

## UNUNITED FRACTURES TREATED BY LONG-AXIAL DRILLING OF THE FRACTURED BONE-ENDS.

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IN a paper upon the subject of ununited fractures, read before the Plymouth Medical Society in the early part of this year, I described a method of operation which I believe to be original.

Briefly, the operation consists in thoroughly exposing and cleaning the ends of the fragments at the seat of fracture, refreshing them by removing the thinnest possible transverse section of bone that will ensure a complete removal of all dense fibrous tissue, and *drilling in the long axis of the shaft several channels in the indurated bone-ends*; the effect of this manoeuvre is the production of an artificial porosity of the osseous tissue. The drill is made to penetrate to healthy bone; at the same time the medullary cavity, which may be found occluded, is made patent by longitudinal perforations. Apposition and immobility of the fragments are secured by plates or other mechanical means.

This method, which has been employed in many cases of long-standing non-union, has not yet failed to produce an abundant callus. Gratifying results have been obtained where a previous and unsuccessful operation had so shortened the limb that any further removal of the indurated bone must have left functional disability.

A case such as the following first suggested the method of long-axial drilling: The bones, denuded of periosteum, were indurated almost to the degree of eburnation. There was already present nearly two inches of shortening. To reach healthy bone by refreshing would require the sacrifice of an impossible amount. Long-axial drilling was therefore ventured on, in the hope that bone-repairing material, whatever it may be, might be induced to travel by the way of these channels to the line of fracture. The experiment was attended by complete success; callus was abundant.

Whatever may be the true explanation of these striking results, it would appear that by long-axial drilling I inadvertently imitated, in a rough manner, the condition of canalization and porosity which attends natural repair. This condition is well shown in the accompanying drawings, hitherto unpublished, which illustrate some investigations in bone-union by Mr. Lenthal Cheatle, to whom I am greatly indebted, not only for permission to use these figures, but also for the suggestion of the analogy between the porosity artificially produced by my operation and that due to nature's method.

I regret that owing to the exigencies of the moment it is impossible to look up the register of all my cases, and I must therefore be content to give a general statement of clinical details and results.

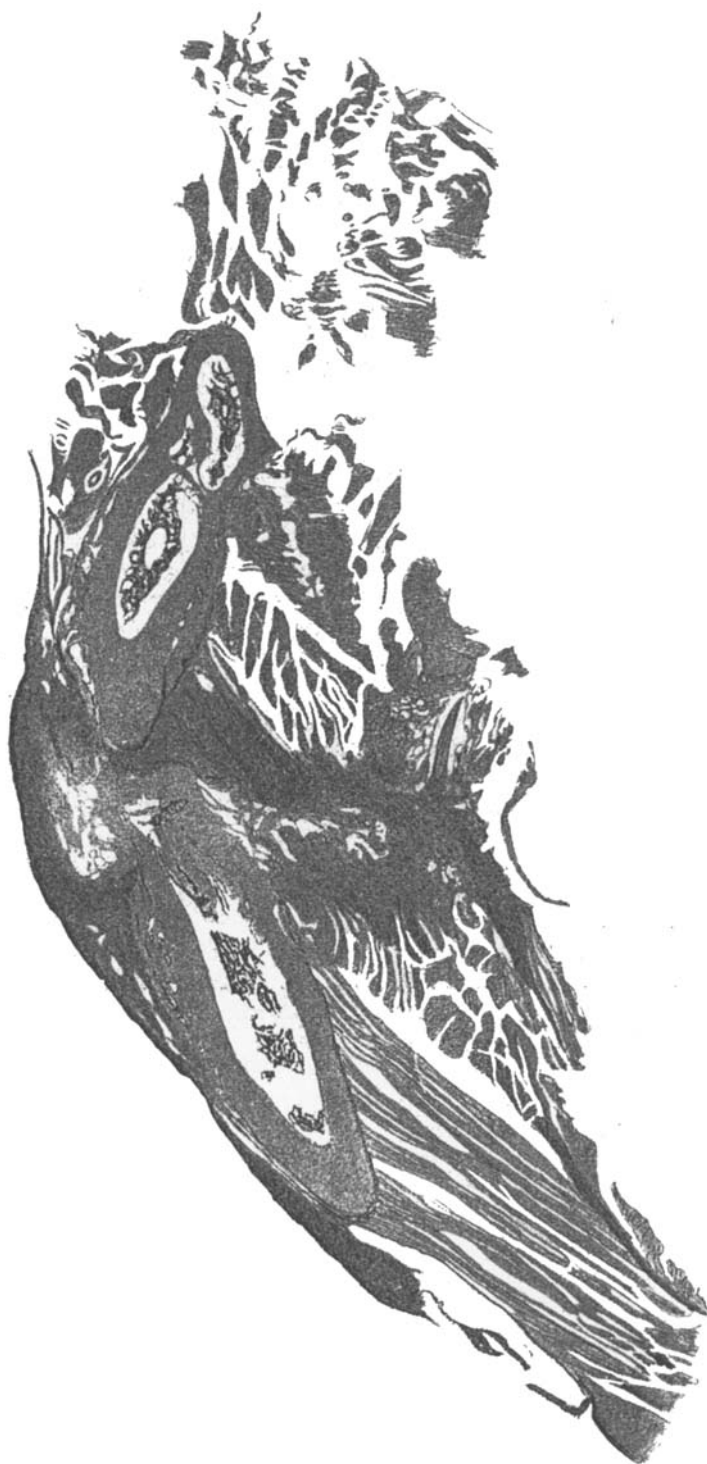


FIG. 227.—LONGITUDINAL SECTION OF GUINEA-PIG'S RIB ONE WEEK AFTER FRACTURE.  
The fibrous tissue of the periosteum has become very thickened. There is a hemorrhage at the ends of the bones, and an increase of fibrous tissue between the bony extremities. (*Cheate.*)



FIG. 228.—LONGITUDINAL SECTION OF A GUINEA-PIG'S RIB FOURTEEN DAYS AFTER FRACTURE.

New bone has formed beneath the periosteum away from the actual fracture. Cartilage has made its appearance around the fractured ends and slightly between them. Porosity of the bones at their extremities has increased, and under high power osteoclasts are numerous. Hæmorrhage has disappeared. (*Osse.*)



FIG. 229.—LONGITUDINAL SECTION OF GUINEA-PIG'S RIB THIRTY-THREE DAYS AFTER FRACTURE. Porosity of the bone has become so marked that the compact tissue is merely a shell. Ossifying cartilage can be observed between the porous fractured extremities. (*Chealé.*)

All the cases in which I have used the method have been men with old fractures of the tibia. These fractures have been ununited for varying periods, with more or less induration and eburnation of the bones. In all there has been a long history of repeated attempts to induce callus formation.

**Technique.**—In the preliminary and operative details I have followed Lane's technique. The skin is prepared by iodine before, and on the day of, operation; long instruments are used, and the wound is not touched by the hand.

The ends of the bone having been exposed, they are brought out into the wound, and their terminal surfaces are refreshed by the removal of a very thin slice of the superficial tissue. The plugs of callus or fibrous tissue which block up the marrow cavities are removed from each end by a gouge or drill. The circle of indurated bone is then drilled in four or five places in a direction parallel to the long axis of the bone, using drills Nos. 1 to 3, driven either by hand or by an electric motor. Each drill-hole ought to penetrate through the indurated area of scar-bone until normal bone is reached. This is indicated partly by the lessened resistance to the drilling, and partly by hæmorrhage occurring freely from the holes when the drill is removed; this hæmorrhage, in fact, is the best evidence that the drill-hole has done what it was meant to—that is, opened up a vascular area of bone, and put this into communication with the seat of fracture. Usually a penetration of one to two inches is needed to fulfil these conditions, but sometimes a still deeper drilling is necessary. The deeper the holes, the greater in number and the larger in diameter they ought to be.

Both fragments having been treated in this manner, and replaced in as good position as possible, they are rigidly fixed by plates and screws. The wound is closed by Michel's clips. No drainage is used.

**Results.**—In every case rapid union has occurred. Perhaps the only fault has been the formation of rather an excess of callus; but this has always produced a strong leg fit for arduous service duties, the cosmetic result being a matter of no great moment in a seaman.

#### ILLUSTRATIVE CASES.

*Case 1.*—A. B., a seaman, age 30, whilst serving on the East India Station in the summer of 1910, received a fracture of both bones of the left leg, having been struck by a parting cable. He was treated ashore in the local hospital, and invalided home in January, 1911, with ligamentous mal-union. The lower third of the leg, with the foot, was angulated backwards at about 120°, and the limb was therefore quite useless.

**FIRST OPERATION.**—Six months after the accident. Bones exposed, no callus found, fibrous union only; the bone-ends were pointed, and embedded in dense fibrous tissue. Three-quarters of an inch of dense bone removed from each fragment of tibia. Fibula not exposed. The refreshed surfaces were fairly dense, and the medullary cavity greatly narrowed: but there appeared every prospect of a good result. No attention was paid to the periosteum. (Even at that period, four years ago, and before the appearance of Macewen's work, I had come to regard the periosteum as of very secondary importance in osteogenesis.) The fragments were fixed with a 4-hole Lane's plate. Wound healed by first intention.

There was no sign of union three months later, mobility then being obvious. Bier's hyperæmia, with active movements and other callus-stimulating methods, were adopted without any success.

SECOND OPERATION.—The seat of fracture was exposed, and the loose plate removed. No trace of intermediate callus was found. The medullary cavity was closed, and both bone-ends were densely eburnated. It seemed useless to remove more bone, and therefore the operation described in this paper was carried out.

The train of thought which occurred to me at the time was somewhat as follows. Removal of further bone would so far shorten the limb as to render it useless. The periosteum, which had been preserved, had done nothing to make callus. If the periosteum does not produce the callus, then the new bone can only come from living old bone. Can osteoblasts travel? Certainly not unless a free channel is provided for them. Therefore I must provide a fair-way along which they may reach the site of fracture. If I cannot oppose healthy bone to healthy bone, I can at least provide a line of communication.

The result was astonishing. The ends were secured by a plate, supplemented by a wire. (The wire was necessary in this case to secure immobility, but I never use wire if I can help it.) Superabundant callus was formed, with firm rapid union, so that with a raised boot-heel the man could walk without a limp. He was given a rating as a ship's corporal, and returned to full active duty one year after the original accident, and three months after the final operation.

Case 2.—A gunnery lieutenant suffered a compound fracture of both bones of the leg at the lower third, resulting from a cable accident. The  $\perp$  shape of the line of fracture tempted me to use a wire encirclement, but with no success. The wound did not close at one end, but there was no apparent sepsis at the time. After the end of three months there was weak fibrous union only;  $x$  rays showed no callus. The officer's promotion depended upon his early return to duty.

OPERATION.—Very slight amount of fibrous tissue. The general appearance gave one the impression that union might eventually have taken place after many months. Long-axial drilling, as in the other case. Fragments plated. Union by first intention, with abundant callus formation. The patient was able to return to duty in time to obtain his promotion to commander.