

**THE OPERATIVE TREATMENT OF CLOSED FRACTURES OF
THE LONG BONES BY METAL BANDS,
WITH A DESCRIPTION OF A NEW INSTRUMENT.**

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INTRODUCTION.

DURING recent years much thought has been given to the operative treatment of fractures. At first discussions centred round the mechanical aspect of such treatment, some preferring the osteosynthesis obtained by extraperiosteal means (Parham-Martin bands, wires, etc.); others the union maintained by screws, nails, hooks, etc., penetrating the bone itself. Very soon the problem became complicated by the perfection of sterilized bone-grafts, Albee in America and Nageotte in France leading the way, this work being stimulated by the researches of Leriche and Policard,²² which seemed to discredit fixation by metal plates, whether fixed by screws or bands (as giving rise to the formation of necrosis and superficial sequestra). Later still, operative treatment was shown to be a factor in delaying consolidation, the traumatism of the intervention itself being the cause. In the present article we present the results of research into the immediate and remote effects obtained by the use of Parham's bands, applied alone in cases of oblique fractures, but associated with plates of metal or bone in transverse fractures.

We desire to express our indebtedness to M. Pierre Duval, Professor at the Faculty of Medicine of Paris, for facilities of research and clinical work, and also for access to the records of his clinic which he most kindly put at our disposition.

We first directed our attention to the advantages of, and indications for, the use of Parham's bands, and in this connection especially to the action of metal plates on new bone formation. The general indications for the use of Parham's bands in fractures of the long bones have recently been set forth at length by various authors, and may be generally accepted. The technique has been well described recently by Digeon,¹⁸ especially as regards muscular interposition, methods of reduction, and the protection of nerves in relation to the fracture. We wish especially to claim for Parham's bands several very definite advantages, once the general principles of osteosynthesis by open operation are realized.

1. *The Ease of Application and the Simplification of Material used.*—The introduction of Parham's bands is extremely simple; the area of application having been chosen, one merely has to pass the hollow curved director described later. The armamentarium of electrically-driven saws, screw-drivers, drills, etc., finds no place here. But above all, as the reduction takes place little by little under direct visual control, one is able to obtain a perfect linear coaptation, and at this moment, and not till then, maintain this union by tightening the band. On the other hand, when using plates and screws, it will be admitted that the slightest error in drilling the holes leads to an imperfect coaptation, and to redrill the holes seriously compromises the solidarity of the fragments. Therefore, in cases of *simple oblique* fracture we believe that the metal band is superior to the plate.

The coaptation with plate and screw may be perfect; with bands it always is. Two points must be noted: from the experience of our cases we believe it is a mistake to employ a single band; two at least must be used, each placed close to the extremity of a fragment (*Fig. 240*). This is an application of the law of levers; placed at the centre of the fracture (*Fig. 241*) the strength is greatly diminished. Nevertheless, one must be careful to leave at least 2 mm. between the band and the extremity of the fragment; otherwise the latter may disengage itself from the band, as in two of our cases.

In *comminuted* fractures bands are excellent: the band acts as a ferrule, drawing the fragments together, preserving smaller splinters, and forming a veritable 'conglomeration' of bone. Screws and hooks are useless in such cases; an alternative is the employment of several or branched plates, but these are objectionable by their multiplicity, and often split the smaller fragments, already numerous enough, and thus prejudice their vitality.

Lastly, Parham's bands are equally indicated in *transverse* fractures, if associated with metal or bone plates. We discuss later the merits of these plates.

2. *Superiority of Parham's Bands to Other Methods of Circular Ligature.*—These bands are flat, and do not cut or damage the periosteum, as is the case where wire is used; the compression is gradual and controlled at will. Wire certainly damages the periosteum severely, and we have seen cases where the bone itself has suffered from the force necessary to retain the fragments. Furthermore, in twisting the ends of the wires, one frequently breaks them, or the twisted ends break off flush in hammering them snugly to the bone. The twisted end may irritate the tissues and cause a fistula in the absence of sepsis. Cunéo has introduced a 'safety knot': this does not break or twist off, but

the end may cause irritation. In any case the reduction and its maintenance by wire is more or less guess-work, as compared with the easy compression and traction given by Parham's bands.

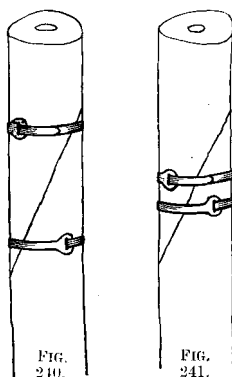


FIG. 240.—Bands placed correctly near extremities of fragments.

FIG. 241.—Bands placed incorrectly near middle of fracture.

3. *Early Passive Movement.*—Early passive movement is the rule in all fracture treatment. Do Parham's bands give any advantage in this respect? Martin, of Philadelphia,⁶ quotes the case of a patient, operated upon for fracture of the tibia by two Parham's bands, who became delirious on the night of the operation, left his bed, and walked: no displacement of the fracture occurred. Now there is no doubt that the mere traumatism of an operation does slightly delay union, especially early callus formation; therefore it must be always kept in mind that the maintenance of apposition is solely secured by whatever mechanical means have been employed, and this for rather longer than in non-operated fractures. Later the consolidation and union is stronger than in fractures treated by external splints. Now the question of mobilization, we believe, turns upon the length of the lever in question and the force that can be exerted on this lever. Thus:—

a. In fractures of the *forearm* we allow gentle mobilization at once (second day), the arm in the meantime resting in a plaster 'gutter splint'.

b. Fractures of the *tibia and the fibula* we mobilize on the fifteenth day, and allow walking with crutches on the twenty-fifth.

c. Fractures of the *humerus* must be treated with caution, for the humeral lever supports the weight of the arm and the leverage is powerful. Here mobilization is allowed on the tenth day and active movements on the twentieth, the arm in the meantime being merely slung and bandaged lightly to the thorax.

d. Fractures of the *femur* require much care and judgement. Digeon¹⁸ mobilizes these cases as early as the thirtieth day: we cannot agree with him. Nearly all our accidents have occurred in these cases—bending of the callus, delayed union, etc.—and our practice is to keep these cases immobilized for at least fifty days.

How should these fractures be immobilized? In order to avoid large plasters we began by using continuous extension—bending and angulation occurred. We then tried the large plaster generally used for tuberculous diseases of the hip—exactly the same results took place while moulding the plaster after operation. We believe that the following method gives the best results: A bivalve plaster-cast is prepared beforehand and applied to the limb, which is maintained in continuous extension. The operation is performed with the thigh resting in the posterior valve; when completed the anterior valve is placed in position and the whole cast held together by bandaging.

4. *What are the Effects of Parham's Bands on New Bone Formation?*—We will now give a brief résumé of the disadvantages of metallic osteosynthesis; later we present the results of a study of cases upon which re-operation was necessary for various reasons, and of the study of a series of radiographs taken at various intervals from the time of operation to several months later.

Leriche and Policard²¹ made recently a careful study of 15 cases of osteosynthesis by means of Lambotte's plates; but the fact must be noted that in all these cases the plate was placed *beneath the periosteum*. According to these authors, microscopic examination shows a certain amount of fibrous tissue external to the plate. Around the plate there is sometimes a sheath of new bone, while beneath it the bone immediately subjacent is dry, white, and avascular. If the plate was removed early (20 to 90 days) they found an extremely thin lamelliform sequestrum. Further investigation showed an ischæmic necrosis, and, deeper, the bone in the process of rarefaction. The central callus was slow to appear, and poor at that, and the tissues were impregnated with iron salts. Millet²² repeated the researches of these investigators and confirmed their findings; he attributes this superficial necrosis to ischæmia, produced by compression and the destructive action of the body fluids attacking the metal. This writer states further that the plate is rarely covered by new bone. Albee¹¹ says that metal plates have no place in osteosynthesis. In the presence of these changes one easily understands that consolidation is delayed if metal plates are used.

Hallopeau,¹⁹ Dujarier,²⁰ Frédet et Ronvillos¹⁶ vigorously attacked these observations, from the clinical point of view, bringing forward their statistics and results. Hallopeau quotes an interesting case of a double symmetrical fracture in the same patient: one fracture was treated by Parham's bands, the other by external splints. Clinically the former consolidated very much more rapidly.

Cunéo and Rolland²³ examined the action of metal in the tissues, and the tolerance of the latter to the former. They found that the organic iron salts formed had no deleterious action on the tissues, bony or otherwise.

With this preliminary, we now proceed to give our own results, as shown by clinical investigation, radiographs, and the microscope, in cases where we have used (1) *Parham's bands alone*, or (2) *Parham's bands associated with plates*.

1. **The Employment of Parham's Bands Alone.**—An examination of radiographs taken in series shows, as early as the fifteenth day, irregular shadows, more or less opaque, completely surrounding the operative area and band. These shadows become increasingly distinct, till, by the twenty-fifth day, they extend longitudinally along the bone, the appearance being that of a spindle or tapering sheath.

In certain cases—especially in the tibia, clavicle, and bones of the forearm—the shadow remains more localized and does not extend along the bone. In other cases—the humerus, and especially the femur—the callus is excessive; but if radiographs, taken at the expiration of several months, are examined, one nearly always sees a distinct thinning of this callus, while in many cases it is reduced to a minimum.

Further, these radiographs show that the callus surrounds and covers the band, contrary to the assertions of the opponents of metallic plating; but we would call special attention to the small clear area, well seen in *Fig. 262*, between the callus and the band. This demonstrates that, in immediate contact with the band, early ossification is delayed; but radiographs show that later this clear space disappears. On the other hand, Frédet has seen this space persisting at eight months.

Radiographs taken in profile and anteroposteriorly after the callus has thinned out and 'settled down' reveal at once an irregularity in its development: it is always far better developed and more abundant on the side of the bone opposed to the track of operative approach. Hallopeau¹⁹ has confirmed this, and believes that the mere exposure of a fracture by operation delays union.

In two of our cases (femurs) we were obliged to re-operate for pain. In both these cases essentially the same conditions were discovered, a bony mass completely hiding

the bands. After chiselling away this callus, the bands were found completely embedded and firmly fixed. The bands, which were of soft steel, were covered with a black, slightly-adherent layer, but no trace of rust was found, and no sequestrum. The tissue was extremely vascular, and the steady oozing could only be controlled by irrigation with hot saline solution. The new bone was more developed on the side of the fracture opposed to the wound, and was moderate in amount.

All authors have insisted that callus is more abundant in fractures treated by metallic osteosynthesis than by simple reduction. From this point of view it seems to us that Parham's bands give better results than other metallic appliances; but here we must again emphasize the fact that when using plates (Lane's or Lambotte's) and other methods of fixation (nails, screws, or hooks) the periosteum is always incised and the metal placed beneath it.

We believe that the interference with the periosteum, however carefully carried out, explains this trouble with callus formation. Now Parham's bands are always placed extraperiosteally. To the objection that the sensitive and vascular periosteum is traumatized and strangled, we reply that it is of little importance. We have only twice seen cases of persistent pain necessitating the removal of the bands, and as for strangling the periosteum it can matter little, for the blood-supply of this membrane is not longitudinal and continuous, but of the type of intestinal vascularization, by means of abundant and fine anastomoses. Furthermore, the bands in no way interfere with the periosteum at the line of fracture: it is here intact; while finally, all research, from Macewen to Gallie and Robertson,²⁴ shows that the periosteum is a vascularizing membrane primarily, and takes no part in actual bone formation apart from this property, important though it be.

Summing up: our study of cases treated by Parham's bands alone shows:—

- a. A delay in consolidation hardly appreciable even if it exists.
- b. Complete absence of necrosis at the point of contact of the bands.
- c. A callus formation which is regular, reduced to a minimum, and completely surrounding the bands.
- d. An absence of pain, and perfect toleration of the bands by the tissues.
- e. Absence of rust or toxic action by organic iron salts.

2. The Employment of Parham's Bands associated with Bone or Metal Plates in Transverse Fractures.—Parham's bands find an application in transverse fractures if associated with metal or bone splints. At the beginning we used the metal plates to hand, namely, those of Lane or Lambotte; later, to obviate the bands slipping from the plate, we used Sherman's plates provided with grooves to receive the bands. Later still, bone-grafts (living and dead) having come to the fore, we used Parham's bands to fix various forms of bony splints. We wish first to submit certain points which we

have found essential in the general technique of osteosynthesis, and then to describe the methods and material which have given us the best results.

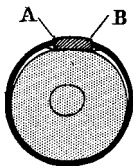


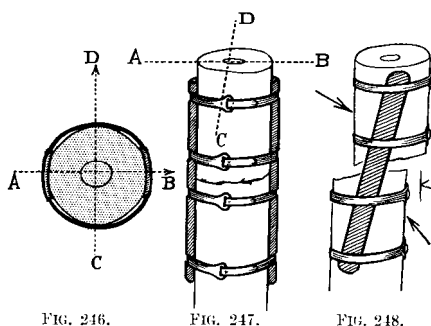
FIG. 242.—Diagram showing points (A, B) at the edge of the plate where the band is liable to snap.

a. METAL PLATES AND PARHAM'S BANDS.—We have no hesitation in saying that Sherman's plates are far superior to all others in this combination. Extremely strong, they nevertheless present a very limited area of contact with the bone—a great advantage—at the same time being provided with grooves which render slipping of the bands impossible if the technique is correct. Lambotte's plates have been made with grooves, but being much thinner they necessitate a larger area of bone contact to give the necessary strength, which is unfavourable to the vitality of the underlying bone. We have already

shown the advantages and disadvantages of metal plates, which are still under discussion; but upon one result of the use of such plates everyone agrees—the volume of the callus formed. Now in the femur, the tibia, and the humerus this excess of callus is of little or no importance, but it is otherwise when the clavicle or bones of the forearm are in

question. In these bones the exuberant callus is so disadvantageous, and may cause so much trouble, that we believe Parham's bands with plates to be contra-indicated if the fracture is distinctly transverse, and employ for preference either Dujarier's hooks, or drilling and wire.

What are the results of bands and plates? We have had several failures, bending of the callus occurring on mobilization. Can these accidents be explained or remedied? First, the tissues encircled by the bands are not homogeneous: the resistance offered by the bone and the steel plate is not the same, and there is no doubt that during the few days following operation the encircling force slightly diminishes, whether it be that the plate sinks into the periosteum, or that the band slips more easily on steel than on bone. We have certainly seen cases where the plate has slipped on the band. Another observation is that with mobilization the band may break, and we believe the reason to be as follows. The band after encircling the bone passes on to the plate (Sherman's), which is quadrangular, and



FIGS. 246, 247, 248.—Diagrams illustrating incorrect position of plates at opposite poles of the same axis (A B). The axis at right angles (C D) is unprotected, and displacement is liable to occur.

in so doing bridges a very small triangular space between the former and the latter; it snaps at the edges of the plate (Fig. 242, A, B). This might be avoided by altering the form of the plate. We observed as an illustration of this the case of a young girl who was moved from hospital to her home because of a scarlet-fever epidemic. During transport both bands broke and the callus bent. Continuous extension produced perfect alinement, and on the seventieth day the plates and bands were removed from a mass of new bone which *completely surrounded them*.

There is a great difference in the mechanical distribution of the force which may be applied to *oblique* or to *transverse* fractures. In oblique fractures the force is distributed in the length of the bone and in the direction of the weight applied, while in transverse fractures the maximum and optimum resistance of a plate is to force applied perpendicularly to it, a parallel force tending to cause displacement. We therefore use *long* plates fixed by *four* bands: two close to the line of fracture, two towards the extremity of the plate (Figs. 243, 244, 245). In fractures of the femur, where the fixation appliance has to withstand considerable strain, it is wise to use *two* plates. These plates should never be placed at the two extremities of the same axis (Figs. 246, 247, A B), because an axis with feeble resistance (Figs. 246, 247, C D) will be left unguarded. They should, on the contrary, be placed each at the extremity of two axes perpendicular the one to the other (Figs. 249, 250, A, C).

b. BONE SPLINTS AND PARHAM'S BANDS.—Stimulated by the remarkable work of Nageotte and Sencert on the revitalization of tissues sterilized in alcohol, a large number

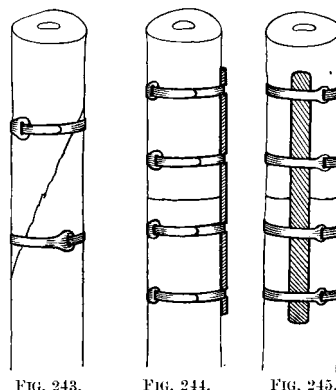


FIG. 243.—Oblique fracture, requiring two bands only.

FIGS. 244, 245.—Transverse fracture, requiring four bands.

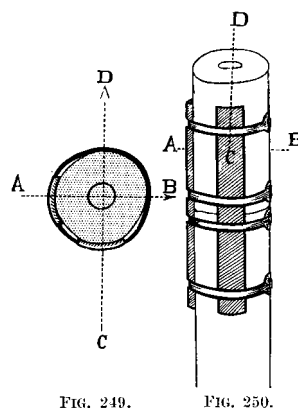


FIG. 249.

FIG. 250.

FIGS. 249, 250.—Diagrams illustrating correct position of plates at the extremities of two axes (A B, C D) at right angles to each other.

of surgeons attempted the use of sterilized bone transplants in human surgery. Although these bony transplants were totally different from the tissues used by these authors, both in their clinical behaviour and histological character, it was nevertheless hoped they would be vitalized and organized by the invasion of osteoblasts from the adjacent bone-ends. Gallie and Robertson²⁴ have recently shown by careful experiment that boiled bone may be thus invaded, vascularized, and absorbed, while at the same time new bone is formed.

We have had some experience in the use of bone transplants as splints with Parham's bands, and we now present our results and conclusions. By the courtesy of Professor Pierre Duval we are also able to bring forward the results of several of his cases, observed by ourselves. Duval used bone plates sterilized in alcohol in the form of a shuttle, resembling a Lambotte plate, provided with grooves for the bands: this plate was always placed *upon* the periosteum (*Fig. 251*). Hallopeau¹⁹ uses a sterilized beef-bone plate some 10 to 12 cm. long, triangular on section, but with a rounded back, this plate also carrying four grooves for the bands (*Fig. 252*). Heitz-Boyer prefers a sterilized bone plate or splint

resembling that of Hallopeau, but bearing lateral ridges which are destined to rest on the edges of the groove cut in the bone (*Fig. 253*). In the cases of the two latter plates a groove has to be cut to receive them into the bone at the site of fracture by means of an Albec saw.

Of Duval's cases, 9 consolidated and were satisfactory; in 2 a fracture of the plate occurred; and in 1 case severe infection took place; the wound was re-opened and the plate removed. The latter lay loosely on the bone and was soiled with pus. In each case where the bone plate broke, re-operation was necessary and the plate was removed. In no case was the plate incorporated with the living bone. No vascularization was seen; on the contrary, the bone appeared rarefied in contact with the plate, which was roughened but not surrounded by callus; the callus was well developed on the opposite side of the bone. In short, the plate was free and independent, both superficially and deep.

The plates after their removal were examined

by the kindness of Dr. Rolland, who reports that "histological examination shows that no invasion of osteoblasts from the neighbouring bone has taken place: there is no trace of commencing absorption, nor is the graft vascularized". Thus the conditions found where bone plates have been used are essentially the same as described by the opponents of metallic osteosynthesis. As to the cases which consolidated well and in which a good result was obtained, we found the same fusiform callus formation as when metal plates were used, especially developed on the side of the bone opposed to the plate, and in about the same period of time.

Our results, then, with bone plates have not been encouraging; but in view of the work of Gallie and Robertson we wish to emphasize that the bone was heterogenous, devoid of periosteum, and dead. In Nageotte's work he insisted on the employment of *embryonic* connective tissue, which condition the bone of an ox does not satisfy.

Lastly, if one hopes for vascularization, absorption, and osteoblastic invasion of the graft, it should undoubtedly be placed beneath the periosteum, while a great advantage of Parham's bands is their extraperiosteal position. To satisfy both these conditions would injure and compress this membrane, seriously compromising the result.

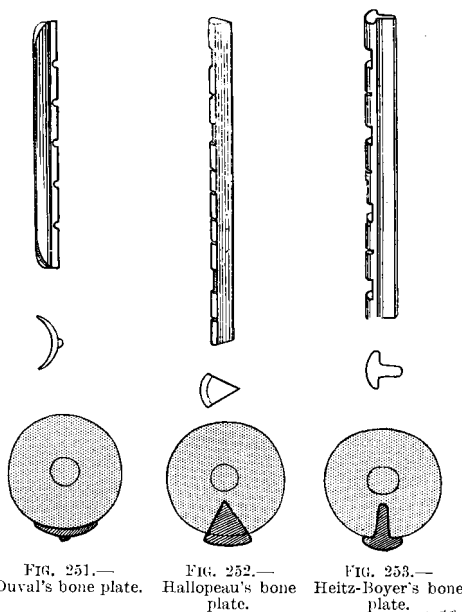


FIG. 251.—
Duval's bone plate.

FIG. 252.—
Hallopeau's bone
plate.

FIG. 253.—
Heitz-Boyer's bone
plate.

We therefore conclude that bone plates give no advantages from the point of view of consolidation, they lack the necessary resistance and solidity, and are apt to break. The operation is much more complicated if one uses bone splints, which need a groove for their reception: they are not incorporated in the callus, and are not converted into living bone. For these reasons it seems to us that bone plates are not preferable to those of metal, attractive as they may be in theory.

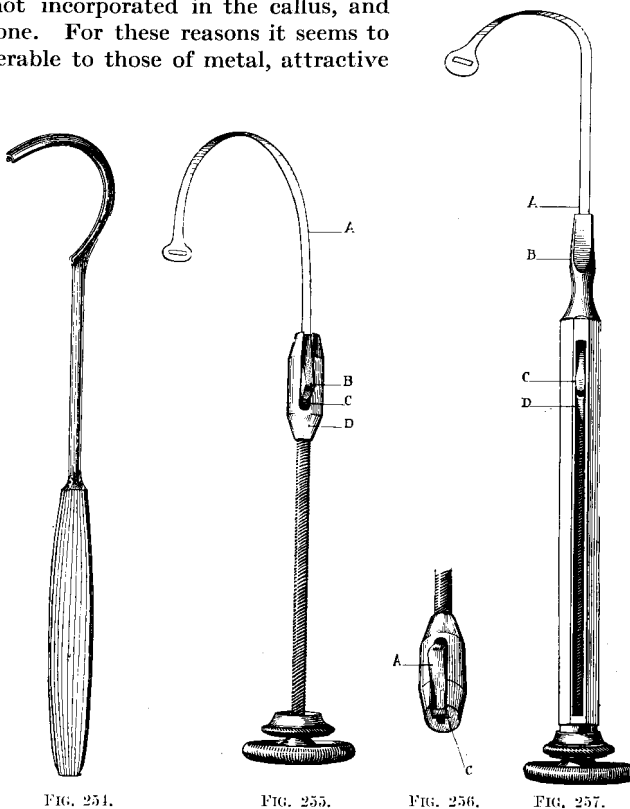
Instruments Required for Parham's Bands.—Those used

by Parham and Martin are a tractor, an aneurysm needle to which the band is attached by a ligature, and bands of soft steel. These, with the operative technique, are well described by Digeon.¹⁸ They have many disadvantages. Firstly, the method of passing the aneurysm needle and drawing the attached band through after it is clumsy and difficult. Where the needle passes, the band may not be able to follow; it becomes caught in the tissues, loses its direction, and twists. Frequently the ligature between the needle and band breaks. Tanton,¹⁷ in face of these difficulties, invented a 'needle' provided with a hook for the 'eye' of the band; but, although an improvement, his 'needle' does not pass easily. One of us (J. G.) devised a hollow

aneurysm needle ('*rail passe lame*'), which seems to us to overcome the drawbacks of previous instruments (*Fig. 254*). It consists in a hollow curved director, at right angles to its handle, and made in two sizes. This director having encircled the bone at the selected point, one introduces the band at the extremity of this instrument, which thus forms a tunnel through which the band slides. The director is withdrawn, leaving the band in accurate position. The latter must now be tightened: here, again, the tractor used by Parham is not all that could be desired, the band frequently twisting and slipping, and necessitating manœuvres prejudicial to asepsis. Frédet¹⁶ suggested a long band with a 'running knot' at the centre tightened by traction with pressure forceps, a useless and tiring process.

Putti³ has invented an excellent instrument, but we prefer that of Gatellier. The threaded stem of the tractor ends in the form of a shell 'nose-cap' (*Figs. 255, 256, 257*), which exactly fits into the hollow extremity of a cylinder containing this stem.

The latter at its extremity is provided with a slit the exact size of the band. The band, passing through this slit, meets an exactly similar slit in the 'nose-cap'; traversing the latter it now meets a cam which lifts the moment the slot of the band engages the former, a spring snapping back the cam into the slot. The band can now be tightened round the bone by a wheel acting on the stem, while the slot is disengaged from the cam by slight pressure on a button.



FIGS. 254, 255, 256, 257.—(Gatellier's instruments for use with metal bands.

The apparatus takes to pieces readily for sterilization, and is re-assembled without screwing. It has given us every satisfaction, and is used in the service of Professor Duval.

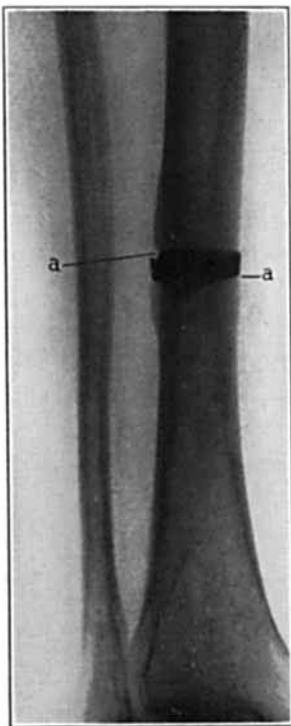


FIG. 258.—Case 1. Fracture of tibia and fibula, eight months after operation; perfect result. *a*, Slight constriction at band; callus insignificant.



FIG. 259.—Case 2. Supra-malleolar fracture four days after operation.



FIG. 260.—Same fracture as in Fig. 259, eleven months after operation; perfect anatomical result; very little callus. *a*, Slight constriction at band, which is not surrounded by callus.

ILLUSTRATIVE CASES.

Case 1.—(Fig. 258.) H. M., age 40. First seen July 2, 1920. *Operation*, July 5. *Discharged* Sept. 9. Oblique fracture of tibia, junction middle and lower thirds, fracture of fibula. Interposition of tibialis anticus. Reduction. Two Parham's bands. *Radiogram*, July 16, showed perfect position. Eight months after, *linear consolidation without appreciable callus*. Anatomical and functional result perfect.

Case 2.—(Figs. 259, 260.) L. S. First seen Jan. 30, 1920, for supra-malleolar fracture with marked displacement of tibial fragment. *Operation*, Feb. 10, 1 Parham's band produced excellent reduction. Left April 1. *Radiogram* at 11 months shows perfect anatomical result. Minimum of callus; functional result excellent.

Case 3.—G. T. Supracondylar fracture of femur involving knee-joint. Considerable backward displacement of lower fragment.

Operation, Nov. 14, 1920. V-shaped incision, joint washed out, reduction, and 2 bands. *Radiogram*, 4 months later, showed circular callus enclosing bands, and not excessive.

Case 4.—M. M., age 32. Fracture lower third humerus. Posterior incision, 1 Parham's band, May 31, 1920. *Radiogram*, Dec. 4: Excellent reduction. Moderate amount of fusiform callus surrounding band.

Case 5.—G. H., age 60. Spiral fracture of tibia and fibula in lower third, with moderate displacement. *Operation*, Oct. 6, 1920. Reduction and 2 Parham's bands. *Rodiogram* three months later, showed good position; moderate fusiform callus formation; bands surrounded with small clear space at point of contact with callus.

Case 6.—(Figs. 261, 262.) P. C. Admitted Oct. 30, 1920, fracture of middle third of humerus, and of both bones of both forearms. Extreme displacement and comminuted fracture (3 pieces).

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Operation, Nov. 14, 1920, after failure of non-operative treatment. Radial nerve freed, bone-ends trimmed, and 1 Parham's band placed encircling all three fragments.



FIG. 261.—Case 6. Fracture of humerus two days after operation.

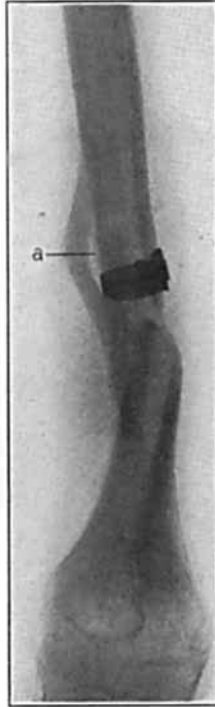


FIG. 262.—Same fracture as in Fig. 261, seven months after operation. *a*, Large clear space in contact with the band.

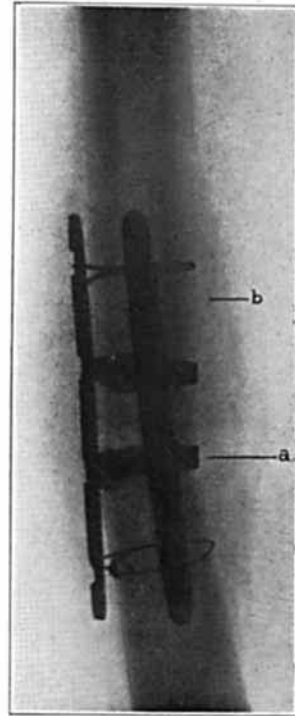


FIG. 263.—Case 7. Fracture of femur three months after operation; moderate amount of callus on side opposed to plate. *a*, Clear space. *b*, Callus opposite the plate.

Radiogram, Feb. 24, 1921, showed perfect reduction and position. Three months later, voluminous callus formation with clear space round band. Function good.

Case 7.—(Fig. 263.) D. J., age 15, seen Sept. 1, 1920, with fracture middle third of femur. Effusion into knee-joint aspirated several times. *Radiogram* showed transverse fracture with much displacement. *Operation* Sept. 10. Incision through vastus internus and reduction by Lambotte's tractor. Two Sherman's plates and 2 Parham's bands, with 2 wire loops.

Radiogram.—Perfect reduction. Four months later, moderate callus formation, especially developed on side of bone opposed to plates. Bands embedded in callus, with small clear space around.

Case 8.—(Figs. 265, 266.) G. S. Seen July 7, 1920. Transverse fracture of tibia and fibula at junction of middle and lower third.

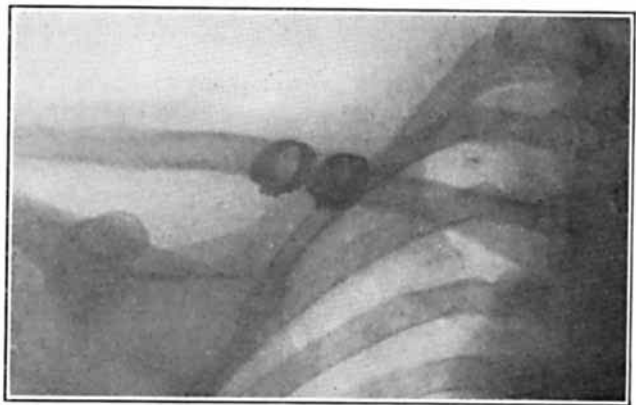


FIG. 264.—Fracture of clavicle after operation; perfect result.

Operation.—July 9. Reduction. Sterilized bone-plate and 2 Parham's bands.

Radiogram.—July 11. Excellent reduction and position. Walking on thirty-fifth day. Two and a half months later some pain.

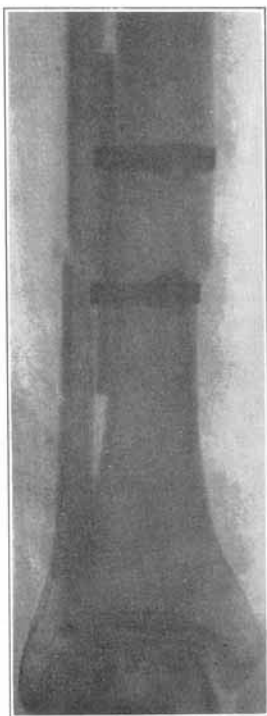


FIG. 265.—Case 8. Fracture of tibia and fibula forty days after operation; bone plate broken, callus minimum.

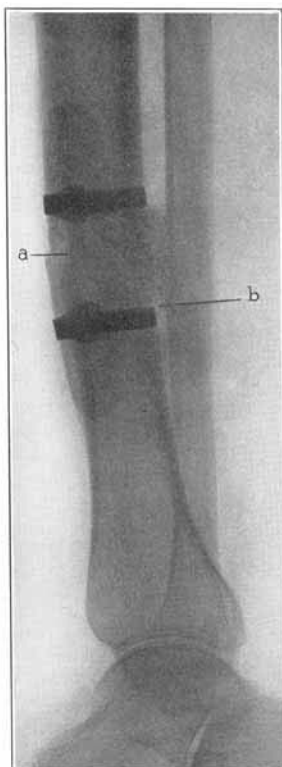


FIG. 266.—Same fracture as in Fig. 265, four months after operation; callus developed on side opposite plate; clear space well shown. *a*, Fracture of bone plate. *b*, Clear space.

Radiogram.—The bone is bent; the bands are intact, but one Sherman's plate has slipped from beneath a band allowing this bending. Dec. 11, continuous extension applied. Jan. 20, re-operation. Bands and plates removed. Latter not covered by callus, former well embedded. April 21, **Radiogram.** Sound consolidation; callus moderate in amount; result fairly good.

Case 10.—(Fig. 267.) L. L., age 23. Fracture lower third of thigh. Upper fragment displaced externally, and lower markedly backwards.

Operation, Sept. 20, 1920. Bone extremities trimmed and regularized. Bone plate fixed to external surface of femur by 4 Parham's bands. Plaster.

Radiogram next day. Very good position and reduction.

To note: Technique was bad. (1) Bone-plate much too short. (2) Bands too near centre of plate.

On the twenty-fifth day the plaster was removed for massage, the patient made a sudden muscular effort with the leg, and the bone bent.

Radiogram.—The bone-plate has broken owing to faulty position of bands and powerful leverage overcoming weak resistance of too short a plate. Continuous extension for thirty days produced good result.

Nov. 2. Bone-plate broken, callus formation on side of bone opposed to bone plate, band hidden by callus, and usual clear space round band.

Re-operation, Nov. 5. The two pieces of bone plate lay free, red appearance, and not invaded by new bone. No callus round plate, but entirely on other side of the bone, where it was excessive. Bands were covered by callus, but were easily cut and withdrawn. Small clear space around band.

Case 9.—(Figs. 268, 269.) V. A. Admitted to hospital Sept. 11, 1920, with a transverse fracture of upper third of thigh, marked overlapping and displacement. Put on continuous extension.

Not satisfied with reduction. **Operation,** Oct. 4, 1920. Bone-ends trimmed, 2 Sherman's plates and 4 Parham's bands placed. **Radiogram.** Reduction and position satisfactory. Ward was closed on account of a serious scarlet-fever epidemic. Patient returned Dec. 7 with bowing of the thigh.



FIG. 267.—Case 10. Fracture of lower third of femur. This illustrates bad technique, the bone plate having broken owing to its being too short.

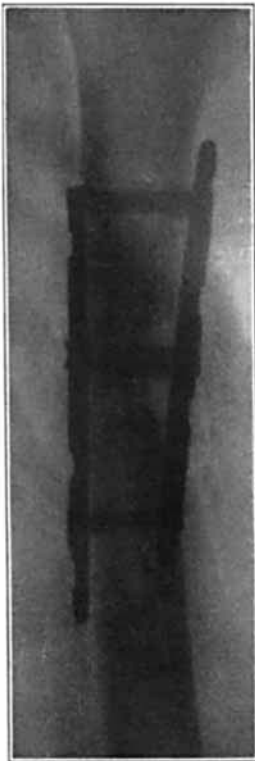


FIG. 268.—Case 9. Transverse fracture of upper third of femur in which a Sherman's plate has escaped from a band, allowing inflexion of the femur.

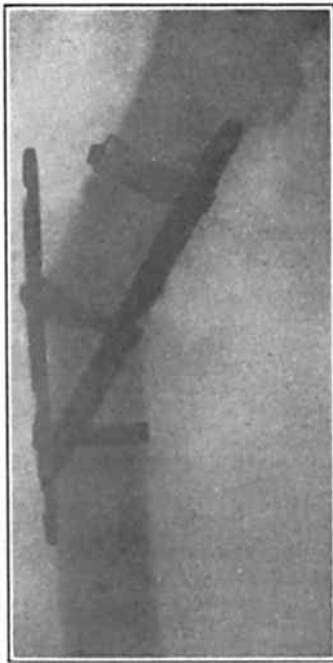


FIG. 269.—Same case as in Fig. 268.

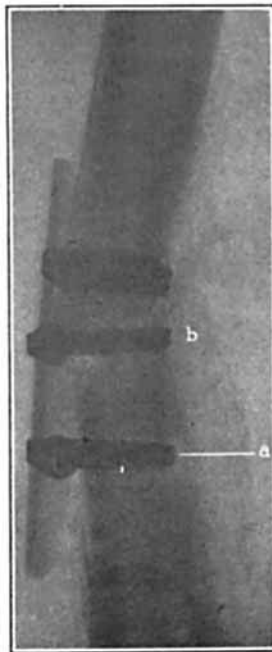


FIG. 271.—Another example of bad technique, showing callus developed on the side of the bone opposite the plate. Here again four bands should have been used, and Sherman's plate instead of Lambotte's. *a*, Clear space. *b*, Callus opposite the plate.



FIG. 270.—Case 11. Transverse fracture of lower third of femur, showing another instance of faulty technique. Fixation is bad owing to the employment of two bands only instead of four. Sherman's plate, too, is better than Lambotte's. *a*, *b*, Clear spaces.

Case 11.—(Fig. 270.) D. F., age 52, seen in consultation April 4, 1920, with transverse fracture of the femur in lower third, with much overlapping of fragments.

Operation, April 10. External incision; the bone extremities were trimmed and 1 Lambotte's plate was fixed by 2 Parham's bands.

Radiogram.—Reduction and position good. April 22, slight bending noted.

Observe also the bad technique. Two fragments are displaced, the plate only offering resistance in a single axis: two plates should have been employed. Also four bands should have been used.

Continuous extension was

applied, and resulted in consolidation in a good position by July 1.

SYNOPSIS OF THE ELEVEN CASES.

Cases 1 and 2.—Perfect anatomical result. Callus hardly appreciable, and linear union.

Cases 3, 4, and 5.—Very satisfactory anatomical result. Callus not exuberant, circular and fusiform. Bands embedded in callus, and a small clear area is visible around them.

Case 6.—Moderate callus surrounding band; well marked clear space.

Case 7.—Two Sherman's plates and four Parham's bands—certain amount of callus on opposite side to plates. Bands surrounded with clear space.

Cases 8 and 10.—Bone plates and Parham's bands. Bone plate broken and callus developed on opposite side to plate. Bands badly placed, and bone plate too short to resist.

Case 9.—Sherman's plates and Parham's bands. Bands loosened. Plate disengaged and slipped.

Case 11.—Lambotte's plate and two Parham's bands. Failure of resistance because only one plate was used (resistance in one axis only). Faulty fixation by two bands when four should have been used.

CONCLUSIONS.

1. The simplicity and the ease of application of the Parham-Martin bands establishes their superiority for closed fractures to all other means of operative splinting. Their application is carried out with the minimum of operative manipulation, and perfect apposition is ensured and maintained. They are better than wire for encircling the bone.

2. We have been able to observe the remote results of fractures thus treated in cases where we have been obliged to re-operate, and in a series of radiographs. They show that the objections made to metallic osteosynthesis, which are very real, cannot be applied to the use of Parham's bands. The consolidation is certainly not delayed, there is no necrosis at the point of contact of the band, and it is surrounded by callus (a small clear space may remain). Furthermore, any organic iron salts that may be formed have no toxic effect on the tissues; the callus is not excessive in quantity, and is frequently reduced to a minimum. Lastly, the bands very rarely give trouble from their presence, and may with confidence be left buried.

3. Transverse fractures require to be treated with metal or bone plates (or splints) encircled by the bands. Our results with bone plates have been very disappointing, though we admit Nageotte's principles in theory, and believe the work of Gallie and Robertson to be most valuable, though needing clinical confirmation in its application to recent fractures.

We are satisfied with our results with Sherman's metal plates and bands, but our failures corrected our technique. Certain principles in technique must be adhered to if perfect results are to be secured.

4. The improved instrument devised by Gatellier which we have described is a great improvement on all others, and is as near mechanical perfection as possible.

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