FRACTURES OF THE SHAFT OF THE FEMUR—A DISCUSSION ON THEIR TREATMENT AND PROGNOSIS.

By SIR THOMAS MYLES, M.D. UNIV. DUB., F.R.C.S.;
Surgeon to the Richmond Hospital.

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For a long time past it has seemed to me that surgery, while advancing by leaps and bounds in other domains, has been singularly unprogressive in the matter of fractures, especially of fractures of the thigh. One reads every day in the journals records of daring and brilliant operations in the abdomen, thorax, or cranium. Suggestions full of careful thought are made by many workers in these fields, but, so far, little progress has been made, and, with a few exceptions, but little surgical thought has been bestowed on the subject I have chosen for my communication. In this particular branch of surgery the surgical mind seems to have fallen into what Swinburne calls "the slothful hebetude of the grave." We are still not merely in the early Victorian era—that age of ugliness—but it is hardly an exaggeration to say, in the days of Galen and Hippocrates.

The full tide of human thought has swept past us, engulfing old landmarks in almost every direction, but here a rigid conservatism apparently offers an insurmountable obstacle to progress, and one still sees in a most up-to-date hospital, fully equipped with the costly appliances demanded by modern surgical technique, patients with broken thighs treated by practically the

same methods as their predecessors have been treated for the last hundred years, or even more.

Very few appear to consider the subject worth giving more than a passing thought to, and the result is that progress has been practically nil. And yet the subject is worthy of the most careful consideration, as I hope to show very soon.

One reason why it has had so little consideration bestowed on it, perhaps, is that medical men themselves rarely suffer from fractures of the femur, in this respect contrasting markedly with appendicitis, enlarged prostate, and other more widely diffused ailments, the prospect of being a possible subject to each or any or all of these maladies being constantly before our mental vision, thus stimulating that imaginative faculty which is essential for novel suggestions.

If medical men themselves were more frequent sufferers from these injuries they would long since have rebelled against the traditional methods of treatment, and more modern methods would soon have displaced the older ones.

Fracture of the femur is not a common accident; practically it presents itself amongst two classes of the community only—the workingmen and the sportsmen. Of course it may happen to anyone in a railway or other accident, but, speaking broadly, it is met with most frequently amongst the classes I have mentioned. Now it may not be of any great consequence to a millionaire or a salaried official to be lame and weak in one leg, but it means a great deal to a hunting man, and still more to a workingman, whose bread depends on his muscular efficiency.

The first question I have set myself to consider, therefore, is that of the prognosis in such an injury in a work-

ingman or a hunting squire. Is a workingman as efficient after this accident as before, and can a sporting man ride, shoot, play cricket, tennis, &c., as well as he used to before he broke his femur? The answer to these questions can be supplied in part by one's individual experience, and in part by a study of museum specimens and X-ray photographs. My own experience of the result of routine treatment in these cases is not very encouraging. I have found that in nearly all cases occurring in adults there has been considerable shortening and consequent lameness, some stiffness in the knee-joint, some limitation of the movements of rotation at the hip-joint, a varying degree of muscular atrophy, pain with changes in the weather, and almost always an ugly knob of callus to be felt or seen at the seat of the united fracture.

Some of these patients amongst the well-to-do found that riding became painful afterwards, probably from the pressure of a bony projection on some of the nerve trunks; none of them could run or jump as they used to do, and they all suffered for some years after from coldness and œdema of the foot on the injured side. At first I felt inclined to blame myself for these results, but further study of the subject soon taught me that such results are the invariable and inevitable results of the methods of treatment usually adopted—methods sanctioned by tradition and the teaching of the schools.

A study of the museum specimens of this injury is very instructive, and calculated to modify one's previous conception of what actually takes place in these cases. We are not all pathologists, nor have we all access to museum specimens, by the study of which we may hope to educate ourselves; consequently we are not much to blame if our imaginary conception of what takes place in these in-

juries is found to differ very materially from the actualities presented by museum specimens. I remember once, some years ago, asking a well-known surgeon of great intelligence—now, alas! no more—if he found as great difficulties as I had in effecting even decent approximation of the broken ends in fractured femur. To my astonishment he told me that under an anæsthetic he never had any difficulty in effecting perfect end-to-end apposition in transverse fractures, and that he always got perfect results in such cases! I could only congratulate him on his good fortune, and envy him the mental condition which enabled him to hold such a belief.

Now such a belief—absolutely foundationless—is fairly widespread. The general idea amongst such believers is that it is not difficult under complete anæsthesia to get end-to-end apposition of the fragments, that they can be held in this position by splints, weight and pulley arrangements, &c., and that a nice spindle-shaped lump of callus surrounds and holds the ends together, and that the patient's leg is just as well as ever after the fracture, if not a little better!

It is a very curious fact that amongst the many museum specimens of this injury I have examined I have never yet had the good fortune to meet one illustrating this method of union. One is forced either to believe that the museum contributors for several generations have wickedly combined to exclude such specimens from their collections or, "*horribile dictu*," that such specimens do not exist. That the latter is the more probable explanation is supported by a study of X-ray photos of these injuries. Of these there are a great many now in existence, and men who have made a special study of X-ray work—such as Dr. R. Lane-Joynt and Dr. W. Haughton—

tell me that they have no specimens in their collections illustrating this traditionally-accepted method of union.

As a matter of fact a study of museum specimens and of X-ray photos show certain constant factors in these cases :—

1. There is always shortening due to overlapping of the fragments.

2. The lower fragment may be in front or behind, inside or outside the upper fragment; it is never exactly where it ought to be.

3. The lower fragment is rotated either inwards or outwards; it is never in perfect alignment with the upper. It may be in approximate alignment, but it is never in perfect alignment, and it cannot be.

4. It is absolutely impossible to decide by the unaided eye, touch, or measurements what the actual displacement of the fragments is. The mass of muscle surrounding the bone, the extravasated blood, the enveloping skin and fasciæ all combine to soften the asperities of the actual outline in the same way as a fresh fall of snow smooths out and diminishes the irregularities of contour in a landscape.

It is the tell-tale X-ray which shatters one's hopes and shows us that the limb, after all our effort, is little better than a whitened sepulchre; that we are still far indeed from the realisation of our ideal.

The amount of actual bony displacement that may exist, completely masked by the soft parts, is incredible to all save those who have studied this question with the aid of X-ray photos.

Let anyone glance for a moment at the specimens illustrated here, and he will, I think, have no difficulty in understanding why such patients complained of pain and weakness in the limb, of marked lameness, of coldness and

œdema of the foot below, nor is it more difficult to understand that men so afflicted can no longer ride, run, swim, or tramp across a moor, gun in hand, as they did before their accident.

It is, I think, fairly obvious, therefore that fracture of the shaft of the femur is a very grave accident indeed, and one well worthy of the most careful consideration.

Hitherto surgeons have quietly accepted the teachings of the great men of the past, that shortening of an inch or more is the inevitable outcome of such injuries, and that nothing can be done to prevent it. But surely this is an unworthy position to take up at this period of the world's history. Are we not bound to make use of all the advantages that progress in other directions has made available for us? Is the technique which has made safe the great operations in other branches of surgery not to be utilised in this particular branch of our work? Are we bound to doom a young man to lameness and inactivity for the rest of his life through lack of courage to face a comparatively novel problem?

My plea is for greater boldness in dealing with these cases; that in suitable circumstances we should not deny them the advantages, added risks notwithstanding, which the improvements in modern technique have placed within our reach. Let the facts be stated frankly and plainly to our patients; let them understand clearly the risks and advantages on the one hand, the freedom from risk and disadvantages on the other, and I am convinced that the average young man will not hesitate to face the risks inevitably incidental to all operative methods.

There is one other point to which I should like to refer before leaving this part of the subject. Hitherto the loss of muscular efficiency in these cases has been attributed to the shortening due to the overlapping of the segments and possibly to some angularity at the seat of union.

While not denying that these factors play a prominent part in producing the ultimate result, I am convinced that too little importance has been attached to the want of perfect alignment in the united fragments. Somehow most of us in making a mental picture of the femur consider it as roughly a straight bone, slightly convex forwards. Take a normal femur and study it carefully; it is by no means a straight bone, but a series of curves and angles. I need not attempt here to give a verbal picture of the anatomy of the femur. It is to be found with more or less accuracy in every text-book of anatomy. But if we look carefully first at a normal femur and then at any of the specimens of united fracture in the museums, we cannot fail to see how large a part the inevitable lack of perfect alignment must play in producing that diminution of muscular efficiency which is so painfully apparent in these cases.

No method of treatment other than exposure by dissection holds out any hope of a perfect restoration of alignment. It is only by actually seeing the parts dove-tailed back into their original positions that we can ensure perfect alignment. Apart from this operative exposure, the most careful measurement, palpation and manipulation are in vain—even the X-ray itself fails us here. True we can rotate the lower fragments inwards or outwards, but practically we can neither precisely determine the actual position *qua* rotation of the upper fragment, nor can we adequately correct it if we wish to do so by any appliance at present at our disposal. I am quite aware that in urging the more frequent use of operative methods I am assuming a grave responsibility, and this responsibility I propose to diminish by certain limitations. In the first place, operations of the kind to be described hereafter should not be undertaken by men other than those en-

gaged in daily operative work at the hospitals. They should not, save in very rare cases, be undertaken in private houses. They should never be performed save in healthy youths or adults.

A very perfect technique must be at the operator's disposal, and plenty of skilled assistants. The operator must have an adequate armamentarium, and his requirements in this direction should be determined by previous experiment on the cadaver.

Given all these preliminary requirements, operations on fractured thighs should not be more hazardous than any of the countless operations performed in the hospitals of a great city throughout the year.

It is fairly well known now, thanks to X-ray photography, that the broken ends of the fragments present great diversity in the minute details of their appearance. Sometimes the bone is broken nearly square across, with or without partial or complete detachment of angular fragments. In others the line of fracture is of varying degrees of obliquity, ranging from one to as many as five inches in length. In cases of extreme obliquity, the long axis of the bone seems to be almost bisected, so that each segment offers but little holding ground for any mechanical appliance to be embedded in. In others, again, the line of fracture is an irregular spiral; while in some the bone may be extensively comminuted. It is obvious, therefore, that it will be very difficult to make any one method of treatment equally efficient for the treatment of these diverse conditions, and the surgeon who proposes to substitute operative for non-operative methods of treatment must be prepared to modify his plans as the actual conditions to be dealt with are revealed by X-ray examination, and by the preliminary exposure of the seat of fracture.

The methods I now propose to discuss are of three kinds:—

1. Simple wiring of the fragments together after exposure and drilling.
2. A modification of the ingenious apparatus suggested by Mr. Park Hill, of Denver.
3. The use of short steel screws as recommended by Mr. Arbuthnot Lane.

SUTURING WITH WIRE.

Even with the most perfect equipment the securing of a plain transverse fracture by drilling and wiring is a task of great difficulty. To get the parts rigidly into position at least four separate wire sutures must be passed, each suture entering the periphery of one segment, then emerging through the medullary canal at the seat of fracture, re-entering the medullary canal of the other segment and emerging at its periphery.

If four such sutures can be passed and secured with a uniform degree of tension, an excellent result will be achieved. But practically this is impossible to accomplish. One suture must be at the side of the bone remote from the surgeon, and this suture it is practically impossible to make secure.

Assuming that the ends of the fragment have been projected through the wound and duly drilled, the sutures can now be passed, with some difficult manipulation no doubt, but still the four sutures can be passed and got into position for tightening. Now comes the crux. The segments when reduced are overlapping. This overlapping has to be overcome by traction on the lower segment, but this very traction now makes the aponeuroses and muscles so tense that there is no room for one's hands to grasp and make traction on the suture most remote

from the operator, and if this deepest suture is not made taut a hinge movement will be permitted by the other three—not only will a hinge movement be possible, but even a worse result may happen—namely, that the lower fragment may slide so far outwards as to be ultimately in lateral, not end-to-end, apposition.

This result is due to the fact that so-called flexible wire, iron or silver, is never as flexible as silk or other common suture material. It is mechanically impossible to make wire sutures as tight as silk could be made around the four angles which each suture must traverse. Further, any slight initial relaxation that may have occurred at the operation tends to increase from day to day, partly by actual stretching of the wire itself, partly by the absorption of the bone from pressure at the drill holes. If the broken faces can be kept squarely in position these changes do not occur, but if the least lateral movement is allowed by the absence of the fourth suture the factors described at once become operative.

I do not mean to say that this is a fatal objection to the method, as the defects may be neutralised by splints, but then one great advantage of operation is lost—viz., the ability to dispense with the splints altogether and to procure immediate fixation of the fragments in their original relative positions. A consideration of these factors and practical experience have led me to abandon the simple wiring method in clean cut transverse fractures.

In oblique fractures the problem is totally different, and here the wires may be used most effectively. The method I have adopted in such cases is as follows:—

An incision is made on the outside or in front, and the segments examined by both sight and touch. In these oblique fractures it is usually fairly easy to determine the previous relations of the spikes and recesses on the two frag-

ments to each other. Once this is done it is easy to drill at least one hole in each segment in such a position as will give satisfaction afterwards. It is not advisable to drill the bone directly at right angles to its long axis. It is better to drill it obliquely—that is to say, to drill the lower fragment at a slightly higher level than the upper. This makes the wires more tense when the muscles tend to draw the lower segment upwards. This difference in level must not be too great, as then there will be a thread of wire intervening between the fragments, preventing perfect apposition. It may be advisable to drill a second, or even third, hole, but in the long oblique type one drill hole is sufficient—the upper and lower ends being simply secured by a circular lashing of wire or chromic catgut.

THE PARK HILL METHOD.

The method that I think, on the whole, promises to give the best results is that associated with the name of Mr. Park Hill. The principle underlying this method seems to me to be very sound, though in the original appliance certain mechanical deficiencies became apparent on use. These deficiencies have been largely corrected by adopting the suggestions of my friend, Dr. R. Lane-Joynt, whose mechanical aptitudes are so well known, and are placed so freely at the disposal of his professional brethren.

The apparatus which he has devised and perfected, and which I am now using fairly extensively, may be described as follows:—First let us understand the fundamental principle on which the instrument is based. Everyone is familiar with the fact that a fractured tibia undergoes but slight displacement if the fibula remains unbroken. To Mr. Park Hill belongs the credit of proposing to supply to a broken femur or humerus an artificial equivalent of the fibula in the lower limb.

To do this several holes are drilled in the upper and lower segments of the broken femur, at right angles to the long axis of the bone. In these holes long, strong, steel screws are firmly embedded, their free ends projecting six or seven inches, or more, beyond the muscles and skin of the limb. If these free ends are now caught in a long clamp, so strong and so tightly clamped that the screws cannot move, it is obvious that the clamp becomes practically an artificial fibula to the femur, and it is equally obvious that if the fragments have first been absolutely restored to their original position, and when so restored that the clamp has then been tightened on the screws, nothing short of great violence can disturb the bony segments. When first using this apparatus we met with certain mechanical difficulties, and all the modifications suggested and executed by Dr. Joynt have been designed to overcome these difficulties.

First you have the difficulty arising from the fact that the femur is curved slightly and the clamp sides are straight. In other words, assuming that four or six long screws are put from outside into the shaft of the femur, say one inch apart, and exactly equi-distant from the anterior and posterior surfaces of the bone, a line connecting the external ends of these four or six screws will be a curved line, while the sides of the clamp that holds them are in a straight line. The result of tightening the clamp, therefore, will be to tend to diminish the normal forward convexity of the femur.

On the other hand, if the sides of the clamp be curved, it will be necessary to equip oneself with a number of clamps to suit the varying degrees of femoral convexity and the exact seat of the injury. Again, if six screw holes have to be drilled in the shaft of the bone, to ensure that they are exactly in the proper line, each equi-distant

between the anterior and posterior surfaces, it will be necessary to make an enormous incision, and to expose the bone over a very large area.

These difficulties have been overcome in Dr. Joynt's modification of the apparatus by interpolating a universal joint, capable of being rigidly locked in the middle of the clamp. This device makes the instrument easier of application, and increases its efficiency enormously.

Thus it is no longer necessary to make a huge incision, exposing the bone over a large area. It is now sufficient to make one incision, say two inches in length, at the seat of fracture, to enable the operator to see and feel that perfect adjustment has been accomplished. The screws, four or six in number, are inserted through small puncture wounds at some distance from the site of fracture. So long as those in each segment of bone are fairly well in line it is immaterial if those in the upper segment are not at first completely in line with those in the lower, as the universal joint in the clamp allows the lower segment to be rotated in any desired direction until perfect alignment of the segments is obtained, when the clamp can easily be locked securely.

Parenthetically I may say here that the farther from the seat of fracture that the top and bottom screws are inserted the greater will be the mechanical advantages of the method in securing absolute rigidity in the fracture.

The drawings attached explain clearly the principles upon which this ingenious device is based, and will be easily understood by anyone.

The method, it will be apparent, is not suitable for children, as the femur is too small in calibre to carry the screws well, and force applied through the screws, using them as levers, may cause longitudinal fractures of the

bone; but for uncomplicated cases in adults it promises to be the easiest and safest method yet devised.

Moreover, in fractures near the trochanters above, or the condyles below, it is incomparably superior to any method of wiring or the use of screws. It is in fractures near the trochanters that the most hideous results are met with from the ordinary treatment by splints, flexion of the thigh, bandages, &c.

The upper segment in these cases is seriously displaced; being usually flexed, abducted and everted, the lower fragment is drawn up inside and behind it, so that when union takes place the result is something which resembles the striking end of a polo mallet. The shortening and irregularity are not the worst features, however. Owing to the abduction of the upper segment the top of the great trochanter is approximated to the pelvis, so that when union has taken place actual abduction becomes impossible owing to the top of the trochanter striking against the pelvis.

Further, it is practically impossible to maintain any real extension by strapping plaster fixed above the knee only, a limitation necessitated by the flexion of the thigh required to bring about even approximate parallelism of the two segments.

Another point not to be forgotten is that in fractures close to the trochanter minor splints applied in front exert little or no pressure on the upper segment, owing to the fact that a bandage around the thigh at the level of the perineum is really below the end of the upper fragment.

Similarly in fractures near the condyles, where great distortion occurs through the rotating influence of the calf muscles, the Park Hill apparatus promises to be of great service.

In this situation wiring is, from anatomical and mechanical reasons, very difficult, involving great labour and prolonged exposure of the parts, whereas even a very small lower fragment will permit of the application of two screws, one of which may be inserted into the condyle itself if necessary.

The clamp and screws are left *in situ* for about four weeks, when, in a healthy patient, it will be found that fairly firm union has taken place. One very striking clinical fact about the use of this method is the immediate relief from pain that the patients obtain. All muscular spasm seems to cease, good sleep is obtained, and the discharge of the natural functions is no longer an ever-recurring painful ordeal.

If the technique has been perfect one dressing suffices for the entire case. When this dressing is removed a number of small crusts are found around the apertures in the skin through which the screws emerge. These latter are gently withdrawn by unscrewing. They should not, even if loose, be pulled out. In a few days' time the minute channels have healed and the patient is practically well, with a limb, save for the muscular atrophy due to inaction, as efficient and useful as before his injury.

In all these operations it will be advisable to have X-ray photos taken at intervals from points 90° apart, to ensure that perfect apposition is being maintained throughout.

THE USE OF SCREWS.

This method, which owes its origin to the suggestion of our brilliant countryman, Mr. Arbuthnot Lane, is well worthy of a more extended trial than it has hitherto received. It is especially applicable to cases of oblique

fractures; the greater the obliquity the better, provided that the ends of the bone are not comminuted.

The method of employing screws has been given with such amplitude of detail by Mr. Arbuthnot Lane that it is not necessary for me to refer to it here. A word of warning, however, is necessary for those who are yet practically unacquainted with the method, but may wish to make a trial of it. It must not be forgotten that to ensure getting the screws exactly into correct position the fragments must first be accurately reduced, and then firmly held in position by the special forceps designed for the purpose. This necessitates rather a free exposure of the bone and detachment of the muscles from the areas grasped by the forceps blades. If this is not done necrosis of the crushed muscle fibres may ensue and afford a nidus for infective organisms to develop in.

Again, in the small bones of women and boys the screws hardly get enough grip to make secure union. In the adult this objection does not hold, and excellent results indeed can be obtained. In fact, in a satisfactory case, the after result of the use of two well-placed screws is, to my mind, better than that obtained by any other method, but it must be acknowledged that it requires a higher degree of mechanical aptitude to use the screws properly than to employ the wire or the Park Hill apparatus.

One has also to keep clearly before one's mental vision the position of the femoral vessels, that they may not be injured by the ends of the screws coming through the bone, and the length of the screws to be used must be very precisely determined before insertion.

All the precautions as to riming the proximal compact layer of bone so as to allow of depression of the head

of the screw, insisted on by Mr. Lane, must be carefully adopted if success is to be achieved.

It will, of course, be understood that in this method the incision to expose the fracture may be in front or outside, as may seem most convenient, but the presence of the femoral vessels prohibits incision on the inner side of the thigh.

Recently an ingenious suggestion has been made to use an aluminium plate as an imbedded splint by fixing it with screws to the two fragments and closing the wound over the lot.

I have no practical experience of the method, and therefore do not venture to offer an opinion on its merits. Further experience by its originator will doubtless in time enable us to contrast its comparative efficiency with the methods described above.

In concluding this communication I may be permitted to offer a word of advice to those who may desire to practice one or all of these methods, but as yet are without practical experience on the subject.

1. Find out as much as you possibly can as to the exact condition of the broken bone at the seat of fracture by a series of X-ray photos.

2. Think out very carefully beforehand which method is likely to give the best result.

3. Drill the bone with a Morse drill set in a brace.

4. If using the Park Hill screws see that the tap for cutting the screw thread in the bone is of exactly the same size as the screw to be inserted later, and is but little larger than the Morse drill.

5. Never try to hurry the tap, let it cut its own way in the bone.

6. When the ends of the fragments are exposed, measure their diameters and mark the screws at a point

from their buried ends, exactly equal to this depth, so that they may not project through the bone, and perhaps injure the vessels.

7. If using the Park Hill method remember that the wooded faces of the clamps taken from the boiler wet will shrink as they dry, and the screws holding them in position must be tightened in an hour or so.

8. Take an X-ray photo the next day from two points 90° apart to insure that position is maintained.

9. Remember that to pass a ligature around the bones a very large and powerful needle must be used, as the tough tissues about the linea aspera offer a considerable obstacle to the passage of a needle.

Lastly, practice the operation on the cadaver before trying it on the living.