsation will be seen. Aspiration, of course, is performed as before prior to injecting the last 10 c.c. of local anæsthetic during the withdrawal of the needle.

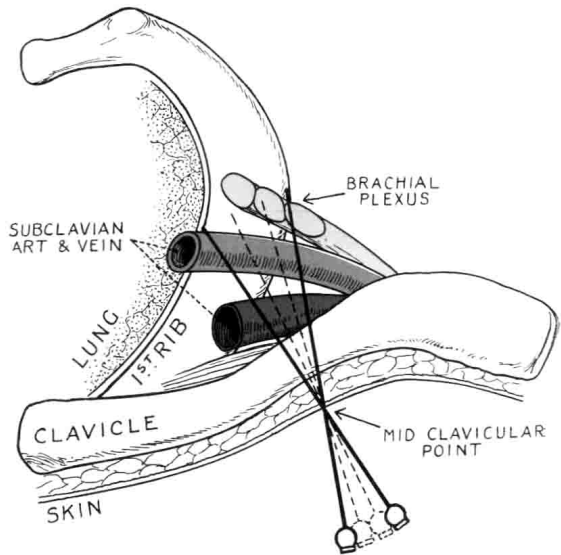


FIG. 634

Diagram which elucidates the technique of injecting the brachial plexus with local anæsthesia. (After Patrick.)

**APPLICATION OF THE PLASTER**—The patient is seated on a low backless stool and the surgeon sits facing the patient, and the assistant sits behind the patient. A second assistant holds the arm in the desired position. Surgeons who had great experience of this method in the Spanish war are unanimous that the optimum position for immobilization is one of  $45^\circ$  abduction (Fig. 635). "If the arm is placed in this position with the forearm flexed to a right angle and in the position of neutral pronation and supination, the fragments will nearly always be in true alignment" (Jolly). In necessary cases suitable precautions to prevent wrist-drop must be taken.



FIG. 635

Thoraco-brachial plaster applied. Note the optimum position ( $45^\circ$  abduction). (After Jolly.)

**Radius and ulna**—If one bone alone is damaged, particularly the ulna, the case presents comparatively little difficulty. If necessary large portions of these bones can be removed with every hope of an excellent functional result. In the case of the radius, tense fascial planes surround this more deeply placed bone and attention must be directed to ensuring adequate drainage. A plaster cast extending from the deltoid region to the metacarpals is an admirable form of immobilization. When both bones are fractured the position of full supination should be employed, otherwise the arm is immobilized in the mid prone position.



### THE TREATMENT OF LATE CASES

It has been emphasized throughout this work that wound excision must not be attempted after eighteen hours. This time limit is, of necessity, somewhat arbitrary, and cases round about the demarcation period naturally present difficulty. When signs of visible infection are manifest, no doubt arises as to the correct method of procedure. In other instances it is always well to hold a consultation with a colleague.

Cases visibly infected can be divided into two categories :—

- (a) Those with signs of toxic absorption.
- (b) Those without such signs.

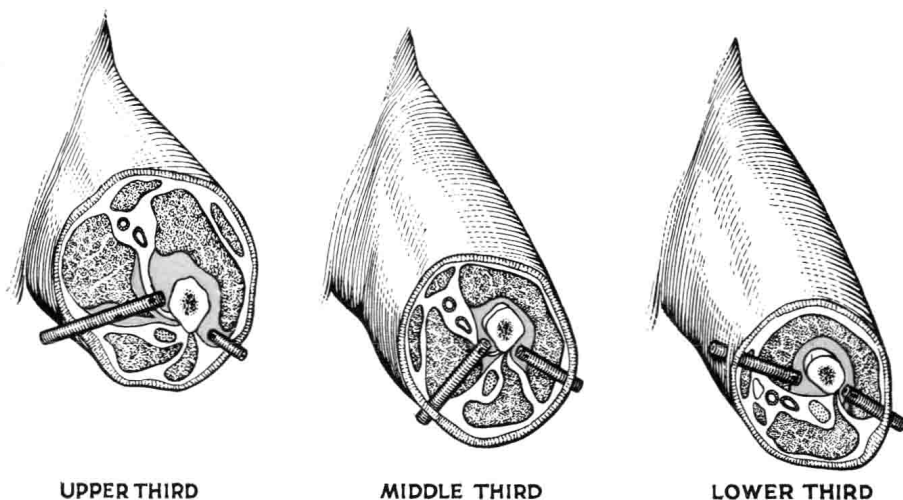


FIG. 636

Showing the correct position for inserting drainage tubes in the upper, middle and lower thigh respectively. Usually only one tube is required. (*After Bohler.*)

In both the need for débridement of the wound is imperative. By “débridement” is meant what has been insisted upon throughout this work—the original interpretation of the term—namely a rapid operation designed to open infected fascial planes, provide free drainage and remove foreign matter and tissue unquestionably dead. As far as the bone part of the operation is concerned loose fragments must be removed, and it is highly desirable to excise enough but no more of the fragments attached by their periosteum to ensure free drainage of the medulla. Drainage tubes are seldom employed, but in the case of the femur, on the other hand, it is often desirable to utilize them, for the overlapping muscles often make proper drainage impossible through the wound. Fig. 636 shows the best positions for placing soft rubber tubes in the case of the upper, middle and lower thirds of the thigh respectively. The same principles are followed in a few other situations where common sense dictates that pocketing is liable to occur.

A. When signs of considerable toxæmia are manifest, and particularly if anaerobic organisms are the cause, the closed plaster technique is definitely

contraindicated. Open treatment in every sense of the word is the order of the day. The wound must be freely open and irrigation by the Carrel-Dakin method, or one of its substitutes, cannot be bettered. Certainly, sulphonamide therapy should be instituted at once, but in this instance, by common consent, its local application is without value.

*B.* In visibly infected wounds without marked toxæmia, the closed plaster technique, after débridement, is highly successful. Indeed, it is in these cases that it reaches the zenith of its usefulness and the manifold advantages of its use are displayed. The wound should be so packed with vaseline gauze as to provide avenues for the freest drainage possible. If necessary there is no objection to incorporating within the plaster cast one or two drainage tubes if without their aid a closed pocket is inevitable. Unquestionably, if signs of toxæmia develop, the plaster cast must be removed, but there should be no undue alarm concerning a patient with a raised temperature if his general condition remains good, and, above all, if his pulse is not too rapid and he does not complain of pain.

### SEQUESTRA

The 1914-18 conflict left no doubt that sequestrum formation and its treatment was a major surgical problem destined to occupy attention for years after the declaration of peace. Although by correct treatment the patient's life and limb may be saved, once a compound fracture becomes grossly infected, neither adequate drainage nor anything else we may do is likely to obviate death of some portion of the bone; sequestrum formation (Fig. 637) must be expected.

**When to operate**—It is a common error to attempt to remove a sequestrum too early. Especially in the case of the shaft of the femur or the humerus, sufficient time must elapse for the involucrum to become consolidated, otherwise the risk of fracture following sequestrectomy is considerable. Again, if the sequestrum is not loose, its extraction is likely to traumatize living bone in juxtaposition and, what is perhaps even more important, under these conditions sequestrectomy will almost certainly be incomplete. Within reasonable limits, the longer the operation is deferred the easier it becomes.

Undue delay is likely to result in a sclerosed involucrum, making healing difficult; in addition the surrounding soft parts become so encased in fibrous tissue that the blood supply to the new bone is impaired. These factors tend to cause recurrence and chronicity after sequestrectomy. The time at which the operation is performed is, therefore, a matter of real importance and must be well chosen. While varying within wide limits, twelve weeks after the primary operation is the optimum time in the case where there is a parallel bone to act as a splint (*e.g.*, tibia, ulna). In the case



FIG. 637

Sequestrum following a guillotine amputation of the femur.

(Hugh Donovan's Case.)

of the humerus, femur, clavicle and mandible, when the entire circumference of the shaft is jeopardized, it is advisable to wait longer.

In assessing the optimum time to operate, the first consideration is the patient's general condition. If it appears that freer drainage and removal of at least some dead bone will obviate progressive toxic absorption, then the course is clear—an operation must be designed to effect this end with the least possible trauma.

In other and more usual circumstances a plan is made not only to rid the patient of the sequestrum, but to effect a permanent local cure, which is not by any means always a simple matter.

In assessing the local condition the following are extremely helpful:—

**Serial radiographs** often reveal gradual separation of the dead bone from the surrounding involucrum of new and imperfectly formed bone (Fig. 638).

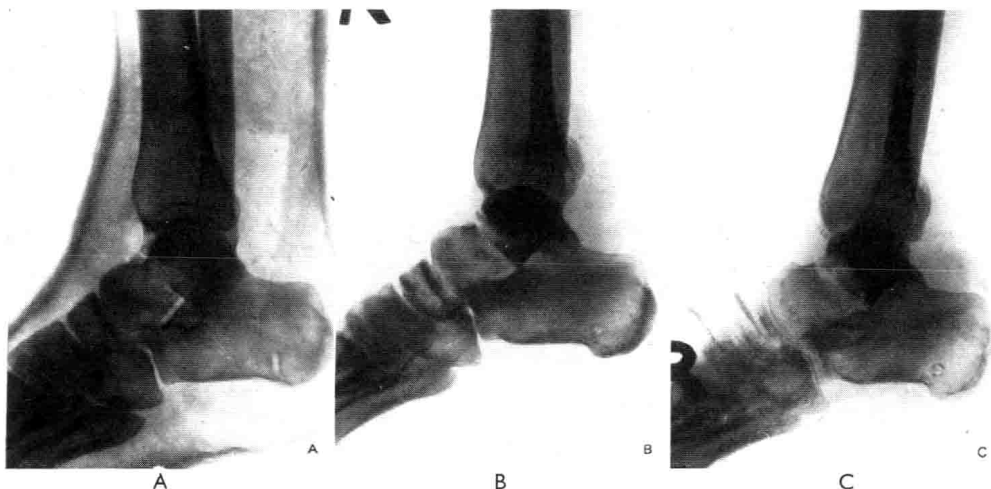


FIG. 638

The ripening of a sequestrum. Compound fracture through the neck of the astragalus involving the ankle-joint and the subastragaloid-joint.

A, Eighteen days after the injury. Showing decalcification of bone in the vicinity, except the body of the astragalus.

B, Seven weeks after the injury. Decalcification continues in all bones of the leg and foot, but the body of the astragalus retains its original density, and it must be either dead or hibernating.

C, Fifteen weeks after the injury. The opaqueness of the body of the astragalus makes it definite that it is a sequestrum.

While radiography is of the greatest possible assistance, the films are sometimes difficult to interpret; in all cases it should be only a factor—a highly important factor—in making a decision that the time is ripe for sequestrectomy.

**Probing** is often extremely valuable in determining that a sequestrum is loose. The probe comes in contact with hard and bare bone. Bareness does not mean that it is dead. The sensation is that there is nothing whatsoever between the probe and the bone. If the bone is bare, but alive, the impression is that there is a thin film of soft material (granulations) between the bone and the probe. If the dead bone be loose, pressure with the probe may cause it to move.

### SEQUESTRECTOMY

Special care must be taken to avoid nerves, large vessels and the near-by joint. Adequate access to the bone is essential; at the same time the approach must be designed to be as direct as possible. At the end of the operation saucerized bone—by which is meant that there are no overhanging bone edges—should lie at the bottom of the wound (Fig. 639).

The ideal can seldom be attained except in superficial bones (tibia, ulna), but by correct technique and particularly by a carefully planned anatomical approach much can be done to create a channel from the skin surface to the marrow cavity, of the type which experience has shown helps to minimize the bugbear of these cases—recurrence and chronicity. With this object in view, when designing the approach, the situation of sinuses and the site of the original wound fade into comparative insignificance. If one or other of these exits can be incorporated in the new incision, so much the better; if not, they are disregarded in favour of an incision which is farther away from large nerves and blood vessels and yet provides the best access and freest drainage.

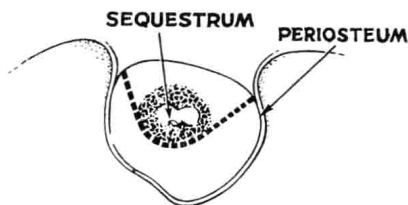


FIG. 639

Ideal sequestrectomy.

### TECHNIQUE—GENERAL

**A bloodless field is desirable**—In situations where a tourniquet is applicable it should be employed. Even so, in some situations loss of blood is likely to

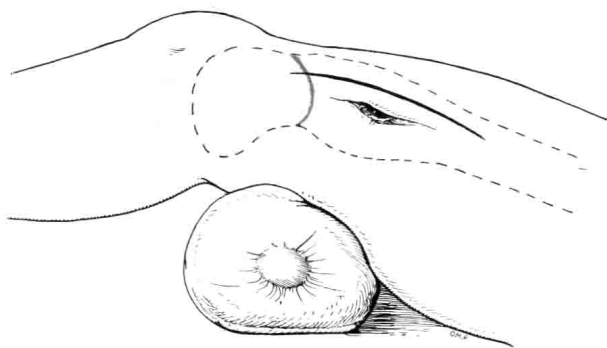


FIG. 640

Showing the position and incision for sequestrectomy of the lower end of the femur.

be considerable after the tourniquet has been removed. As, by reason of the long-continued sepsis, these patients are often ill-prepared to withstand loss of blood, it is essential to have blood grouping carried out and arrangements completed for an immediate transfusion should it become necessary.

**The limb must be stabilized**—Attention must be directed to placing the limb upon a sandbag

in the most convenient position for the selected approach and to seeing that it is maintained firmly in that position throughout the operation (Fig. 640).

**Radiographs should be at hand**—Especially in cases where there is more than one sequestrum, it is essential to be able to refer to the X-ray evidence during the course of the operation.