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SYMPOSIUM: AAOS 75TH ANNIVERSARY TRIBUTE TO PAST PRESIDENTS

The Classic

Local Chemotherapy with Primary Closure of Septic Wounds by Means of Drainage and Irrigation Cannulae

M. N. Smith-Petersen MD (1886–1953), Carroll B. Larson MD, Williams Cochran MD
The 12th President of the AAOS 1943 (MNS-P)

Marius Nygaard Smith-Petersen was born in Grimstad, Norway, of a prominent merchant marine family in 1886 [2]. He came to the States with his mother in 1903 and, initially unable to speak English, completed high school in Milwaukee, Wisconsin, in 1906. He then attended the University of Chicago (1906–07) and graduated from the University of Wisconsin (1910) and the Harvard Medical School (1914) [4]. He completed his surgical internship under Harvey Cushing at the Peter Bent Brigham Hospital, then his postgraduate orthopaedic training under Dr. Elliott Gray Brackett, at the Massachusetts General Hospital and became his assistant in practice 1917. In 1922 Dr. Smith-Petersen entered private practice in Boston, working at the Massachusetts General Hospital. He continued working there with a heavy clinic and operating schedule until shortly before his death from a brief illness in 1953 at the age of 67.

Dr. Smith-Petersen traveled widely, was active in many national and international societies, and received many international awards and honorary memberships. As with other Presidents during the war years, he faced challenges organizing the annual meeting for 1944, although the number of members and guests attending had increased (to 1,018) compared to 1943 [3]. During his tenure the first volume of the Instructional Course Lectures was published. He had an extraordinary capacity for work and ability to focus [2], reflected in his creativity scholarly productivity.

The article we reproduce here reflects not only Smith-Petersen's innovative thinking, but his willingness to accept challenge with a new approach [7]. In 1934 he began using suction-irrigation cannulae made of glass to allow intermittent irrigation in patients with osteomyelitis in whom the wounds had been tightly closed about the cannulae. For the time, when open packing of chronic osteomyelitis as advocated by Orr was a standard [1], Smith-Petersen's approach was radical. He commented, "Several members of the Osteomyelitis Service did not look with favor upon this method of treatment, and the orthopaedic surgeon responsible for the treatment did not feel any too confident; consequently, the cases treated in this manner were few and far between, and progress was proportionally slow" [7]. He modified the cannulae design from round to oval to help prevent leakage and began constructing them from vitallium in 1938 to avoid breakage. Initially he used Dakin's solution, but then tried a silver-pectinate solution, and in the year before publication (1945) began using penicillin. His willingness to continuously modify his approaches (exemplified with other innovations, including the tri-flanged nail [5] and mold arthroplasty [6]) attests to his sense of responsibility and humility. "A great responsibility," he commented, "rests on

Marius Nygaard Smith-Petersen, MD is shown. Photograph is reproduced with permission and ©American Academy of Orthopaedic Surgeons. *Fifty Years of Progress*, 1983.

the surgeon who introduces a new method of treatment. The desire to have a new idea published is so great that the originator is often led astray, and the method is broadcast before it has proved worthwhile, and before the technique has been perfected" [4].

Richard A. Brand MD

References

1. Campbell WC. *Operative Orthopedics*. Saint Louis: CV Mosby Co; 1939.
2. Dr. M. N. Smith-Petersen, 1886–1953. *J Bone Joint Surg Br*. 1953;35:482–484.
3. Heck CV. *Fifty Years of Progress: In Recognition of the 50th Anniversary of the American Academy of Orthopaedic Surgeons*. Chicago, IL: American Academy of Orthopaedic Surgeons; 1983.
4. Mostofi SB. *Who's Who in Orthopedics*. London, UK: Springer; 2005.
5. Smith-Petersen MN. Intracapsular fractures of the neck of the femur. *Arch Surg*. 1931;23:715.
6. Smith-Petersen MN. Arthroplasty of the hip: a new method. *J Bone Joint Surg Am*. 1939;21:269–288.
7. Smith-Petersen MN, Larson CB, Cochran W. Local chemotherapy with primary closure of septic wounds by means of drainage and irrigation cannulae. *J Bone Joint Surg Am*. 1945;27:562–571.

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Introduction

The fundamental principle in the treatment of deep sepsis is the creation of a path or preferably an avenue of escape for the accumulated products of infection. "Packing the wound open" is the method generally used to accomplish this purpose, but it has many drawbacks. Making a wound close from the bottom means a prolonged period of healing, during which time there is bound to be considerable loss of serum from the granulating surfaces; this fact alone is a serious objection to drainage by packing the wound open. Relatively frequent dressings, painful to the patient, and time-consuming for the surgeon, are another objection to the method. Partial primary closure of the wound is the logical answer to this problem.

Historical Background

Development of Drainage and Irrigation Cannulae

In 1934 the first "drainage and irrigation cannulae" (Fig. 1) were made for the Osteomyelitis Service of the Massachusetts General Hospital. These were straight glass cannulae, each with a flange at one end to prevent it from slipping out of the wound. After incision and drainage of an osteomyelitic area, two of these cannulae were inserted, and the wound was closed tightly around them. Rubber tubes were connected to the cannulae,—one leading to a bottle of irrigating fluid at the head of the bed, the other to a waste bottle on the floor. At regular intervals, irrigation fluid was allowed to flow through the wound until it came out clear; the rubber tube from the outlet cannula was then clamped off, allowing the irrigation fluid to accumulate in the wound before the rubber tube from the supply bottle was clamped off. Dakin's solution was the agent used both for its cleansing and for its bacteriostatic effect.

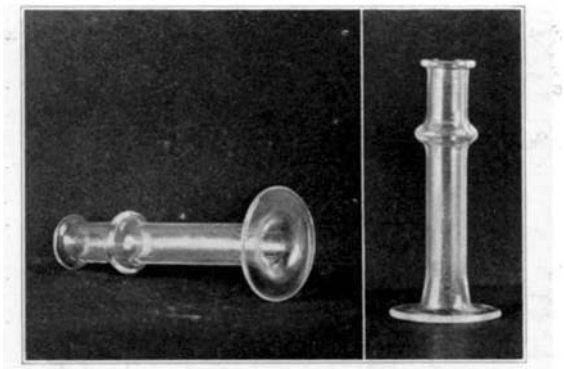

Fig. 1 Original glass drainage and irrigation cannulae (February 1934).

Several members of the Osteomyelitis Service did not look with favor upon this method of treatment, and the orthopaedic surgeon responsible for the treatment did not feel any too confident; consequently, the cases treated in this manner were few and far between, and progress was proportionally slow.

It was soon found that the round glass cannulae allowed leakage, and also caused pressure necrosis of the skin edges. Furthermore, they teetered sideway, and were apt to slip down against the bony floor of the cavity. These

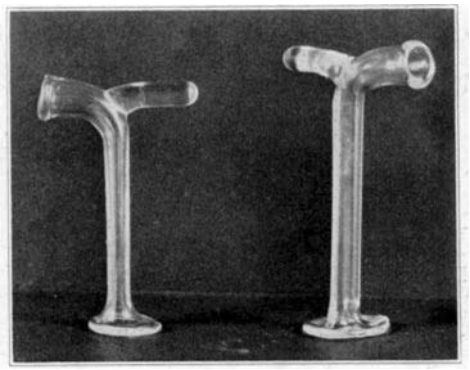

Fig. 2 Modified glass cannulae: elliptical, neck bent, strut added (April 1935).

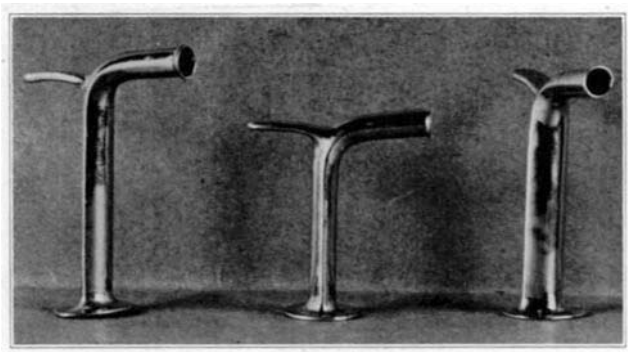

Fig. 3 Vitallium cannulae, present models (1938).

difficulties were gradually overcome; the cannula was made elliptical to avoid leakage and pressure on soft parts (Fig. 2), the neck of the cannula was bent at a right angle and a strut was added. These changes permitted stabilization of the cannula by providing space in which to pack gauze between the skin and the neck and strut (Fig. 2). Glass was not ideal because of the possibility of breakage; so, in 1938, the first vitallium cannulae were made (Fig. 3). Only minor changes in shape and caliber have been made since that time.

Irrigation Fluids and Chemotherapeutic Agents

Dakin's solution has been used extensively from the very first, and even now it is often substituted temporarily for other chemotherapeutic agents.

Silver-pectinate solution has been used in a limited number of cases as a local chemotherapeutic agent, but not as an irrigation fluid.

Penicillin has been used for the last year. The system of two drainage and irrigation cannulae has been found to be a very practical way of introducing the penicillin locally (Figs. 4 and 5).

Technique

After primary closure of the wound around the cannulae, gauze sponges are packed between the skin and the neck, as well as between the skin and the flange or strut (Figs. 6 and 7). This packing stabilizes the cannulae and prevents them from teetering; it also keeps the deep portions of the cannulae away from the floor of the septic area. Additional dressing is applied, and held in place by an elastic bandage. By introducing a certain number of cubic centimeters of air through a syringe, a corresponding amount of fluid is delivered from the supply bottle into the wound through the inlet cannula. The outlet cannula is left open until clear fluid appears; then it is clamped off.

When penicillin is used as the local chemotherapeutic agent, the amount decided upon is delivered into the wound by the above technique every four hours. The strength of the solution up to the present has been 250 units per cubic centimeter. The period of local administration of penicillin has varied from a minimum of two weeks to a maximum of four weeks. It is decided upon on the basis of the extent and the duration of the sepsis, preoperatively, as well as the clinical course postoperatively. If at any time a change in the local chemotherapeutic agent is indicated, the system is kept intact except for the supply bottle and its contents. Indications for such a change are: secondary infection, such as *Bacillus coli* or other penicillin-resistant organisms, or interference with the flow of penicillin through the septic area. Dakin's solution has been the only chemotherapeutic agent used as a temporary substitute for penicillin. Dressings are infrequent,—the dressing applied at the time of operation is frequently left undisturbed for a week or ten days; local discomfort from a sticky, bloody dressing may demand a change as early as three or four days after operation, but, after this initial change, there may be no indication for dressings until the cannulae are removed.

Removal of Cannulae

During the developmental stage, the cannulae were removed under local anaesthesia at the end of two to four weeks, without any attempt being made to close the soft-tissue defects created by them. Consequently, dressings were necessary for varying periods of time, but they were minor, not time-consuming and not painful. Since the advent of penicillin, the technique has changed only slightly: The cannulae are still being removed at the end of two to four weeks, usually under pentothal anaesthesia, but the soft-tissue defects are closed, leaving only a small rubber catheter in place for the administration of penicillin for a few more days. This use of the catheter is a sign of lack of faith in nature's ability to combat residual infection

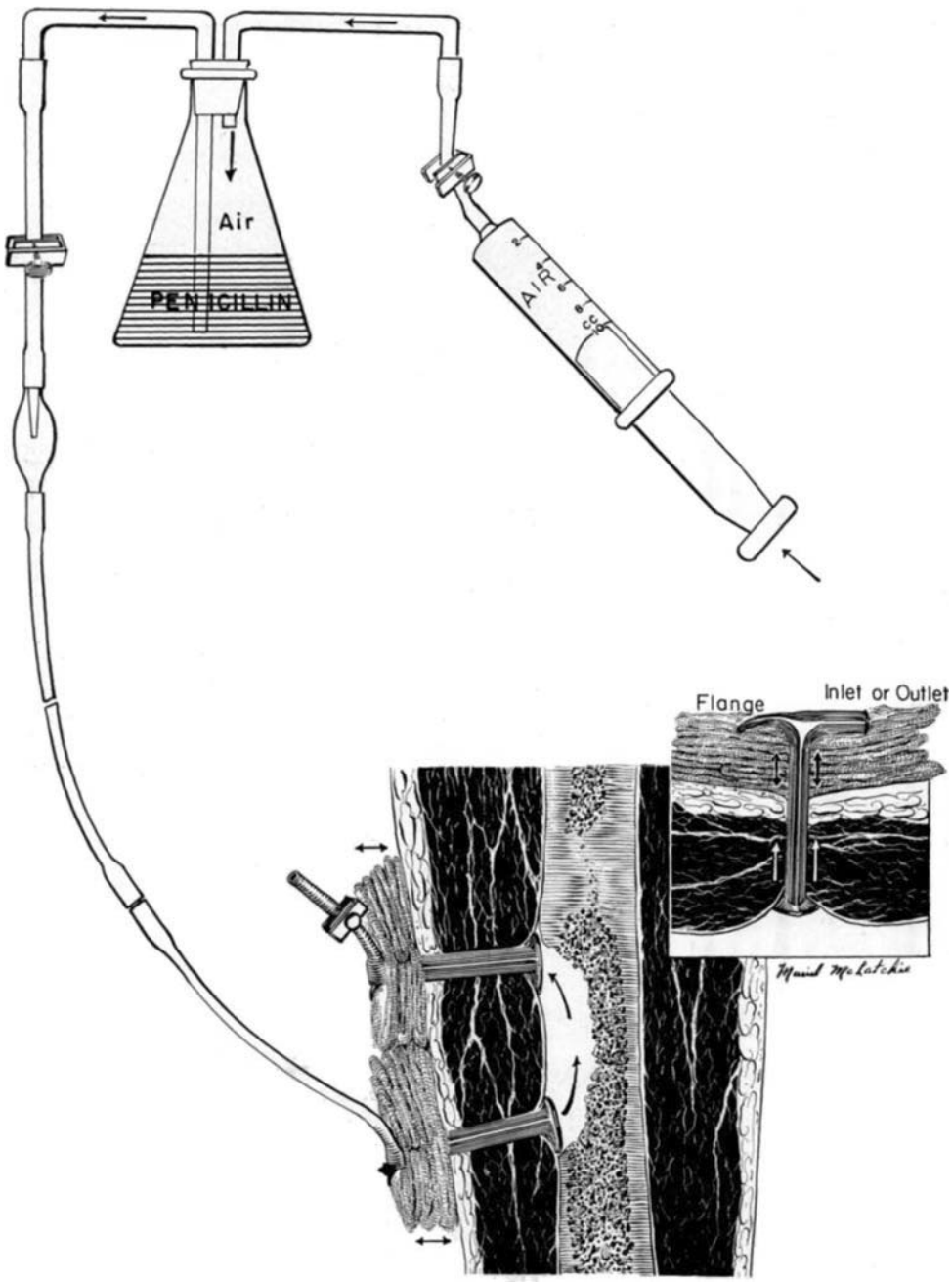

Fig. 4 Diagrammatic representation of the use of cannulae in connection with a closed system for the local administration of penicillin.[1]

successfully; cultures taken at the time of the removal of the cannulae invariably show bacterial growth.

Systemic Chemotherapy

Bacteraemia and septicaemia are ever-present threats accompanying local infection. Systemic chemotherapy has made miraculous progress during the last few years, and it would be poor judgment indeed to confine ourselves to the use of local chemotherapy. Systemic penicillin has been administered for a minimum of twenty-four hours before operation, throughout the period of local chemotherapy, and for a few days to a week following the removal of the cannulae; 100,000 units per twenty-four hours has been the usual dosage.

Variations in Technique

The number of cannulae at our disposal has been and still is very limited. Consequently, there have been occasions when no cannulae were available; at such times rubber

[1] This closed system of local administration, as now used, originated with two Surgical Residents, Grant Rodkey, M.D., and Richard Webster, M.D.

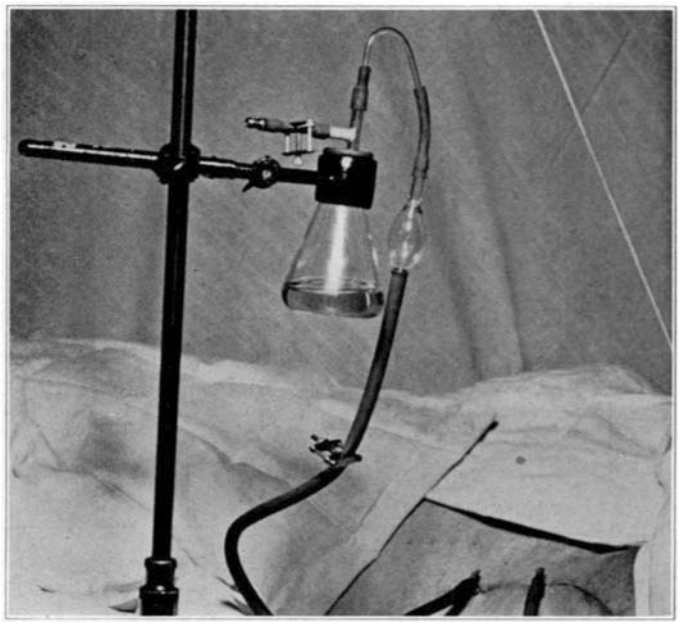

Fig. 5 Apparatus in use in a case of hip-joint sepsis.

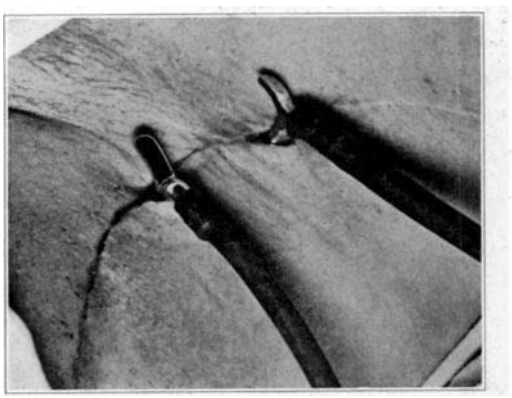

Fig. 6 Close-up view of cannulae in place twelve days after insertion. Very minor local reaction.

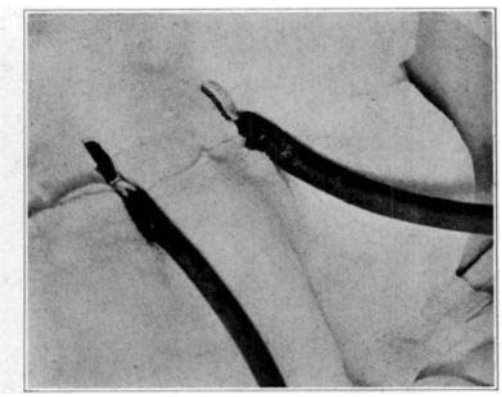

Fig. 7 Same case as Fig. 6. Packing in place.

catheters have been used in their place. The technique of wound closure and local instillation of penicillin has been the same as that employed with the cannulae. Rubber catheters clog more easily, and may cause local reaction.

Case Reports

This is a preliminary report of a method of local treatment of sepsis. Our experience with it has been so favorable that we feel justified in submitting it for trial. It has not been used in combination with systemic chemotherapy for a long enough period to allow an end-result study.

Three of the early cases are reported. They were selected not only because they are favorable, but also because they are typical. The roentgenograms are reproduced from lantern slides, since the films are no longer available.

One case, treated by systemic and local penicillin, is reported as an illustration of the present method.

Case 1

A boy of thirteen had recurring osteomyelitis of the left fibula of two and a half years' duration (Fig. 8A). At operation saucerization was performed, and two glass cannulae were inserted (Fig. 8B). The cannulae were removed under local anaesthesia twelve days later, without repair of the skin defects. The wound healed completely in one month. Roentgenograms, made eight weeks after the operation, showed satisfactory bone repair, with no sequestra, and no areas suggestive of persistent infection (Fig. 8C).

Fig. 8A–C (**A**) Case 1. Osteomyelitis of the left fibula before operation. (**B**) Roentgenogram after saucerization and insertion of glass cannulae. (**C**) Roentgenogram eight weeks after original operation—six weeks after removal of cannulae.

This was one of the cases treated during 1934, the first year the cannulae were used. Almost eleven years have elapsed without any recurrences.

Case 2

A student of twenty-four had recurring symptoms referable to his right ulna. Roentgenograms (Fig. 9A) showed changes characteristic of osteomyelitis. Operation in 1934 consisted in sequestrectomy, saucerization, and the insertion of glass cannulae (Fig. 9B). The wound healed completely in five weeks (Fig. 9C). There was no local recurrence, but several secondary foci developed during the nine years following this initial focus.

Case 3

A man, thirty-eight years old, had rheumatoid arthritis, with a rigid spine, and fibrous ankylosis of both hips. In 1934 he had had a fascia lata arthroplasty of the left hip, with postoperative sepsis, which had persisted for five years (Fig. 10A).

In December 1938 a vitallium-mold arthroplasty was performed on the right hip. Two months later, in February 1939, a vitallium-mold arthroplasty was performed on the left hip, and free pus was encountered in the iliac fossa. Two vitallium cannulae were inserted, and the wound was closed around them (Fig. 10B). One month later the cannulae were removed (Fig. 10C).

At the time of the patient's discharge from the Hospital, the wound was healed, and there has been no recurrence of sepsis up to the present, a period of six years. The patient has fair function of both hips, and is working at a job requiring standing from four to six hours a day.

Case 4

A student of nineteen had multiple foci of osteomyelitis, occurring over a period of seven years. In July 1944, acute symptoms from a new focus, in the mid-shaft of the right femur, developed (Fig. 11A). Operation included saucerization, and insertion of two vitallium cannulae, with wound closure (Fig. 11B). Free pus was encountered in the medullary canal. The postoperative course was smooth. The patient was particularly appreciative of the absence of painful dressings, because of his previous experience with them.

Systemic penicillin, 100,000 units in twenty-four hours, was administered for ten days after operation, and for a week after the removal of the cannulae. Local penicillin was injected every four hours: ten cubic centimeters, 250 units per cubic centimeter. This was continued up to the time of the removal of the cannulae.

The cannulae were removed on the twenty-sixth postoperative day (Fig. 11C) under pentothal anaesthesia, and

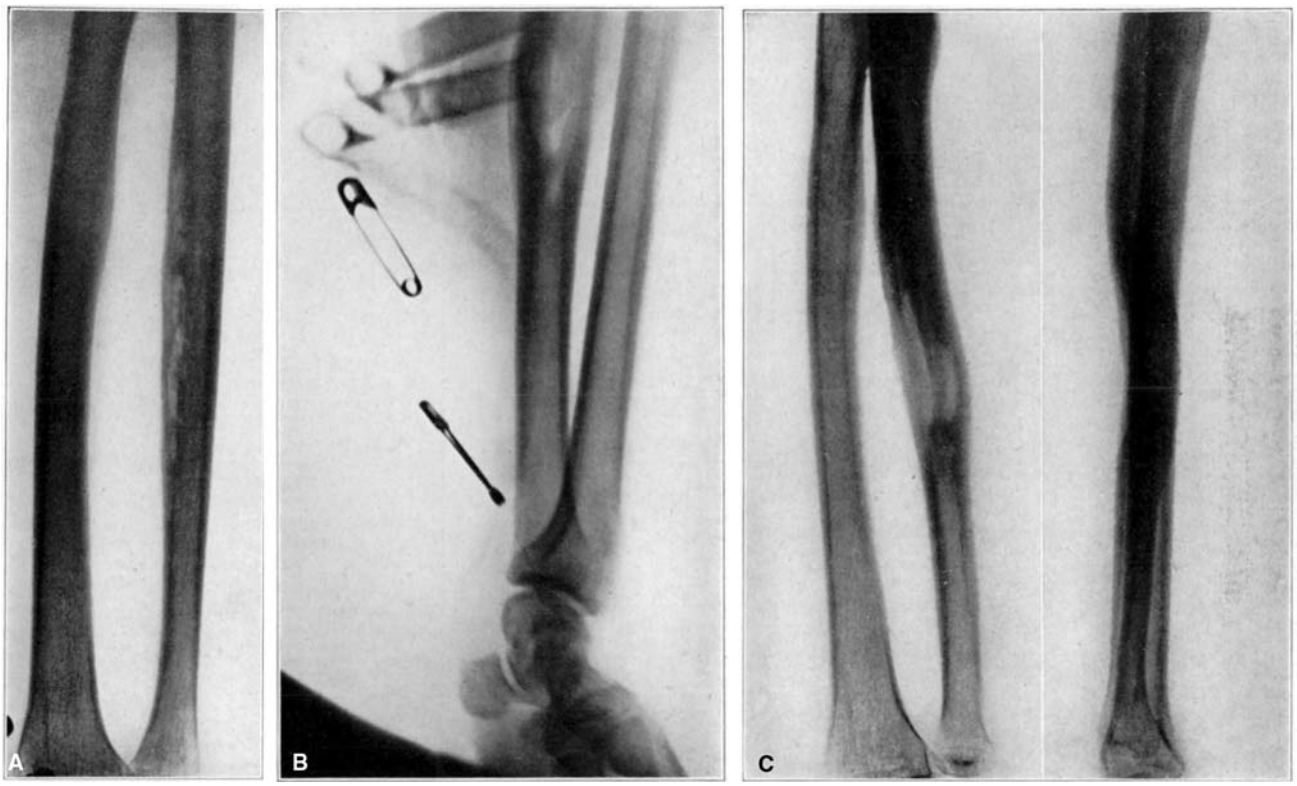

Fig. 9A–C (**A**) Case 2. Osteomyelitis of right ulna before operation. March 1934. (**B**) After operation—saucerization, insertion of glass cannulae, and closure of wound. (**C**) After removal of cannulae. Wound healed in five weeks. No local recurrence.

the defects were closed. A small rubber catheter was left in place, and penicillin was continued locally for ten more days.

The wound was entirely healed six weeks after the original operation. Roentgenograms at that time showed satisfactory progress of hone repair (Fig. 11D).

Only ten months have elapsed since operation, but so far there has been no local recurrence of sepsis.

Discussion

Favorable Aspects

Looking back upon eleven years of experience with local chemotherapy, administered through a closed system of cannulae, several favorable aspects stand out. The almost complete primary closure reduces to a minimum the loss of serum from the granulating surfaces. This is important because the loss of serum protein can be considerable, as was demonstrated in one case treated by the method of "packing the wound open". The determined loss of serum protein for one period of twenty-four hours amounted to 36.9 grams; the average daily loss over a period of a week was 11.9 grams. True, this was not an average routine case, but it serves to emphasize the importance of reducing granulating surfaces to a minimum.

The infrequency of dressings appeals to the patient and to the surgeon. Septic dressings are painful, no matter how gently they are done; and they are bound to be timeconsuming.

The time for complete healing of the wound is materially shortened; and the scar is linear and level, instead of broad and puckered.

The postoperative clinical course in the majority of cases treated by this method has been smooth: the temperature chart levels off quickly; the patients are happy and look well.

Unfavorable Aspects

This is not a perfected method with 100 per cent. cures. There have been cases with local recurrence of sepsis, but these have been relatively few.

No matter how carefully the cannulae are sutured in place and stabilized by proper packing, local reaction from pressure and slight motion is apt to occur. Such reaction is very slight and easily excised at the time of the removal of the cannulae.

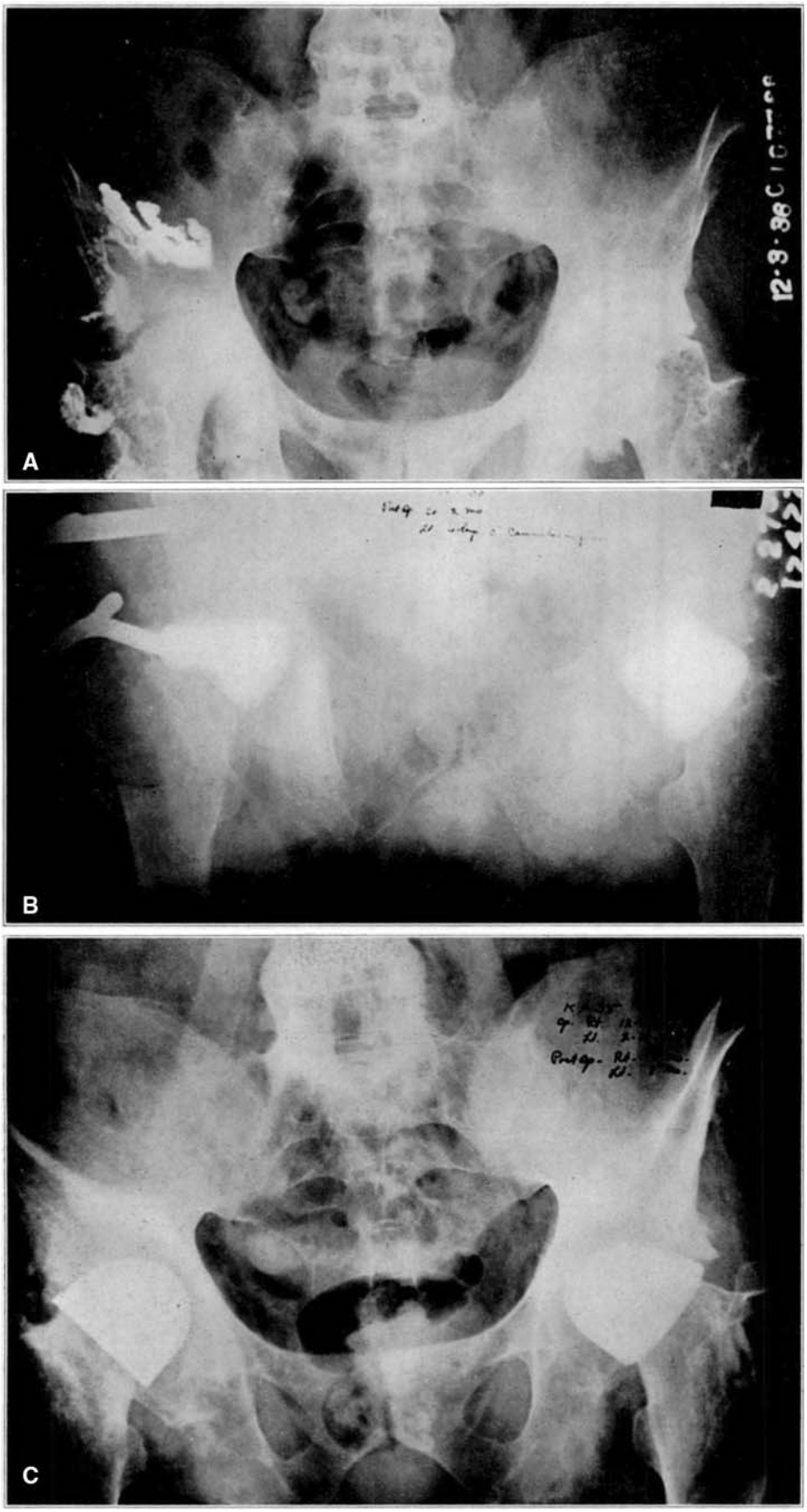

Fig. 10A–C (**A**) Case 3. Old septic hip with lipiodol injection of sinus. (**B**) Old septic hip after vitallium-mold arthroplasty and insertion of two vitallium cannulae. (**C**) Seven months after removal of cannulae. Wound healed. No recurrence of sepsis.

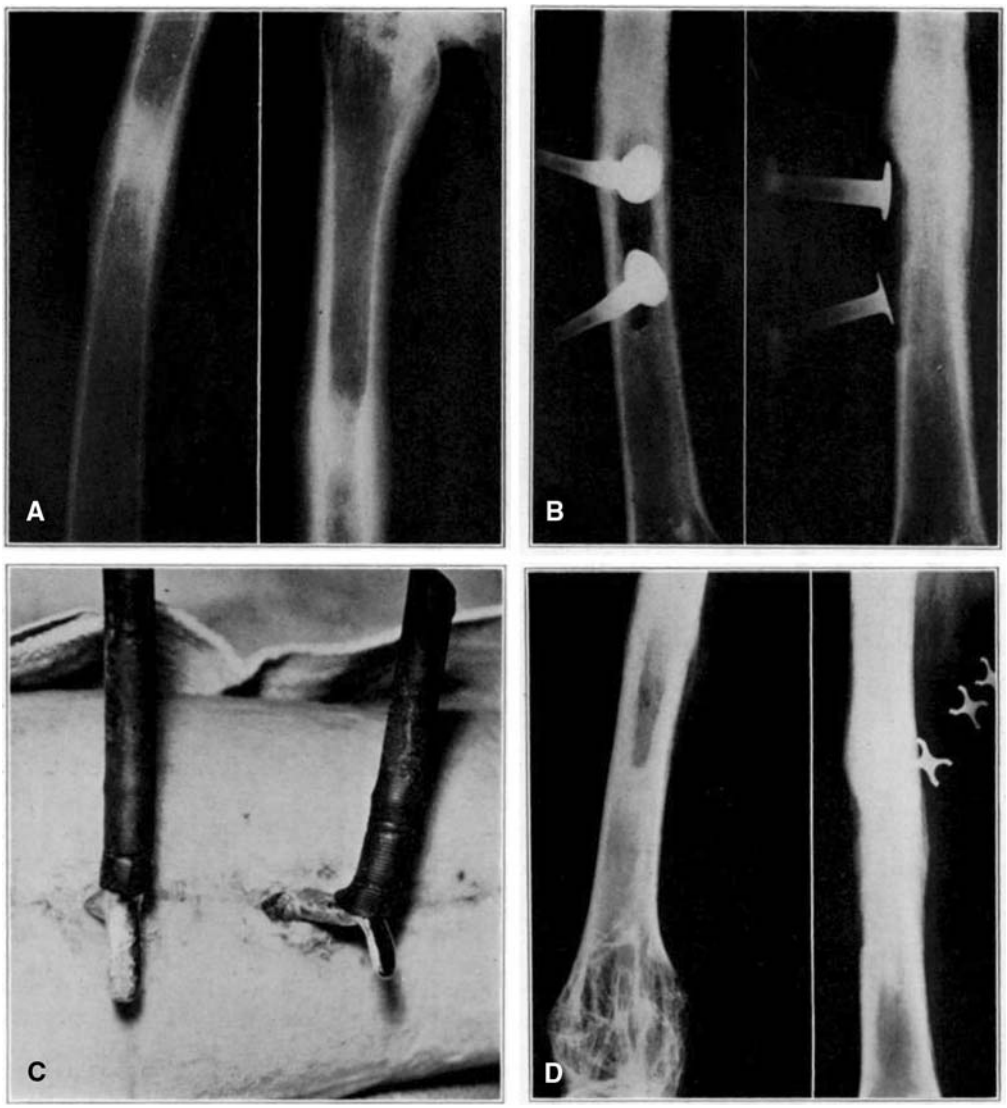

Fig. 11A–D (**A**) Case 4. Osteomyelitis in mid-shaft, right femur. Preoperative roentgenograms. (**B**) Postoperative roentgenograms, showing vitallium cannulae in place. Note how the dressing prevents the cannulae from resting on the floor of the saucerized area. (**C**) Photograph of wound twenty-six days after insertion of the cannulae, just before their removal. (**D**) Roentgenograms, six weeks after the original operation. Satisfactory progress of bone repair. Wound entirely headed.

The drainage and irrigation system is not immune to clogging. A change in fluid and flushing the wound usually eliminate obstructions without much difficulty.

Penicillin

With the great advances that have been made in chemotherapy in recent years, particularly since the advent of penicillin, a wider application of this method of treatment is possible. So far our experience has been limited to osteomyelitis of the extremities and bony pelvis. As further knowledge is gained regarding the effectiveness of penicillin and other chemotherapeutic agents, it becomes less and less hazardous to eliminate, partially or completely, soft-tissue defects in the presence of potential or even active sepsis. Topical application of the chemotherapeutic agents seems an important factor for success, and the cannulae are an efficient means of administering such treatment.