its thickest. To permit the flap thus fashioned to slip into place it was then necessary (1) to make a cut with scissors in the periosteum at the posterior border of the bone flake and to extend this cut to the upper limit of periosteal detachment; (2) to undercut the skin posteriorly (in some cases it is necessary to make lateral cuts to free the skin sufficiently to secure apposition without tension; in others a U-shaped flap is preferable). The anterior, upper, and lower borders of the opening were next levelled with a chisel to allow the flake to sit squarely in place. A further strip of skin was excised along the anterior border of the opening, so that the suture line should lie well away from the opening.

The whole area was cleansed with peroxide, haemostasis attended to, and the packing removed from the cavity, which was filled with bipp paste.

The fixation of the flap was effected by (1) interrupted fishing gut sutures through the skin; (2) a wide mattress suture passed deep to the bone flap (Diagram 5).

DIAGRAM 5.

A rubber-dam drain was inserted at the lower part of the J (in some cases a separate stab-incision is best), a flavine gauze dressing was applied, and the limb splinted.

After-Progress.

Reaction of 100.6° and 100.0° occurred on the second and third days; typical bipp sero-pus drained for two weeks. The upper end of the incision ulcerated where the stitches passed through old scar. Stitches were removed on the tenth day. The ulcerated area was dressed with flavine, brilliant green being useful occasionally as a stimulant.

In one month the bone flap was firmly fixed in place. Complete healing occurred in five weeks.

VARIATIONS.

1. *Sepsis*.—In many cases the cavity reaches the central hospital "ready made." Nevertheless, a preliminary cleansing operation with a subsequent sterilizing course is desirable. It is difficult to give any precise smear figure for the septicity margin that can be dealt with by bipp. In any case it is much lower than the smear figure for the cavity before the plastic operation, as the infected tissue is removed by the curette. In half the cases both streptococci and bacilli have been present in the smears (though never more than two or three per field in a thickish smear); one would not dream of suturing soft parts under such circumstances. The period between the two operations is usually much shorter than that in the case recorded; seven to ten days is usually sufficient. Clinical "cleanness" of appearance in these cases seems as dependable as the smear estimate, as far as ultimate results go.

2. *The Bone Flap*.—Extra vascularity can be secured by utilizing a portion of cortex into which muscle or tendon is inserted. In a case where part of the sartorius insertion was used, the bone flap oozed freely. Splinting counteracts the only disadvantage.

3. *The Size of the Opening*.—The size of the opening, not the size of the cavity, is the most important factor in this procedure. The largest opening so far dealt with has been 2 inches in length; perfectly sound union was obtained. Should one hesitate at using a bone flake longer than this, on the grounds of its nutrition, a periosteal pedicle could be made at both ends, or periosteum alone be used to cover part of the cavity.

4. *Severe Scarring of Skin with Ulceration*.—I have not encountered extensive ulceration of the skin in association with a bone cavity. It is courting disaster to attempt to form a flap out of scar tissue; the shortest plan of treatment would be wide removal of one of the walls of the cavity, but even after this one would have to be prepared for a severe reaction or worse. The flap itself should not contain any but the slightest scar.

RESULTS.

Thirteen cases have been treated in this manner—one in the humerus, one in the ilium, the rest in the tibia.

In two cases in which the cavity was very clean (and no sequestra present) the preliminary operation was dispensed with; no untoward result followed.

In six cases there was a reaction of 100° to 101°; locally, inflammatory oedema has been the utmost complication apart from stitch ulceration in old scars.

Three healed per primam with no serous discharge; the rest had the usual bipp sero-pus for periods varying from one to three weeks; one was reinjected with bipp on two occasions, the bone flap not being a good "fit"; sound healing was attained ultimately. The average time of complete healing was three and a half weeks.

In no case has necrosis of any part of the bone flap occurred. The bony union was sound in every case but one at the end of a month, as far as palpation could ascertain. In the case in which two injections of bipp were needed, union of the flap was delayed till nine weeks after the operation.

SUMMARY.

1. Bipp filling of bone cavities is in every case a successful method of treatment provided always that the preparation is thorough.

2. There are two types of cases: (A) The larger group—where a sufficient thickness of soft tissues is present to cover the opening—here simple filling is adequate. (B) Where no soft tissues can be placed over the opening, which lies flush with the skin; these cases can be treated successfully by covering the opening with a skin-bone flap and filling the cavity with bipp.

3. The advantages are:

(a) Less extensive disturbance of tissues than in any other operative procedure for closure of the cavity—no small consideration in war scars.

(b) Anatomical restoration of the bone is achieved; strengthening and not weakening results; fresh osteogenic surfaces are exposed.

(c) Good cosmetic result.

The objections are:

1. A foreign body is left in the tissues; but it (a) combats infection, (b) stimulates osteogenesis, and (c) is removed naturally when these ends have been attained.

2. *Sepsis* is neutralized by adequate preparation, careful technique, and bipp.

3. A plastic bone operation is not to be approached lightly in the presence of the slightest sepsis. But (a) the bone used is more vascular than normal; (b) the exceedingly vascular bone at muscular insertions can be used; (c) bipp smearing prevents infection.

4. *Difficulty of Raising the Flap*.—Much patience and care are needed in the use of the chisel and saw. War hospitals are not often equipped with electric saws; the two experiences I have had of the use of Albee's motor in bone grafting leave no doubt that the operation could be greatly simplified by this instrument.

My thanks are due to Colonel A. Simpson, Administrator of the Lord Derby War Hospital, for permission to publish this article; and to Major MacNeill, officer in charge, surgical division, for his advice and help in reading the proofs.

CHRONIC BONY FISTULAE.*

BY

R. ATKINSON STONEY, F.R.C.S.I.,

VISITING SURGEON, ROYAL CITY OF DUBLIN HOSPITAL; MÉDECIN MAJOR 2^{ME} CLASSE, ARMÉE FRANÇAISE.

CASES of chronic bony fistulae arising from a compound fracture and discharging months, or even years, after the infliction of the wound, are to be found in every large military hospital. The French authorities have established special hospitals and centres for such cases, and various kinds of special treatment, including thermal baths, radiant heat, and injections of various kinds, have been tried. But, in spite of these methods and the issue of special rules and instructions, a considerable number of such cases came under my care during the summer and autumn of 1918. During earlier periods of work in France I had treated such cases by the removal, as thoroughly as possible, of the focus of infection and of all dead or foreign material, and then disinfection of the wound by applying pure carbolic acid and tincture of iodine, plugging the whole for forty-eight hours with iodoform gauze, and then allowing the wound to granulate up.

As a rule, the cases so treated did fairly well, and probably 70 per cent., or more, were cured. The cure, however, was lengthy, and in a certain proportion of cases

* Read before the Surgical Section of the Royal Academy of Medicine in Ireland, February 28th, 1919.

the plan failed even after two or more operations. I think I have overcome this difficulty by the use of modified bipp. The chronicity of these cases is due to the fact that the infection is firmly implanted in the tissue of the bone, and that frequently a sequestrum or foreign body is present. If on x-ray examination either of these complications is present, no cure can be expected from any method of treatment, which does not include their removal. The operation must be planned after the results of x-ray examination are known. If possible the fistulous track should be excised right down to the bone, and the more of the fibrous scar tissue removed the better. When the bone is reached, the periosteum should be raised for some distance all round the opening. The whole infected areas of the bone should be thoroughly explored and laid open, all sequestra and foreign bodies should be taken away, all overhanging walls removed by forceps or chisel, until the walls of the cavity in the bone slope gradually to the deepest point. If possible the bony walls should be gouged away till healthy bone is reached; as is shown by free oozing from the cut surface. Frequently it is not possible to carry out this step of the operation completely. The whole wound is now dried and swabbed with ether or methylated spirit and packed for a couple of minutes with gauze wrung out of one or other of these liquids. Modified bipp (iodoform 2, bismuth 1, and vaseline 12) is then rubbed into the walls of the bony cavity, which finally is filled with it. If the cavity is small and regular, and it has been possible to remove its original walls fairly completely, and if there is a good depth of healthy tissue between it and the skin, the wound may be closed in layers, using one or two layers or even more of catgut for the periosteum and muscles, a separate layer of catgut for the deep fascia, and silk impregnated with bipp for the skin and superficial fascia with a few sutures of fine silkworm gut to obtain good coaptation of the skin edges. Gauze smeared with bipp is placed over the wound, and a thick layer of wool and a firm bandage is applied. If all goes well, the dressing need not be changed till the stitches are removed about the tenth day, when the wound will be found firmly healed.

If, however, for any reason it is not thought safe to close the wound it is plugged tightly with a long strip of iodoform gauze impregnated with bipp. The wound is first dressed at the end of forty-eight hours, when on removal of the gauze a perfectly dry clean cavity should be left. It is filled with bipp. A superficial dressing is applied and changed every fourth or fifth day, fresh bipp being put into the cavity as fast as it disappears. It is a matter of surprise how quickly a large cavity will fill up and heal under this treatment; in no circumstances should curiosity ever tempt one to put a probe into one of these cavities during the course of healing, or interfere with it in any way. Indeed, I look upon a probe as one of the most dangerous of surgical instruments and a fruitful source of chronicity and delay in healing. The healing of these cases can often be hastened by inserting loose sutures at the operation and tying them at the first or a subsequent dressing. In some few cases it may be advisable, if the cavity left is very large, to undertake a special operation for suture at the end of about a week, when it is seen that the wound is dry and that there is no further tendency to suppuration. The reason for plugging tightly for forty-eight hours is to check the haemorrhage and get a perfectly dry wound; the bipp with which it is then filled is as nearly as possible innocuous to new formed granulation tissue, and is pushed out as the latter fills up the cavity, till finally epithelialization can take place.

One great advantage of this treatment is that the gauze impregnated with bipp can be removed without causing fresh haemorrhage, as it does not stick to the walls of the cavity; its removal is practically painless. There is probably no special virtue in using iodoform gauze, beyond the fact that it is easily obtained in suitable widths without ravelled edges. I have never seen any signs of iodoform poisoning even after the use of two or more yards of iodoform gauze used with 3 or 4 oz. of bipp; the excess of bipp is gradually squeezed out as the gauze is packed thoroughly home into the cavity.

During last summer and autumn I had under my immediate care 25 cases of chronic bony fistulae, which had lasted for periods ranging from two months to over four years. The average duration of all these cases from

the time they were wounded until operated on by me was a few days over sixteen months; many of them had passed through six or more hospitals, and more than one had already been operated on seven or more times. Practically all the larger bones of both upper and lower extremities, and also the ribs, sternum, pubis, and crest of the ilium, were so treated. In 22 cases, or 88 per cent., the wounds were completely cicatrized when the patient left the hospital. One required a small secondary operation, done under cocaine anaesthesia, before he could be evacuated cured. All the others were submitted only to one operation; in 12 cases the operation was concluded by plugging, in 9 by complete suture, and in one the wound was partially sutured and partially plugged. In these 22 cases the average length of time between the date of the wound and the curative operation was exactly sixteen months, whereas the average stay in hospital after operation was only one month and two days. Eight cases were discharged healed in a fortnight, though three of them had had previous treatment for over forty months. One of these, it must be noted, had been a prisoner in Germany for over three years. Only three patients remained in hospital for two months or longer; the longest period was ten weeks, and this patient had been previously treated for seventeen months. In one of the three cases unhealed when I left France there was an extensive wound of the sternum and ribs which had been under treatment for five and a half months before operation; three weeks later it was nearly healed. In a second case, of injury to the ribs complicated by empyema, the wound had been received twenty-five months previously. I operated on him twice; at the first operation some necrosed pieces of ribs were removed, but the presence of pus in the pleural cavity was not discovered; the second operation was performed less than a month before I left France, and at the time of my departure the patient was doing very well and the discharge was greatly reduced, so that a cure might be looked for. The third case gave more trouble.

A soldier was admitted two months after being wounded in the back of the right chest. There was a sinus just below the right sterno-clavicular articulation. He stated that the shell fragment had lodged, and that when admitted to the field ambulance there was a swelling where he now had the fistula. An incision made in the hope of finding a projectile refused to heal, and resulted in the sinus seen on his admission. Though he had a scar below the right scapula, repeated x-ray examination failed to detect the presence of a foreign body in the thorax, abdomen, or neck. At the operation it was found that the fistula led to the joint between the first right costal cartilage and sternum. The cartilage and border of the sternum were removed, the wound was sutured but failed to heal; six weeks later the wound was again excised and plugged, the same thing was done three months later, and finally a fourth operation was performed exactly six months after the first, and the wound was closed by suture. Even this was not a complete success, but three weeks later there was only a little clear serum coming away, and it looked as if the wound would soon be healed. It is hard to decide from the history what was the cause of this fistula; the operation performed at the ambulance was apparently only trivial, as only cocaine was used, and it is hard to imagine that the bones and joint could have been injured or infected, and it was certainly not done by the projectile. It is perhaps possible that there was an unrecognized tuberculous process going on at this point, the swelling caused by which was first recognized when examining the patient for an exit wound. This theory would explain the marked failure to respond to operative treatment.

Of the three cases, or 12 per cent., in which a cure is not claimed the average period of previous treatment was eleven months, whereas the average time of observation afterwards was three and a quarter months. Two cases, the first and the third, were, at the time of my departure, rapidly progressing towards recovery, and have probably before this become cured, one, it must be confessed, only after his fourth operation. The other case was complicated by an empyema, and though his condition, both local and general, was greatly improved, yet his complete recovery could not be vouched for with any certainty. In illustration, I shall give the following brief details of a few typical cases.

CASE I.

A young soldier, admitted July 2nd, 1918, wounded by a shell splinter in the left leg on July 7th, 1917. An old fracture of both bones of the leg at the junction of the lower and middle thirds had caused considerable shortening and much scar tissue. There was a discharging sinus over the inner aspect of the tibia and two over the fibula. He had undergone several operations. On July 3rd the sinus over the tibia was excised and a large area of bone exposed, the opening in the bone was

freely enlarged and a sequestrum removed. The sinuses over the fibula were curetted, but no sequestra were found; the surrounding skin was extensively undermined and thick silk sutures were put in so as to close the wound except in the centre. Bipp was applied to the bone cavity, which was packed with bipp iodoform gauze. This was removed after forty-eight hours, and a cavity the size of a large walnut was filled with bipp. The dressings were changed every fourth or fifth day. The cavity gradually filled up and when he left hospital on September 10th, nine weeks after the operation, the wound was completely healed.

CASE II.

A soldier admitted on July 9th, 1918, had been wounded by a shell in the left arm on April 30th, 1918. The left humerus was fractured in the upper third. On September 13th, four and a half months after being wounded, he presented fistulae of the upper third of the arm; the x ray showed that the fracture was consolidated, and that a sequestrum was present. At the operation the two fistulae were enlarged and the bone exposed, the bridge of bone between the fistulae was taken away with the gouge, and several large sequestra were removed from the interior of the bone. Another sinus on the back of the arm was also enlarged and a large sequestrum removed from the surface of the humerus. The interior of the bone was cleaned and doused with Dakin's solution, and after application of bipp was packed with bipp iodoform gauze. He was evacuated cured on November 5th, 1918, seven weeks after operation.

CASE III.

A soldier was admitted on September 23rd, 1918. He had been wounded in the upper part of the left arm by a bullet on February 23rd, 1915, forty-three months previously. He had been operated on several times, but still had a sinus connected with the upper third of the humerus. On September 30th, 1918, the fistula and cicatrix were completely excised, the bone was bare and rough on the surface, and this area was removed by the chisel. The whole wound was treated with bipp. The muscles and deep fascia were united by two layers of catgut, and the skin closed with silk and silkworm gut. He was dressed on the sixth day and the stitches were removed on the eighth day, and he left hospital completely healed on October 14th, a fortnight after the operation.

CASE IV.

A soldier wounded in the left forearm by a shell splinter on May 27th, 1917, when seen on October 17th, 1918, sixteen and three-quarter months later, had two sinuses still discharging over the back of the left ulna. At the operation the middle third of the ulna was freely exposed, the two sinuses were thrown into one, and both central and superficial sequestra were removed, the cavity in the bone was cleaned with bipp and packed with bipp iodoform gauze. The wound was almost completely closed by deep silk sutures. The plug was removed at the end of forty-eight hours and the wound encouraged to close. It was soundly healed three weeks later.

CASE V.

A soldier wounded in the left leg on April 17th, 1917, when seen on October 25th, 1918, eighteen months later, had a sinus over the upper end of the inner surface of the left tibia. The x ray showed that the bone had been fractured, and though there was great irregularity at the seat of fracture, no sequestrum could be seen. On operation, bone at the bottom of the sinus was found bare and irregular; this was chiselled away, and the wound cleaned with bipp; the tissues were sutured in layers with catgut, and the skin closed with silk. The stitches had been removed, and the wound was soundly healed at the end of a fortnight.

Only 88 per cent. of cures are claimed, though it might be suggested that the real percentage of cures was more accurately 96 per cent. However, even the lower figure is quite high enough to give encouragement to those who have felt inclined to despair over the chronicity of these bony fistulae. When I speak of cure in these cases I cannot guarantee a permanent cure in every case, as I have not been able to follow the after-history for a sufficiently long time. All have seen cases in which, usually as the result of some trivial injury or excessive strain, infection has restarted in wounds that had remained healed for months. But I would hope that the large amount of bipp left in these wounds would tend permanently to inhibit the action of any organisms that remained in the tissues, or would even cause their final destruction. In this list I have not included several successful operations for recurrent abscesses developing in wounded limbs at various periods after cicatrization, because, although in most cases they were originally complicated by fracture and osteitis, at the operation no diseased bone was found.

There is a large field for this method of treatment in civil practice in cases of chronic middle-ear disease and complicating mastoiditis. We treated three cases of the latter complication, with surprisingly rapid results, the wounds in each case healing and the discharge from the ear ceasing in between three and four weeks. I suggest

that a trial should be made of laying these cases freely open, plugging them with bipp iodoform gauze for forty-eight hours and then filling the wounds with bipp and allowing them to heal up.

I heard the statement frequently made that these cases of chronic bony fistulae suffered from excessive zeal on the part of the surgeon; so far from this being the case, I think they suffer more frequently from a lack of zeal. The surgeon is disheartened and is satisfied with what one might describe as a "scrapeotomy," instead of undertaking a proper surgical procedure based on modern surgical principles. It is much better to perform one complete operation, even though extensive, which has a fair chance of success, than to perform a limited operation and find oneself forced by its failure to operate again and perhaps yet again.

A METHOD OF SECURING RAPID HEALING OF BONE SINUSES.

BY

A. K. HENRY, M.B., F.R.C.S.I.,

LATE MÉDECIN AIDE-MAJOR DE 1^{ère} CLASS AND SURGEON TO
5TH SECTOR, XVIIth REGION,

AND

DOROTHY K. MILNE HENRY, M.D.,

MÉDECIN TRAITANT, HÔPITAL 115^{bis}, XVIIth REGION, FRANCE.

Fistule osseuse in the late war was the despair of French military surgeons. Their attitude towards the condition had come to be one almost of surgical impatience; and as late as the winter of 1917 this attitude received official countenance in a ministerial circular which suggested that the "fistulized" should be sent to fashionable spas—in the vague hope, it seemed, that an angel might trouble the waters!

A considerable and tedious experience of this condition had led us to regard the official view with a measure at least of understanding. We had, indeed, several immediate successes after operation, but these were occasional, and the prospect of obtaining cicatrization within a few weeks after a single surgical intervention was slight and uncertain.

Our immediate successes had been secured chiefly by instillations every two hours of Daufresne's standardized solution of hypochlorite, after the method of Carrel—notably in a difficult case of a sinus of one and a half years' standing opening in the middle line of the popliteal space. It led into a cavity in the lower end of the femur, from which we removed a sequestrum 3 in. long and $\frac{1}{4}$ in. broad. The wound was completely cicatrized six weeks after operation. In a similar interval of six weeks after sequestrectomy we obtained the healing of a double sinus of the lower end of the tibia.

Another post-operative treatment which occasionally encouraged us was the daily injection of iodoform and bismuth subnitrate suspended in liquid paraffin, used alone or alternately with Carrel instillations. By this method a case of tarsal sinus, which had persisted two and a half years and had been operated on eight times, healed within four weeks.

But these were bright particular instances, and although out of 17 cases we only thrice failed to secure ultimate cicatrization, yet prior to our acquaintance with Mr. Stoney's method success was too often made tedious by repeated operation and protracted treatment, and it was not until our adoption of his technique that we began to approach these cases with a new zest and a confidence which we were able to justify.

Among 15 consecutive cases we had two failures—that is to say, cases which did not cicatrize after a single operation. (One of these cases cicatrized six weeks after a second intervention.) Of the 13 successful cases, 6 were healed in or within four weeks, 4 in or within six weeks, and of the remaining 3 cases one was discharged in seven weeks and the other two were delayed in hospital simply by a trophic eczematous condition of the skin resulting from injury to nerves. Of these 15 cases 11 were treated by suture. In the remaining 4, in which this was not possible owing to inclusion of the sinus in an extensive cicatrix, treatment was by plugging, as described by Mr. Stoney.

The cases which were discharged cicatrized from our