THE TREATMENT OF GUNSHOT FRACTURES.

BY

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THERE are several points in Mr. Hey Groves's article on the treatment of gunshot fractures which appear to be at variance with what I believe to be fundamental physiological principles, and also with my experience in the practical details of treatment with splints. We are all too much concerned to assist the general mass of practitioners engaged in military practice to arrive at a safe, easily intelligible, and practically convenient method of efficient treatment, for me to have any fear that a direct reply to those statements in his article with which I strongly disagree will be regarded in any way as an attack on Mr. Hey Groves; we are all too deeply concerned with the importance of the subject for that to be possible.

The first point at issue is the discussion of the relative importance of the treatment of wound infection and the restitution of normal relations. Though this has been forcibly put by others, it is still necessary to point out that restitution of the normal relations is essential to the efficient working of the natural defensive processes of the blood and tissues. Every surgeon is aware that in such operative procedures as muscle and tendon grafting twisting the muscle is fatal to its survival, at least as far as useful function is concerned; how much more fatal to the survival of the tissues must kinking and damming of the natural flow of blood and lymph be when the maximum value of the circulation is required to combat infection.

It seems obvious that to bring the limb at once into its normal alignment gives the circulation its best chance of a free flow. Further, if fasciae and muscles remain twisted, pockets of discharge form behind the kinks, precisely in parts where the malposition has impeded the circulation in the tissues and rendered them the more vulnerable to toxins. Free drainage of accumulations in the various intermuscular and interfascial tissues in which discharges may collect is obtained by suitable incisions tapping the various strata of natural interspaces; the natural flow will proceed most easily if the tissues are lying in their normal relation without avoidable kinks and twists.

Immediate restitution of normal alignment is one of the strongest agents in assisting Nature to establish a proper system of physiological defence. Of course, cases of gas gangrene and acute infection require, in addition, all the assistance that can be given by free incision, the use of hypertonic solutions, free removal of grossly infected tissues, and any other appropriate device known to surgical art.

The Survival of Bone Stripped of its Periosteum and Apparently Devitalized.

Mr. Hey Groves very properly lays stress on the importance of the medullary circulation, and when he suggests that "if angulation of the fractured bones occurs in such a way as to bring the fragments close to the surface of the wound, this ought to be maintained or even increased," he is clearly contradicting himself, for a bone in an angled position cannot come to that state of physiological rest of the part which is necessary for defence against toxins—not to mention repair. His statement that "it greatly shortens the cleaning of the wound" is open to question and contrary to my experience, and while it may be true that "it facilitates the drilling of any bare bone that may present," this is not in itself an object to be desired. I fully admit that drilling through the hard bone into the medulla is an ingenious and perfectly proper means of providing access for new vessels in the form of granulation tissue; it seems much more physiological to allow the normal surroundings of the bone to provide this as soon as possible instead of having recourse to a surgical artifice. I have frequently had occasion to remark, during the treatment of fractures of the lower limb by means of the Thomas splint, that as soon as the limb is pulled down into correct alignment and brought to a state of physiological rest by means of "fixed extension" the bare ends of the bone which seemed inevitably doomed to suffer necrosis are rapidly vascularized from the periphery by a growth of granulation tissue. This is entirely in accord-

ance with the teachings of Hilton's classical work entitled *Rest and Pain*, a work which is worthy of much more close study by the modern surgeon than it commonly receives. In this war we have to deal with septic conditions in surgery well known to our grandfathers, and while using modern methods of invoking the defensive powers of the tissues, we cannot afford to neglect the lessons they learned in a hard school of experience, unless we are content to let our patients pay the price by buying the experience anew for ourselves.

Much of the most heart-breaking work which those of us who are orthopaedic surgeons have to do is to break up repair tissue formed in wrong positions in order to restore correct position in limbs, when that correct position might easily have been secured in the first instance, when all the parts were free and easy to adjust.

The points I wish to make so far are, first, that while free incision, saline irrigation to promote lymph flow, and mechanical cleansing and excision of the wound all have an important place in the process of defence and repair, the restoration of a free blood supply, and with it free drainage, is best assisted by getting the limb into correct alignment, so that the natural paths of flow of blood and lymph are not twisted or obstructed; and, secondly, that if this is done repair follows naturally and continuously on the initial processes of defence without the necessity of inflicting a new injury on the tissues at a later date in order to restore the shape and normal relations of the limb.

The Best and Most Efficient Type of Splint.

I cannot accept the statement that the muscular pull "which is mainly responsible for the element of displacement of a fracture which is most difficult to reduce" is, to quote again, "constant and elastic in its action, and not merely reflex or voluntary." My experience of the use of the Thomas splint in fractures and in dealing with the spastic contraction of muscles in cases of cerebral palsy of infants, has led me to a firm conviction that the muscular contraction which leads to deformity is essentially reflex. It was not till I grasped this fact that I was able to understand the extraordinary way in which a case of fracture of the femur treated on a Thomas knee splint comes in due course to a state of complete muscular rest, so that the muscles relax, and no force is needed to complete the restoration of the length of the limb.

The wholly inaccurate and misleading impression of the Thomas splint and its use in the treatment of fractures of the lower limb, given in Mr. Hey Groves's article, compels me to attempt to explain how it ought to be used, and to dispel some of the misapprehensions which have evidently arisen. I can do so with some confidence, as I have used the splint constantly since I first was taught how to use it in 1901, and it had then already enjoyed an established reputation for twenty-five years.

The Thomas knee-splint in the treatment of fractures is no new thing—though many surgeons seem to regard it as such. It was written about in 1878 in strong terms of praise by Rushton Parker. The new factor is that many surgeons who have never given much attention to surgery of bones and joints, and have not, so to say, served a regular apprenticeship in this branch of surgery, are now compelled to pay a great deal of attention to it, and have discovered that a section of surgeons accustomed to the treatment of bone injuries are in the habit of using Thomas's splint.

As a surgeon who has used the Thomas splint as a matter of routine, I would lay down the following points as constituting the essential difference between the "fixed extension" employed with the Thomas splint and the "elastic extension" employed in any method of weight and pulley extension. With "fixed extension" the nerve-muscle apparatus concerned in spinal reflexes comes to rest and ceases to act within forty-eight hours of efficient fixed extension, and after that the whole musculature of the limb comes to rest and no further trouble need be feared from "muscular action." On the other hand, with weight and pulley extension the nerve-muscle apparatus is kept on the alert. The muscles remain in the state of elastic tension described by Mr. Hey Groves and do not come to rest. It is true that this state of elastic tension may be overcome by fatiguing the muscle by the use of great weights such as he describes, weights up to 25 lb.

But the use of such weights subjects the tissues to a tension which he properly deprecates—again I quote: "Extension involves tension, and the less tension there is in the tissues the easier the drainage and the better the natural resistance of the soft parts against inflammation." With this statement I am entirely in accord, and I use the Thomas splint because when this splint is properly constructed and properly used there is less tension on the tissues than in any other method of treatment with which I am acquainted.

The first difficulty raised is that it is impossible by a "single act of traction," a "single momentary act," or by a "sudden act" to restore the femur to its full length; the phrases quoted all occur in Mr. Hey Groves's article. In order fully to repel these suggestions, which I consider to be erroneous, I shall attempt to explain the manner in which I am in the habit of dealing with a fracture in the middle or lower third of the femur. I will take as an example a case admitted under my care on May 4th, 1916.

The patient had been hit by high explosive shell on April 29th. He was suffering from numerous scalp wounds, a wound of the chest which gave rise to a pleurisy, diagnosed on May 5th, and numerous small wounds down his right leg, in addition to a fracture of the middle of the right thigh with a large ragged wound on the posterior and outer part of the thigh communicating with the seat of fracture. He was transferred from France on a Mayberry-Wallace splint. He had three inches of shortening, measured from the anterior superior spine to the internal malleolus. The large ring of the Mayberry-Wallace splint, not being correctly shaped, was pressing up into the perineum and not riding on the tuber ischii, as a properly shaped Thomas ring would.

An anaesthetic was administered, the Mayberry-Wallace splint removed, and the wounds covered with temporary dressings. Some difficulty was experienced in getting convenient areas of uninjured skin for application of adhesive strapping for the "extensions," but by cutting the strapping into many tailed strips it was possible to have room to dress the various stray wounds in the leg and yet get efficient hold of the limb. Most of the traction was from the sides of the knee and just above it.

The limb was pulled out by hand to within about $\frac{1}{2}$ in. of the length of the opposite leg without any exercise of great force—that is, the deformity was at once reduced by about 2½ in. A gutter metal splint was applied to the back of the leg and thigh below the fracture, and a bandage sling from the side bars applied to support the upper third of the thigh, leaving the region of the wound free for irrigation and drainage; an interrupted back splint to fit the patient was made but not used, as the alignment was good.

The bottom of the splint was supported in a crutch at the bottom of the bed. At the same time a Thomas right-angled shoe was applied to steady the foot, as there were rather extensive wounds of the leg just above the ankle. The nurses, who were not familiar with the splint, were surprised to find that there was no difficulty in moving the patient for any necessary purpose. About a fortnight ago I heard the patient tell a surgeon who was visiting the hospital that, except for the first two or three days, he had felt no discomfort from the ring.

Secondary haemorrhage occurred from the anterior tibial artery. It was associated with a phlebitis of the internal saphenous vein which caused some disturbance in the course of treatment. In spite of complications, the whole treatment of this case was carried through without removing the splint till July 22nd, when it was taken off altogether as the fracture had united, though the surface wound was not quite healed. The shortening is between $\frac{1}{2}$ in. and $\frac{3}{4}$ in. If it had not been necessary to ease the strapping in places on account of the phlebitis, it would probably have been possible to avert even this small degree of shortening.

This case alone—and it is only one of a series—answers most of the objections raised by Mr. Hey Groves. The suggestion that it "only needs a little slipping of the adhesive plaster . . . a little giving on the part of the soft tissues over the tuber ischii, to allow the powerful thigh muscles still further to drag the bone fragments out of position," contains three fallacies. The first he exposes himself. On the next page he writes: "That extension by adhesive plaster alone is capable of reducing and retaining every kind of fracture has been long ago demonstrated by Bardenheuer and his pupils"; there is therefore no reason to attach importance to a "little slipping of the adhesive plaster"; even if it happened it would be discovered by the surgeon if he uses his tape measure as he ought.

The tuber ischii is the bone on which man sits, and the soft tissues over it are not likely to give. If the ring of the Thomas splint is properly constructed and fits the patient reasonably well, it will not slip off the tuber ischii into the perineum. The thickest part of the padding on

the Thomas ring should not be more than $1\frac{1}{4}$ in. to $1\frac{3}{4}$ in. in diameter even in the largest ring. The ring is usually made larger than this in the Mayberry-Wallace splint and in other splints improvised since the war began. No such splint is a Thomas splint, and its faults ought not to be associated with Owen Thomas's name. I think that the reason why Messrs. Mayberry and Wallace put such a powerful winch on their splint is not because it was needed to overcome the muscles, but because the ring of their splint is too thick to lodge securely on the tuber ischii, so that it slips off into the perineum. The more the winch is wound up the more the ring is driven into the perineum; but this is not fixed extension, and the splint is not even a modification of a Thomas splint, for it does not fulfil the first requisite of a Thomas splint—namely, a properly designed ring.

The third fallacy is that the powerful thigh muscles will further drag the bone fragments out of position. This is a myth which ought to have been exploded long ago.

The behaviour of the muscles in the case of a fracture under treatment by fixed extension was long very puzzling to me, for, like many others, I had an idea that the muscles crossing the seat of fracture had a constant tendency to contract. Experience, however, proved that not only these muscles but all the other muscles of the limb come to rest in a relaxed state if the limb is put in fixed extension. A study of the behaviour of the muscles in cases of spastic paraplegia, together with a consideration of the experiments of Magnus on spinal reflexes in the dog and the cat, gave me the clue to the situation.

In spastic paraplegia or spastic central diplegia in children the inhibitory control of the upper neuron is impaired, and reflexes are exaggerated, especially in the strong hypertrophied adductors of the thigh. Any stimulus almost may excite a strong contraction, not only of these, but also of other hypertonic muscles, inducing movements of the hands, twisting of the face, and other phenomena familiar in such cases.

Clinical experience has shown that if the powerful thigh muscles and calf muscles are completely controlled by fixing the limbs in full abduction in a Thomas abduction frame, not only do the controlled muscles cease to fight, but other muscles become less excitable, and the general twitchings tend to disappear; the explanation is that the excitable state of the spinal motor cells maintained by afferent impulses from the hypertonic muscles ceases.

To cut off these afferents Forster divides posterior nerve roots; surgeons of the school of thought to which I adhere prefer to cut them off at their source by controlling the muscles—in many cases dividing some of the stronger adductor muscles to put them temporarily out of action.

These physiological facts lead us to expect similar results in cases where localized groups of muscles are on guard over an injury. There is no loss of the control of inhibition by the upper neuron, and therefore we have normal physiological reflexes from the injured limb to consider, not exaggerated uncontrolled reflexes.

It is a physiological law that the muscles about any injured area remain in a state of tone or guard to prevent accidental movement of the injured part; whether the pleura, an abdominal organ, or a fractured bone is in question makes no difference.

It is a further physiological law that sudden changes of tension in a muscle excite afferent impulses which give rise to reflex contractions, as in the familiar method of testing the knee-jerks. Now, in setting a fracture of the thigh on a Thomas splint the method of procedure I have always understood to be correct is first to extend the limb gently but firmly in the line of its axis by manual extension. In a recent simple fracture the muscle will quietly relax if the surgeon pulls firmly and quietly. If he varies his tension suddenly a reflex contraction at once occurs, and the patient (if not anaesthetized) suffers a spasm of pain. In this way in all recent cases it should be possible to bring the limb to within about half an inch of its full length. No struggle is made to get the other half inch, the extension straps are secured to the bottom end of the splint, and the limb slung comfortably from the side bars along its whole length, great care being taken to preserve in this way the convex bowed contour of the front of the thigh. Sagging at the site of fracture is a very bad fault, and, unfortunately, very common; if the front of the thigh merely looks straight the femur is sagging; the

posterior support, whether a gutter-shaped metal splint, or perforated zinc, or merely webbing slings, must be tightened up if this occurs.

Within twelve to twenty-four hours it will be found that the extension straps are no longer taut—not because they have slipped or stretched to any extent, as is proved by the tape measure, but because the muscles have relaxed. If the surgeon merely tightens the extension straps he finds that he has gained a quarter of an inch or more. In all ordinary cases of simple or even compound fracture, by merely taking up the slack of the extension straps—hand-taut—two or three times a day, it is possible to extend the limb to half an inch beyond the length of its fellow. In civil practice this is what I have always aimed at.

There is no constant extending force put on the muscles, they are merely prevented from contracting. In twenty-four hours at most the nerve muscle apparatus acquiesces in this and no further reflex actions occur; on the contrary, the whole nerve muscle reflex system goes to sleep, the muscles relax and do not remain on guard, as the system of fixed extension has relieved them of all responsibility for the guard against adventitious movement.

The contrary is the case when weight and pulley or elastic extension is used. The nerve muscle system is now kept awake; sudden movements of the patient's body are liable to cause "starting pains" due to sudden reflex contractions. The only means of stopping this is to increase the weight, putting a constant tension on the tissues; but, as Mr. Hey Groves rightly points out, "the less tension there is on the tissues . . . the better the natural resistance of the soft parts against inflammation."

It is on those grounds that I hold that "fixed extension" is physiologically preferable to any method of applying constant extending force, and results show that it is efficient.

When Mr. Hey Groves states, with regard to treatment of cases on the Thomas splint, that he "has never yet seen one in which gross displacement had been corrected by it," he must be speaking from a limited, and possibly unfortunate, experience of the splint. His statement could be contradicted by any surgeon who, at any time during the past thirty years or more, has visited the clinics in Liverpool or elsewhere where the splint is regularly used.

Cases in which malunion has already occurred fall into two classes—civilian and military. In civilian surgery we have been in the habit of interfering with impunity, in cases of compound fracture, very shortly after wounds have closed. In military surgery the danger of recrudescence of virulent infections latent in the wound is so great that an interval of many months must be left after the last sinus has closed. A year ago I regarded three months as a reasonable interval; now I am doubtful if six months is always safe.

It is therefore all the more important, in the case of gunshot fractures, that full restitution of form should be made in the first instance, when the whole area of the fracture is easily manipulated; if malunion is permitted, it may be more than twelve months before it is safe to attempt to correct the mistake.

In civilian practice one has frequently been called on to deal with shortening of $2\frac{1}{2}$ in. to 3 in. two, three, or four months after the injury. In most such cases one can confidently promise to reduce the shortening to $\frac{1}{2}$ in., and often completely. The malunion has to be broken down before the limb can be lengthened. In many instances the fracture can be disunited even several months after the original injury by manipulation only, without having recourse to osteotomy. The guiding symptom as to the possibility of doing this is tenderness at the seat of malunion, for callus which is still tender is rarely very firm.

The difficulty begins after the fracture has been disunited, for the soft parts must be stretched. The method I employ is active extension with block and tackle. This is led through the ring of the Thomas splint, so that when the maximum extension considered advisable at one sitting has been obtained the splint is slipped up the limb and the extension straps secured. It is to be noted that when the block and tackle extension is removed the limb relaxes a little, as it is impossible to tie the straps by

hand to the bottom of the splint quite as tight as the limb can be pulled by block and tackle. This is really the salvation of the situation, as it relieves the tissues of severe tension which if continued would be injurious. From this time on the case is treated as an ordinary recent fracture, unless it is considered necessary to give an anaesthetic again after a week to pull the limb still further down.

It is clear that the cases of malunion brought to the orthopaedic surgeon in civil life following simple fracture or an ordinary compound fracture are seldom associated with the massive cicatrization of all the tissues of the thigh found in cases of compound gunshot injury associated with extensive laceration of the tissues and still more extensive fibrosis the result of septic infiltration of the tissues. In civil cases full correction of a shortening of $2\frac{1}{2}$ inches or more is frequently obtained by these means three or four months after the injury. In military cases associated with very extensive infiltration of the tissues it is necessary to wait about twelve months after the injury, and prognosis must necessarily be more guarded.

The relative value of bone grafts and plates is too big a question to discuss here. Personally I have not put metal of any kind into bone for about ten years. My impression is that metal is physiologically a deterrent to rapid and strong osteogenesis and repair of bone. My training has been to treat fractures by manipulation, and recent experience, during which I have seen many cases of non-union after plating, even in cases in which there is no history of sepsis following the operation, inclines me to the view that plating is an operation requiring a high degree of technical care and skill—a degree of skill attained by Lane and some of his school, but not by all his followers.

The question is whether it is more easy to train a surgeon to be an efficient master of manipulative treatment of fractures on splints or to be a master of Lane's technique in treatment by plating. My own view is that it is easier for a man to become competent in the former, and this course has the advantage of being applicable alike to the septic compound fracture and the simple fracture, while plating to be really successful must be performed in the aseptic case only.

THE TREATMENT OF CONVALESCENT SOLDIERS BY PHYSICAL MEANS.*

BY

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A GREAT military hospital may be compared to a general post office in which the sick and wounded from the front are sorted out into first, second, and third class matter.

The first class matter is distributed rapidly to regular military hospitals and those under the Red Cross, where an operation, or a short course of treatment, puts them right, and after ten days' leave they go back to the fighting line, with few exceptions.

The second class matter requires an additional stay at a convalescent hospital, commanded by an officer of the Royal Army Medical Corps, in which they receive treatment by physical means, including exercise in addition to the usual hospital treatment, and a large proportion of these men again find their way to the front.

The third class matter, however—the cases too tedious for the hospital and the convalescent camp—are more difficult to provide for and dispose of. During the first year of the war they were referred from *dépôt* to *dépôt*, always finding that they were at the wrong address, and it was not until last autumn that the Director-General was able to give his attention to these cases that had begun to accumulate in considerable numbers. He arranged a series of command *dépôts*, commanded by a combatant officer for discipline, with medical officers attached, and to them have been sent all for whom there was some hope of cure, or improvement, within a period of six months.

The objects of these *dépôts* were to return every available man to active service by treatment; to return men fit for light service abroad who could replace fit men in

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