A METHOD OF TREATING COMPOUND FRACTURES OF THE FEMUR DUE TO PROJECTILES.

[WITH SPECIAL PLATE.]

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To deal adequately with all varieties of compound fractures of the femur, due to projectiles, is a problem which has not yet been satisfactorily solved; and it is safe to say that no one form of apparatus meets all the requirements, not even the Hodgen thigh or Thomas knee splint.

In the treatment of fracture, especially of the thigh, no effort should be spared to obtain a good result, which may be summed up thus: A normally aligned thigh, leg, and foot, a loss of length amounting to less than half an inch in transverse or nearly transverse fractures, and in very oblique or severely comminuted injuries of less than one inch.

When one or more wounds are present, arrangements must be made to dress them without disturbing the setting of the fracture; and it may be several weeks, or even months, before the fragments of dead bone are extruded, or before it is considered justifiable to search for pieces of metal. These last considerations should be subordinated to the ultimate end in view—namely, a good, well-united, straight limb, with very little shortening. Therefore, let the fractured bone be put up as carefully as possible and be retained in the required position whilst healing is going on. If it is evident, however, that this is delayed because of the extent of the necrosis, then the apparatus should be removed, with due precaution as to maintaining full extension of the limb, and the portions of necrosed bone be extracted. Thereafter, the main objects of treatment must be pursued with unwavering patience, and with the apparatus reapplied.

After these remarks, I am desirous of recording a method which is being used by me in suitably selected cases; and the question of suitable selection will be discussed later. The method is a combination of plaster-of-Paris and strips of soft iron. Some surgeons deprecate the use of plaster-of-Paris in compound fractures of the thigh because of the difficulty of dealing with profuse discharge; if this is in such quantity as to saturate the plaster, and if it cannot be soaked up by frequent dressings, then I agree with them. If, on the other hand, the discharge is not more than 2 to 4 drachms in twenty-four hours, and comes from small, or medium-sized easily protected wounds, then I join issue with them, and am prepared to cite cases of my own which have been successful.

The materials used in the method which I am about to describe are plaster-of-Paris bandages, rolled on either over flannel bandages or a stockinette garment, and strips of malleable iron. The apparatus is applied under pulley-extension and full anaesthesia.

For convenience of reference to the Figures 1 to 8, the lettering, which is constant throughout the series, is given here.

- A, Couch.
- B, The counter-extension band of leather or webbing.
- C, The perineal band, thoroughly well padded.
- D, The leather or webbing anklet.
- E, The pulley extension apparatus.
- F, The first layer of plaster bandage, and opposite the letter F is an indication where a reinforcing strip of malleable iron has been added in order to prevent outward deviation of the fragments.
- G, The upper end of the inside and essential piece of malleable iron, which is seen in Figs. 1 and 2, bent round into a boss or knob, G, and when covered with plaster becomes an ischial crutch.
- H, The lower end of the inner or essential piece of malleable iron, bent into an S-shaped hook, H, to receive some turns of the plaster-of-Paris, and resting against the upper and inner side of the leg.
- I, The manual traction which has replaced the leather anklet or stirrup at a late stage of the application of plaster.
- J, The plaster-of-Paris over the foot and ankle.
- K and L, The apertures cut through the plaster for dressing the wounds.

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The material required is simple, and consists, first, of a strip of malleable iron, G, H, seen *en face* in Fig. 1. Its length is about 28 in., its width $1\frac{1}{2}$ in., its thickness is $\frac{1}{8}$ in., and it is so tempered that it can be bent with the hand. It is important that the iron should be exactly the

Fig. 1.

Fig. 2.

right temper, and Mr. A. E. Evans, of 38, Fitzroy Street, Fitzroy Square, has supplied me with it. In Fig. 1, b, this strip of malleable iron has been altered in shape at the upper end, G, by pliers. It has been rolled up so as to make a rounded knob at G, which will ultimately lie up against the tuber ischii. The lower end, H, is bent into a double curve, or S-shaped hook, which lies against the upper part of the inner side of the leg; and the object of this double bend, which should be wide enough to allow several layers of plaster bandage to pass through, is to prevent any shifting of the strip of iron when it is placed in position. Fig. 2, a and b, shows the piece of malleable iron in section: a, before it is bent, and b when it is ready for application. The malleable iron is of the gauge 14.

The other requisites are a set of pulleys, Fig. 3, E, a leather anklet, D, and a perineal band, C, which should be thoroughly padded, especially where it passes over the femoral vessels and the tuber ischii. At the latter spot it should not be less than 1 in. thick. The counter extension is effected by leather straps, Fig. 3, B. As it may not be possible after a severe action to have a sufficiency of the ordinary leather perineal bands and of anklets ready, simple substitutes can be supplied; thus, in place of the leather strap B, stout webbing can be used about $1\frac{1}{2}$ in. broad, and this is continued on to form a perineal band. The latter is thickly and evenly covered either with cotton or asbestos wool, which is carefully laid on and then bandaged down to the webbing, so that it lies firmly on it; and, in place of the leather anklet D, a horizontal band of webbing, well padded, may be sewn round above the ankle with a stirrup attached, extending below for the pulley hook. In order to cover the limbs, a pair of stockinette drawers are used, or, failing them, flannel bandages are evenly applied to the limb, after it has been well dusted with boracic powder. Plaster bandages, 3 in. wide and 4 to 6 yards long, which have been recently baked so as to ensure rapid setting, are ready to hand. The patient is placed under an anaesthetic, and the wounds are thoroughly cleansed from any dirt which may be present, and syringed out with tincture of iodine 7 per cent., and water, or 1 in 20 carbolic lotion, and dressed with cyanide or iodoform gauze. The amount of shortening of the limb should be noted. Traction is then made upon the limb by the pulleys (see Figs. 3 and 4). The position of the limbs is of importance, and in view of the possibility of discomfort arising from pressure on the tuber ischii (in the illustration the right side) it is desirable to tilt the pelvis. This is done by abducting the limb on the sound side. By altering the position of the sound limb from

time to time, the area of pressure on the other tuber ischii can be varied. Traction is then made gradually and firmly and the total amount of lengthening of the limb should be noted. In the majority of cases our aim should be to draw the limb down until it is the same length as on the sound side. As the traction is steady and even, and not jerky, there is very little danger of fragments of bones wounding the great vessels. When the limb has been drawn down as far as is considered justifiable, the fragments are gently moulded through the dressings so as to bring them into as straight a line as possible. The exact position of the wounds should be noted by measurement from certain fixed points, such as the anterior superior spine, and the upper margin of the patella, and then a layer of wet plaster bandages (Fig. 4, F) is applied. Although it ought to be common knowledge, yet so many mistakes are made in the simple matter of soaking these bandages, that a few words on the subject may be introduced here. The basin should be deep enough for the bandages to be fully immersed, when they are set "on end," and the water should be of a temperature of from 70° to 80° F. The bandages should be left in the water until bubbles cease to escape, and then removed and very gently squeezed, so as just to rid them of the surplus moisture.

So far the procedure differs in no respect from that of applying an ordinary plaster-of-Paris spica bandage. The novel feature is the use of the bent piece of malleable iron (c, h, Fig. 4). The upper rounded end, c, is pressed firmly against the perineal band, passing beneath the tuber ischii, and so bears indirectly on that portion of bone. The shaft or stem of the piece of iron is bent so as to follow the contour of the thigh, the knee, and the upper part of the leg, and the great point is to push the rounded upper end c very firmly upwards. If the thigh shows signs of bending outward or forward, another flat strip of malleable iron—the outline of which is seen under the plaster in Fig. 4 at f—about 12 in. or 15 in. long, should be so bent as to fit the outer side of the pelvis and thigh, having due regard to the position of the wounds.

In Fig. 5 the method of securing the inner and more important band of malleable iron is seen. The plaster is passed round it and over it several times at g, until a large bulbous end is made, which constitutes an ischial crutch. The plaster is then continued downward until it reaches the double loop of iron at h (Fig. 5). It is passed closely in a cord-like manner through the first loop several times; the bandage, however, being flattened out on the outer side and distributed up and down the limb so as to secure a good hold. When one part of the S-like loop at h is filled up with plaster bandage, then the second loop is dealt with in the same way. This method secures the absolute fixation of the strip of malleable iron c, h, and prevents movement either in the upward or downward direction. Several more bandages are now wound on the limb from above downwards, until it is covered nearly as far as the ankle. In the illustrations one layer of dry bandage only has been applied so as to save discomfort to the model; but, in actual practice, a sufficiency of material will be used to render the joints of the limb and the fracture completely rigid; and, if there is any doubt on this point, the plaster may be reinforced behind the knee by a third strip of malleable iron.

At this stage the leather or webbing anklet is taken off, because it will happen that, owing to the pull which has been exerted at the ankle, there has necessarily been some constriction of the soft tissues, and pressure-sores may occur if the laced anklet is left on. In place of the anklet traction, an assistant now draws firmly on the limb with his hands (Fig. 6, i), and the plaster is then continued down over the ankle and the foot (Fig. 7, j) to just behind the heads of the metatarsal bones. During all this time attention is given to the alignment of the limb; the patella should look straight to the front, and the inner side of the

head of the first metatarsal bone should be in the same plane as the inner edge of the patella; furthermore, the foot should be at right angles.

In Figs. 7 and 8 at k and l are seen the places where apertures are represented as having been cut in the plaster in order to dress the wounds.

It now remains to release the counter-extension band b (Figs. 3 to 8). This is done by cutting through it before and behind at the level of the crest of the ilium, leaving the loop of the perineal band in place. In some cases it may be desirable to carry the plaster-of-Paris bandage further up the body than is seen in the illustration.

Frequently the patient complains of the pressure of the ischial crutch and the perineal band against the tuber ischii for the first forty-eight hours; with practice, however, the requisite degree of pressure to secure sufficient extension can be gauged; and, in any event, minor adjustments can be made, which quickly relieve any distress.

The principle of this arrangement is very simple; the extension is secured in the first place by the tension of the pulleys, and is maintained by the fixation of the shaped malleable iron, c, h (Figs. 1, b, 2, b, and Fig. 5), which through its upper bulbous end makes an ischial crutch and presses up against the tuber

ischii. This piece of iron is absolutely fixed in position by the plaster; and the further adaptation to the contour of the limb, especially above and below the knee and at the ankle, which a plaster-of-Paris support permits, acts as a further counter-extension factor. If it is found that, during the long interval sometimes required for recovery, the limb shrinks inside the plaster, then it is quite simple to apply another and more closely fitting bandage and to secure some further lengthening of the limb by pulleys in the same way as before, if the fracture is not yet united.

In bullet fractures of the femur it is noticeable that the injury, although excessively severe, is often localized to a short area of the shaft, not more than one to three inches in extent, and that the long oblique and spiral fractures so often seen in civil life, and so very difficult to treat satisfactorily, are the exception and not the rule. Thus, in military surgery we see that the fractures tend to be more transverse than oblique, and at the same time pieces of bone of varying size are bodily

driven out of the line between the main fragments. Another type is also met with. The shaft of the bone is split vertically into a number of plates, and these "telescope" so that union takes place with a great deal of shortening. We must recognize that many of the displaced fragments do not die, but help to form a bridge of callus between the chief bone ends, and therefore they should be carefully preserved, and, if possible, held in position whilst union is taking place. In the absence of very severe septic infection the amount of ultimate necrosis of bone will be very small; and we can well afford to wait until we know how much of the bone is dead before attempting a sequestrectomy; more especially so when the projectile wounds are small and the discharge is not profuse and evil-smelling. No surgeon would, on the other hand, attempt to treat a fractured thigh, complicated by a large jagged wound, fetid with profuse discharge, by putting it up in plaster-of-Paris.

The actual cause of the shortening in all these cases is the excessive reflex and tremendous muscular pull, set up by the irritation of the soft tissues, due to the jagged bone ends digging into them when the parts are not kept quiet. The parts must be kept absolutely at rest and the fragments disentangled from amongst the soft tissues; when this is done spasm and pain cease. The modified plaster method accomplishes these results because it is applied in such a way and under such conditions as to draw the overlapping fragments apart. Further, the tension is continuous and unalterable, and therefore the muscles, becoming tired as it were, cease to

Fig. 9.

FIG. 3.

FIG. 4.

FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

pull and the fragments are not ground together. There is immediate relief from pain, due to these causes, after the plaster has been applied; although there is sometimes, for the first twenty-four or forty-eight hours, pain and discomfort due to the pressure of the perineal band across the front part of the thigh and of the thrust upwards against the tuber ischii. The former may be relieved by passing a blunt hook beneath the plaster and pulling the band in front of the thigh upwards or pushing it downwards. The latter yields at once to slight alterations in the position of the limb. If the plaster has not been carried up any great distance above the crest of the ilium, the injured limb may be carried outwards, and so a fresh portion of the soft tissues over the tuber ischii receives the pressure. Also abduction of the limb will lessen the force of the upward thrust of the ischial crutch. The skin in this region may also be drawn from side to side twice a day. It is occasionally useful to adduct or abduct the sound limb in order to vary the incidence of pressure.

Whenever possible, and provided that no strips of malleable iron interfere with the passage of a ray to the fracture, it is advisable during the first few days to have an *x*-ray photograph made through the plaster. If it should happen that the fragments are not in good position, the plaster may be taken off and the limb put up again. When the shortening is between 2 and 3 inches, an attempt at an immediate reduction of the total shortening at one sitting may give rise to serious discomfort, owing to the resistance of the muscles of the thigh to the upward thrust of the ischial crutch. In these cases I would counsel that at the first attempt the effort should be confined to reducing part of the shortening, say to within an inch, and that in two or three weeks' time the shortening should be further reduced before the plaster is reapplied.

Once the limb is placed entirely at rest the tendency is for the discomfort to cease gradually and the wounds to close, because all is quiet. One other advantage of this method may be mentioned: not only can the patient be transported a considerable distance without pain, but also, with the limb securely guarded in every direction, he is able to get up at a much earlier date than otherwise, and can go about on crutches.

I give illustrations of *x*-rays (Fig. 9), showing one type of case to which this form of treatment is applicable, and where the shortening, when the first plaster had been removed, was found to be reduced to 1 inch.

RECENT OBSERVATIONS ON THE PATHOLOGY OF ULCER OF THE STOMACH, WITH INDICATIONS FOR TREATMENT.*

[WITH SPECIAL PLATE.]

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It has naturally been considered for many years past that the gastric juice played an important part either in the initiation or propagation of gastric ulcer. This idea has, however, been held in a vague kind of way and has not been supported by any very definite evidence with regard to what precise effects this secretion produces and as to

what its mode of action really is. The question is of considerable importance in relation to the treatment of gastric ulcer; I therefore propose to discuss the subject, and hope to show that it is the *acid* of the gastric juice which is the chief damaging factor, and that it acts upon the wall of the stomach, both as an irritant and as a necrotic agent.

Efforts to prove that the *ferment* is the chief destructive agent and that the gastric juice can digest the wall of the stomach because the latter is deficient in protective anti-ferment have proved unsuccessful, and treatment directed to replace this presumably absent antibody has had no better luck. Moreover, on consideration it seems unlikely that such a hypothesis should be correct. If the gastric mucous membrane were deficient in antipepsin, the whole or greater part of the membrane should be digested and not merely a circumscribed portion. In no other part of the alimentary canal are ulcers found comparable to gastric and duodenal ulcers. If antiferment is occasionally absent from the stomach it should be now and again absent from the intestine, but the pancreatic juice does not produce lesions comparable in any way to gastric ulcer. Dilute hydrochloric acid is a powerful protoplasmic poison, and, owing to its presence, the gastric juice is alone amongst the digestive juices able to digest connective tissue, and therefore disintegrate foodstuffs and organs whose elements are bound together by that tissue.

DESCRIPTION OF SPECIAL PLATE to Illustrate Dr. Bolton's Paper.

Fig. 1.—Gastritis of monkey's stomach due to hyperacidity. The photograph shows round-celled infiltration of the mucosa, destruction of the gastric glands, and catarrhal desquamation of the epithelium.

Fig. 2.—Photograph of section of mucous membrane of monkey's stomach, showing formation of follicular ulcer due to hyperacidity; the enlarged follicle has burst through the muscularis mucosae, displaced the glands to either side, and appeared at the surface of the mucous membrane.

Fig. 3.—Photograph of monkey's stomach, showing gastritis and follicular ulceration due to hyperacidity.

Fig. 4.—Photograph of section of cat's stomach, showing an ulcer due to necrosis of the mucous membrane owing to hyperacidity.

Fig. 5.—Photograph of acute ulcer of monkey's stomach on the twenty-first day, showing delay in healing due to administration of 0.39 per cent. HCl solution. Follicular gastritis is present.

Fig. 6.—Photograph of acute ulcer of monkey's stomach on the twenty-first day, showing delay in healing due to administration of 0.28 per cent. HCl solution combined with motor insufficiency.

SELF-DIGESTION OF THE STOMACH BY NORMAL GASTRIC JUICE.

In many forms of gastric ulcer a definite initial damage to the mucous membrane can easily be demonstrated—for example, in those due to bacterial infection and other causes of necrosis and haemorrhage, also in follicular ulceration. In such cases it is quite easy to understand how the gastric juice can attack the damaged portion of mucous membrane.

In other cases, however, the damage falls short of producing a visible pathological lesion, but is sufficient to lower the resistance of the mucous membrane to the gastric juice, which attacks the damaged part and completes the death of the tissue. Such damage may be done by poisons circulating in the blood. I was able to demonstrate this principle of self-digestion experimentally some years ago. This was done by producing a gastrotoxic serum active against the gastric mucous membrane, and studying its precise mode of action. Such a serum is manufactured by immunizing an animal by the repeated injection of the gastric cells of another animal. The immunized animal forms in its blood poisons which, on injection into the body of a similar animal to those whose cells have been injected, give rise to necrosis and ulceration of the mucous membrane of its stomach.

The poison fixes itself to the gastric cells rapidly and produces its effects within a few hours. If the gastric juice be neutralized with an alkali whilst the poison is acting, the mucous membrane is found intact on the death of the animal, whilst the controls with an active gastric secretion show the usual necrosis and ulceration. No microscopic lesion whatever is to be detected in the gastric cells which have been acted on by the poison when the gastric juice is thus put out of action. The cells have, however, been damaged to such an extent that the normal gastric juice is able to attack the wall of the stomach.

The resulting necrotic patches in the mucous membrane are stained black by the action of the hydrochloric acid upon the blood, and soon separate, leaving cleanly punched-out ulcers.

Similar necrosis and ulceration does not occur in the intestine when an enterotoxin is injected, although its mucous membrane is exposed to the active pancreatic juice.

* An address delivered before the Nottingham Medico-Chirurgical Society.