Fundamentals of Surgery of Septic Wounds

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IN EXPRESSING to Dr. Churchill our affection for him, I would like to paraphrase a story he told at the conclusion of the first meeting of the Excelsior Surgical Society in Boston in 1946. Many different members of this group had told of our esteem for him and our appreciation of his leadership in the Mediterranean Theater. In rebuttal, he told the following story.

"An elderly couple in the deep South sat in rocking chairs on the veranda for hours, day-by-day, week-by-week and month-by-month, with seldom a word passing between them. Finally one day the old gentleman startled his wife by saying, "Martha, I love you so much sometimes I am tempted to tell you so." We of the Excelsior Surgical Society, Colonel Pete, love you so much we came here to tell you so.

Septic wounds during World War II were a definite problem. Those of us on the consulting staffs during World War II exerted considerable effort toward resolving this problem. A by-product of these efforts was what amounted to a contest in phrase-making. Each would attempt to come up with some expression which would succinctly express a working principle. Examples are *initial surgery* (instead of debridement), *dead and devitalized tissue, pabulum of sepsis* and *excisional surgery.*

Dr. Churchill contributed many of the phrases which we adopted, one of which is most interesting and in a way illustrates his devotion to the science of surgery. As a surgical purist, he was dead-set against the routine use of prophylactic antibiotics as an adjuvant to wound management. He thought our surgery should be good enough to make them unnecessary. After Champ Lyons had arrived in the M.T.O. accompanied by adequate supplies of penicillin and had informed us about its use in an effort to obtain improved surgical results, most of us wanted to institute the routine use of penicillin for all wounded men in the Field and Evacuation Hospitals as a means of reducing the incidence of wound sepsis and so expressed ourselves to the Chief. After some discussion he made his profound and irrevocable decision that we would not routinely give penicillin *prophylactically* but that we would give it routinely against *impending infection.*

Dr. Simeone has demonstrated the vagaries and vicissitudes of dogs in Cleveland which tend to mar the interpretation of his experimental data. I cannot supply this same type of information from St. Louis. In Caserta during the closing days of the war as Colonel Pete sat on his hard straight armless chair with his feet enclosed in his G.I. shoes propped on the table without a drawer he called his desk and fingered the home-made wooden box he called a file he held forth on the merits of objective clinical research. Suddenly he banged his fist on the table (desk) and said "Oscar, never get too far away from the patient."

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In compliance, my observations have been made in patients and are not supported by animal research.

The basic objectives in the management of wounds are to prevent or cut short infection in contaminated wounds, to eliminate the septic process in already infected and suppurating wounds, and, in each, to obtain sound healing of all tissues involved. Surgery in the management of wounds is designed to achieve these objectives with the maximum preservation of tissue, a minimum of scar, a maximum return of function of the part and to do so in a minimum of time.

Wound infection on a clinical basis may be classified as 1) invasive infection; 2) wound suppuration; or 3) surface infection. Dr. Churchill was the first to present this classification to me although he credited it to someone else.

Invasive infection is characterized by bacterial invasion and destruction of living tissue, that is, tissue not destroyed previously by injury. Typical examples are hemolytic streptococcic infections and true gas gangrene. In anaerobic invasive infection, bacteria such as *clostridia* capable of causing gas gangrene or hemolytic cocci in symbiosis with faculative anaerobes take hold in tissue devitalized by injury and then invade and kill living tissue creating circumstances ideal for further spread of infection. Aerobic invasive infection also is more likely to develop and spread in a wound containing dead tissue.

Wound suppuration is a localized suppurative process. Bacteria perhaps incapable of causing invasive infection produce the septic decomposition of dead and devitalized tissue including blood clot in dead space. In this way the wound becomes filled with pus. This is the usual posttraumatic or postoperative wound abscess or infection and is by far the most common type of wound infection.

Surface infection also is a localized suppurative process. It results from the action of bacteria, perhaps incapable of producing invasive infection, on wound exudate from the raw surfaces of open wounds, granulating surfaces, and burns. Collaginous tissues such as ligament, tendon, cartilage, fascia, and cortex of bone cannot survive for long if they remain exposed in a wound. They die and become the nidus for surface infection. Surface infection is a superficial form of wound suppuration.

Invasive infection and wound suppuration—deep or surface—can be present in the same wound and one predisposes and may lead to the other. It is worthy of note that invasive infection is most life-endangering. Wound suppuration is unlikely to become lethal but it may vastly increase morbidity and permanent disability.

A clear understanding of the basic pathology in suppurative wounds is essential. In each the precursor is dead tissue including, and for emphasis it is repeated, blood clot in dead space or even wound exudate of open wounds. By bacterial action the dead tissue is decomposed into pus. The pus which forms gravitates into all of the crevices of the wound and bathes all of the tissues with which it comes in contact. Proteolytic enzymes in this pus gradually necrotize living tissue thereby creating additional devitalized tissue, which, in turn, decomposes into more pus. Thus, a vicious circle is established with persisting suppuration and continuing necrosis of living tissues. The continuing destruction of previously living tissues is really the scourge of wound suppuration.

With these facts in mind, it becomes apparent that for the elimination of wound suppuration and the initiation of the processes of wound healing, the wound must be made free of dead and devitalized tissue. This calls for aggressive surgery, not mere incision and drainage or removal of sutures for drainage. Under adequate antibiotic protection as a safeguard against invasive infection, septic wounds should be opened widely and thoroughly debrided

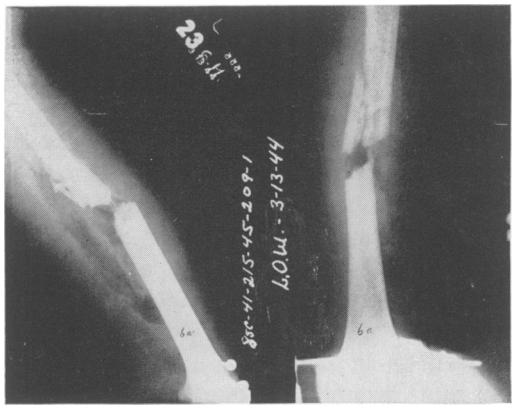

FIG. 1a. Extremity in skeletal traction one month after open comminuted fracture of the left femur in middle third due to high explosive shell fragment. The femoral fragments are distracted and surrounded by gas abscess formation.

(FIG. 1, a–f from Oscar P. Hampton, Jr.: Compound Battle Fractures. Ann. Surg., 122:289, 1945.)

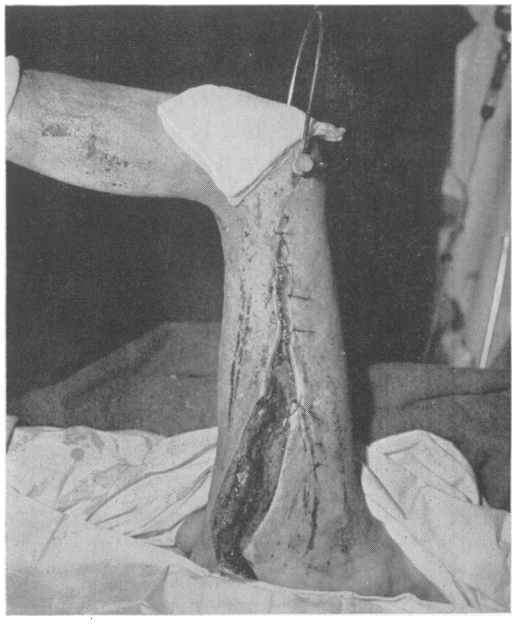

FIG. 1b. The abscess which extended into the buttock was drained through a long incision along the postero-lateral fascial plane. After the surgery shown in C, a small portion of the wound was closed in order to cover bone but the largest portion remained open for good drainage.

with the patient under general anesthesia. All tissue destroyed by the injury or by the septic process itself should be excised. The wounds should be left wide open and dressed so as to provide splendid drainage of wound exudate and the slough of small particles of devitalized tissue which defied surgical excision. As a rule primary wound closure has no place in the surgical management of the septic wound. Rarely, skeletal tissues may be approximated and fixed in apposition because in so doing considerable dead space may be eliminated and the continuing traumatizing effect of moving bone ends within the wound avoided.

Four or five days later in the operating room, with the patient again anesthetized, the wound should be re-explored and, if indicated, any residual bits of dead tissue excised. Complete or partial wound closure usually may be provided at this time often with a drainage of any residual dead space. Adequate pressure dressings and immobilization complete the application of proven principles of surgery.

To create some nostalgia, illustrated case reports of two patients with established wound sepsis from World War II days to which these principles were applied successfully will be presented. Then, three ad-

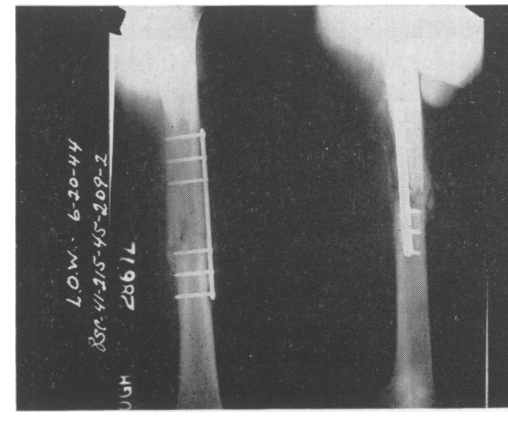

FIG. 1c. The fragments approximated and fixed internally with a six hole plate and screws in order to eliminate dead space and gain a stabilized fracture.

ditional illustrated case reports of patients who had postoperative septic wounds in civilian practice managed successfully in the same way will follow.

Case 1. Management of Septic Fracture of the Femur (Fig. 1, a–f). This patient, four weeks after wounding, presented a grossly septic wound of the thigh with an unreduced fracture of the femur surrounded by gas abscess formation which could have been mistaken for gas gangrene. He could have been considered a candidate for amputation. By complete excisional surgery, closure of dead space, stabilization of the fracture, adequate drainage of the wound and staged wound closure, all under benefit of antibiotic therapy, the septic process was eliminated and a healed fracture and a healed wound were obtained. Of course, internal fixation under such circumstances is not to be recommended very often but in this instance the advantages of approximation of the fragments so as to eliminate dead space and gain a stabilized fracture to permit subsequent handling of the extremity seemed to justify the risk. The end-result indicates that the judgment was not faulty.

Case 2. Management of Severe Suppurative Arthritis with Total Destruction of the Knee Joint

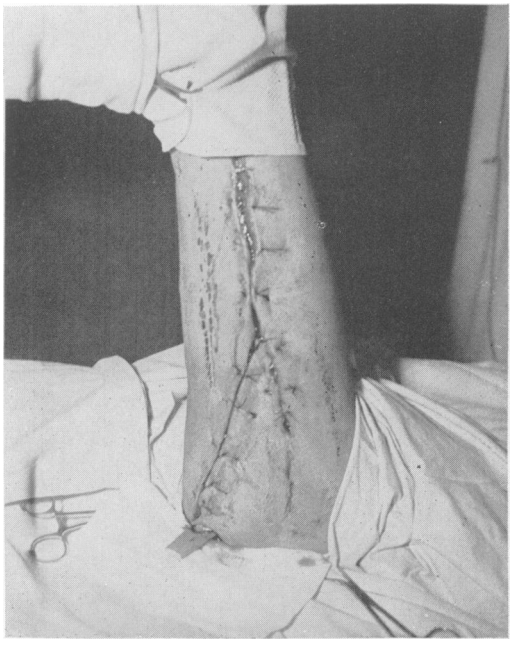

FIG. 1d. Five days later the wound was again thoroughly irrigated and bits of devitalized tissue were excised. The remainder of the wound was closed with drainage.

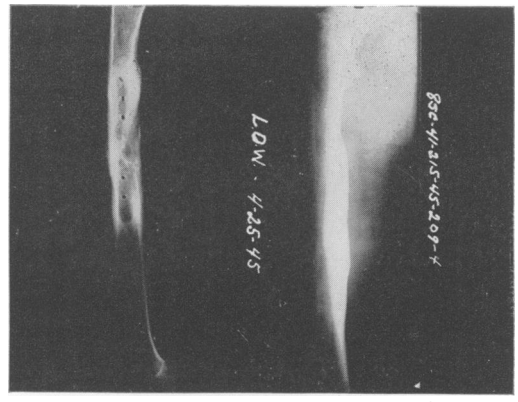

FIG. 1e. The wound healed without sinus formation and the fracture went on to union. Six months later the plate and screws were removed at elective operation.

by Resection (Fig. 2 a–d). This patient received two high explosive shell fragment wounds with the foreign bodies embedded in the knee. The fragments were removed at initial operation but apparently the joint was not well cleaned. Penicillin solution was instilled into the joint and penicillin therapy was given systemically. At the base hospital an open fracture of the femur on the same side was placed in balanced suspension skeletal traction. Treatment of the joint included multiple aspirations and irrigations and reinstillations of penicillin. Even so, septic arthritis developed and continued until the joint was destroyed and the patient became extremely ill. Two months after injury the knee joint was resected. A total of three inches of bone destroyed by the septic process was excised. The raw surfaces of femur and tibia were approximated and held in apposition by an external skeletal fixation apparatus over

FIG. 1f. The healed extensive wound.

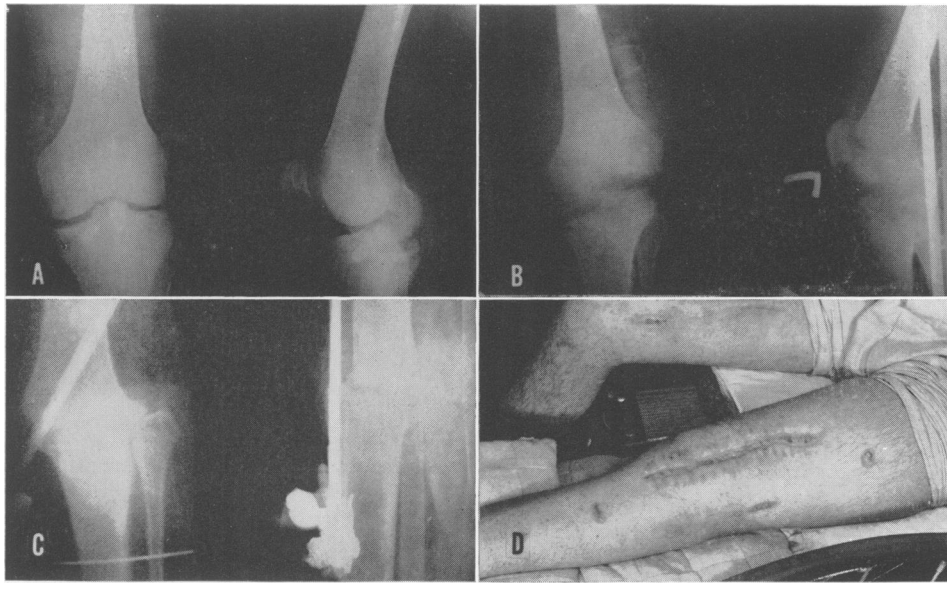

FIG. 2A. Anteriorposterior and lateral roentgenograms prior to initial surgery. Size and location of foreign bodies indicates considerable trauma to the articular cartilage. B. Same two months after wounding, showing ravages of septic process in joint. C. Anteriorposterior and lateral roentgenograms of resected knee joint made about two months later showing incomplete bony fusion. D. Healed wound several months later in the Zone of the Interior. The knee joint was fused by bone. (From Medical Department U. S. A., Surgery in World War II, Orthopedic Surgery Mediterranean Theater of Operations.)

FIG. 3A. Anteriorposterior and lateral roentgenograms showing a severely comminuted fracture of the distal end of the tibia before operation. B. Anterioposterior and lateral roentgenograms showing what was achieved by open reduction and internal fixation. (From Oscar P. Hampton, Jr., Wounds of Joints; Surgical Clinics North America, December, 1958. Philadelphia, W. B. Saunders Co.)

which a hip spica cast was applied. All wounds were left open for drainage. Portions which did not fall together were closed secondarily two weeks later.

The septic process was brought under control and the patient's general condition improved rapidly. The wounds healed and the femur and tibia united by bone giving a solidly fused knee.

Case 3. Postoperative Infection with Pus Filling the Wound and Ankle Joint Following Open Reduction of a Comminuted Fracture of the Distal Portion of the Tibia (Fig. 3, a–b). On the fifth postoperative day the patient showed systemic signs of infection and examination of the wound showed an obvious wound infection with extensive abscess formation. In the operating room, all sutures were removed disclosing a large collection of thick pus filling the wound and ankle joint. The joint cavity and wound were thoroughly irrigated and a few bits of devitalized tissue were excised. The capsule of the joint was closed but the remainder of the wound was left open. Five days later the first dressing was carried out in the operating room where secondary closure of the wound was done. The wound healed and the fracture went on to solid union. Destruction of the ankle joint surface did not take place and a favorable end-result was obtained.

Case 4. Resection of the Knee Joint to Eliminate Far Advanced Suppurative Arthritis (Fig. 4, a–c). The patient was first seen eight weeks after onset of a suppurative arthritis of the knee apparently secondary to several hydrocortone injections because of pain from osteoarthritis. The knee joint, completely destroyed, was in 90 degrees of flexion. The patient, quite ill, had been bed ridden for six weeks. He had been referred for amputation.

At operation the septic condylar regions of the tibia and femur and devitalized soft tissue were excised through a transverse incision. The raw surfaces of healthy bone were approximated and held in strong apposition by the Charnley positive pressure apparatus incorporated in a long leg plaster cast. The wound was merely allowed to fall together with drains to the posterior compartment emerging from each end of the incision for a few days. The septic process was brought completely under control; the wounds healed and the femur and tibia fused in the optimal position. An extremity for which amputation was considered was salvaged by the application of the principles of surgery of a septic wound.

Case 5. Septic Arthritis of Hip Secondary to Infection Following Nailing of a Fracture of the Neck of the Femur (Fig. 5, a–d). This 63-year-old woman was admitted seven months after she sustained a fracture of the neck of the left femur which had been fixed elsewhere with a Jewett type nail. Wound sepsis had followed and even-

FIG. 4A. Anteriorposterior and lateral roentgenograms made soon after the patient was admitted showing far advanced suppurative arthritis of the knee. B. Anteriorposterior and lateral roentgenograms after resection of the knee which removed the dead and devitalized tissue. The ends of the femur and tibia were placed in close approximation by Charnley apparatus and a plaster cast. C. Anteriorposterior and lateral roentgenograms showing successful fusion of the knee. (From Oscar P. Hampton, Jr., M.D., Wounds of Joints; Surgical Clinics North America, December 1958. Philadelphia, W. B. Saunders Co.)

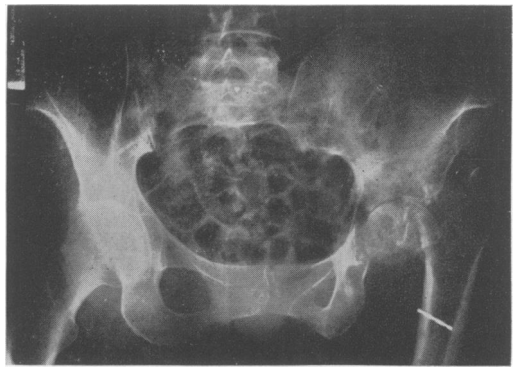

FIG. 5a. Roentgenogram on admission showing that the hip joint has been destroyed by the septic process. Septic necrosis of the femoral head is present.

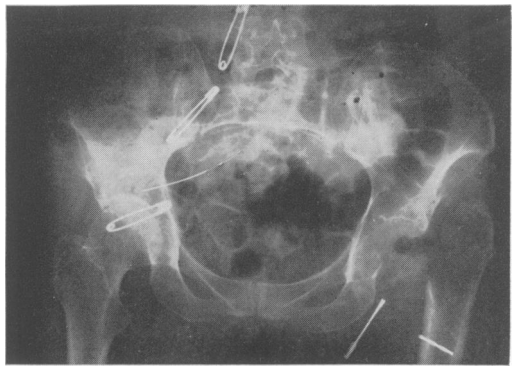

FIG. 5b. Roentgenogram made three days after the femoral head and dead articular cartilage and dead bone had been removed from the acetabulum through a postero-lateral incision which was left open.

FIG. 5c. Roentgenogram showing the hip reconstruction which was carried out five days after the first operation. The wound healed promptly.

tually the internal fixation material had been removed. Sepsis had persisted. The hip joint had been destroyed, the dead femoral head lay loose in the joint and the lateral wound continued to drain pus.

At operation through a posterolateral incision, the dead femoral head and other dead bone and the necrotic articular cartilage of the acetabulum were removed. The entire wound was dressed open. Five days later at a second operation, the wound was cleansed by irrigation, explored and found to be free of sepsis. The hip abductors were transplanted to the subtrochanteric level. The raw trochanter was placed in the raw acetabulum. The wound was closed with drainage (for three days) and a hip spica cast was applied. Plaster immobilization was continued for five months. The wound healed and the hip fused providing a stable hip on which she now walks unaided.

Such experiences support the following concept: "Wound sepsis becomes established as a result of the septic decomposition of devitalized tissue in the wound including the decomposition of hematomas in dead space. If this pabulum is removed and if living tissue is protected from invasive infection by an effective antibacterial agent, the bacterial flora of a clean open wound may be disregarded, wound sepsis need not be feared and any indicated reparative surgical procedure may be carried out under established surgical principles with the anticipation of sound wound healing."

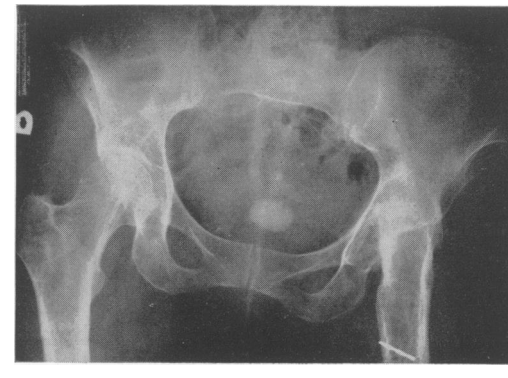

FIG. 5d. Roentgenogram 18 months later showing solid bony fusion of the denuded trochanter to the acetabulum.

The fundamentals of surgery of the septic wound may be summarized as follows. Every suppurating wound needs and deserves operative treatment. It needs thorough surgical debridement to eliminate the septic process and avoid further destruction of living tissue and to prepare it for delayed wound closure. The spotlight should fall upon the pathologic aspects of a septic wound rather than its bacterial flora and the indicated operation should be carried out accordingly. Dead tissue should be excised whenever and wherever it is found; dead space should be obliterated or dependently drained; staged closure should be provided for the open wound; atraumatic technic with fine hemostats and ligatures predisposes to success; pressure dressings and precise splinting are valuable adjuncts; antibiotic therapy is indicated as a safeguard against impending (according to Churchill) invasive infection.