A British Medical Association Lecture ON THE TREATMENT OF FRACTURES.*

BY

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PRIOR to the war, of the three schools of thought as to the treatment of fractures each had adherents, but the school which advised and practised operative fixation appeared to be gaining favour at the expense of the less spectacular treatments of conservative immobilization and mobilization with massage. In certain cases results by either method left much to be desired.

The diversity of opinion, and oftentimes the poor results, led the British Medical Association to appoint a committee to report on the merits and demerits of treatment by operation or by splinting.¹ One of the conclusions reached by this committee was as follows:

"For surgeons and practitioners who are unable to avail themselves of the operative method the non-operative procedures are likely to remain for some time yet the more safe and serviceable."

This conclusion obviously favoured the operative method, and the general practitioner was left in doubt whether he was justified in treating his own fractures or whether he was to hand them over to the surgeon at the nearest hospital.

During the war most members of the profession had ample opportunity of treating compound fractures, or at any rate of seeing the results of such cases treated by conservative means where this treatment was standardized according to the ideas of the Liverpool orthopaedic school, with modifications such as are exemplified by the work of Pearson, Sinclair, and others. Conservative treatment by splinting has thus again come into its own purely on account of the excellent results gained by standardized methods in thousands of gunshot compound fractures obviously unsuitable for operative fixation of fragments.

In the early days of the war some surgeons tried the effect of plating septic compound fractures, in the hope that the good effect of immobilization of the broken ends would outweigh the ill effects of interference and the inclusion of foreign material. This effort was short-lived, and rightly so, as the results were universally bad.

I mention the various methods of treatment in order to emphasize the fact that in treating fractures in civil life, which are for the most part simple fractures, we should not be hidebound adherents of a single method. Where our experience tells us that we cannot get a good functional result by splinting alone we should be prepared to operate, provided we have experience in that method also. The main essential is that, following general principles guiding treatment, we shall pay the strictest attention to detail in whatever method we adopt. I was closely associated with Sir Robert Jones for seven years, and am imbued with his principles and follow his methods, therefore I am biassed towards conservatism in treatment. The advent of radiography has educated the profession as to the shortcomings of accurate fragmental apposition in conservatism, but in addition it has falsely educated the laity. Patients see their x-ray plates showing firmly united fractures in good alignment, with good functional result, but because the fragments are not meticulously apposed they deem themselves the victims of malpraxis, and strained relations may ensue. The public will in time, no doubt, become educated to the axiom that it is not possible to either guarantee accurate anatomical reposition by mechanical means or perfect function by operative methods.

The principles laid down by H. O. Thomas and Sir Robert Jones in the mechanical treatment of fractures are important and have a direct bearing on successful outcome.

1. A fracture is a potential deformity and must be regarded as such. By treatment the potentiality must be prevented from becoming a reality.

2. Strong, steady, fixed extension, with corresponding counter-extension is required as distinguished from forcible intermittent pull succeeded by a period of muscular relaxation. This principle is applicable more especially to fractures of the lower extremity, particularly the shaft of the femur. It is held that a steady traction through a Thomas bed splint, with the counter-extension of the ring of the splint against the tuber ischii, is preferable to the inclined bed and weight-and-pulley method. The latter, though theoretically constant in pull, is practically intermittent when the patient moves up and down the bed, on account of the friction of the limb against the subjacent mattress.

3. Correct alignment in conjunction with obliteration of shortening. A reduction which is incomplete at the primary operation can easily be made complete within the next few days by merely continuing and increasing the extension. The correction is brought about by fixed extension combined with appropriately fixed pads to overcome lateral deviation. This combination may also require the lower end of the fragment to be approximated to the upper by altering the position of the limb.

4. Avoid rigid circular compression which tends to produce ischaemia. In this regard the use of plaster-of-Paris as a primary dressing is dangerous except in the hands of experts. Splints should be shaped to the contour of the limb. Concavo-convex metal splints are the most favoured. They can be bent or twisted at will to produce the desired effect. They must be of greater width than the limb to be immobilized so that the circulation shall not be impeded.

5. Union may be delayed; this is sometimes unavoidable, but there is a vast difference between delayed union and non-union. When union is slow, it is of great importance to leave the limb alone and not repeatedly to move the fragments to see how things are progressing. Thomas laid down the rule that the rest must be prolonged and absolute. Idle curiosity may be instrumental in converting a delayed union into a non-union.

6. Union of a fracture does not imply its consolidation. Bones which appear firm on palpation or manual pressure will, after many weeks, yield to the body weight.

MAL-UNION AND NON-UNION.

Both mal-union and non-union are common occurrences and are often related. Angular deformities should not occur; even if we cannot produce an end-to-end apposition by traction and splinting there should be no difficulty in securing correct alignment. This is of great importance in the lower limb.

The Commonest Types of Mal-union.

In fractures of the neck of the femur the angle between neck and shaft is reduced and a condition of coxa vara results. Where the fracture is in the upper third of the shaft the upper fragment is abducted, the lower fragment pulled up to the inner side of the upper one, and a shortened bowed femur results. In fractures of the middle of the shaft there is a concavity forwards instead of the normal convexity, and genu recurvatum is afterwards found to be present. The same thing happens where the injury is in the lower fourth of the shaft. Here the upper end of the lower fragment lies behind the lower end of the upper one, and the lower fragment may even point almost directly backwards.

Fractures in the upper third of the leg may lead to a high bow leg (Fig. 1). Fractures of the middle third may result in knock-knee with either inversion or eversion of the foot, and fractures of the lower third of both bones generally end with a valgoid deformity of the foot with an internal rotation. The deformity of a malunited Pott's fracture is familiar to us all, and it is very often a shock to the surgeon who treated the case, as the deformity may arise after the patient has left his care.

Deviation from correct alignment means, in accordance with Wolff's law, alteration in structures—that is to say,

FIG. 1.—High bow leg after fracture of the upper third of the femur.

* Delivered before the East Hertfordshire Division, December 15th, 1920.

the internal architecture of the bone changes in response to new forces of strain and muscular stress that the bone itself is called upon to stand. It also means that aberrant forces are thrown on to the joints above and below, and this, combined with deviated lines of muscle pull, will result in chronic pain and discomfort, and traumatic arthritis may result. This traumatic arthritis may be the forerunner of hypertrophic rheumatoid changes in the involved joints.

Even end-to-end apposition of fragments may result in malunion where slight lateral or antero-posterior deviation causes faulty deflection of body weight.

THE COMMONEST CAUSES OF MALUNION.

1. *Being too Sparing with Traction.*

It is useless to be ladylike with a fracture in a strong muscular man, especially of femur or tibia. Traction with a pulley should be begun before the splint is applied, and we should not be satisfied until the affected side is of equal length with the other, even if continued and ever-increasing traction in the splint for a few days is found to be necessary. If the bones are of equal length there cannot be much overlap and no lateral deviation. In recent fractures of the lower extremity pulleys are rarely needed except in the very muscular. Preliminary traction by means of a roller towel clove-hitched round the limb, counter-extension being obtained by another roller towel round the perineum and fixed to the leg of the table at the head end, is generally sufficient. In cases of older standing, not firmly united, a three-ply or five-ply pulley may be requisitioned. Here the counter-extension must be of stronger material. To prepare for such cases ring bolts should be let into the wall at each end of the operating room at a height of about 3 ft. Where union is complete an oblique osteotomy is performed at the site of malunion, and I am accustomed to get primary extension by means of a steel drill through the lower end of the involved bone, sterilized steel wires are attached to it, and the other ends are looped through the pulley hook.

It is surprising what strain can be obtained by this means, and I have successfully reduced a shortening of 3 in. at one sitting without damage to soft parts where the fracture was of six months' standing.

2. *Inefficient Splinting.*

The splint should allow continuous extension in the correct line for the obviation of deformity, and it should control the joint above and below the fracture. Where bones are naturally curved, as the shaft of the tibia, this curve must be imitated in fractures of both bones of the leg by laterally pulling bandages and pads. If the leg is set absolutely straight, an everted ankle and a strained internal lateral ligament of the knee will result when the patient begins to walk.

3. *The Effect of Allowing Body Weight to Fall on Recovering Bone too soon.*

An apparently sound bone may bend when the patient begins to walk, because steps are not taken to prevent faulty deflection of body weight. Textbooks are too optimistic about the period of time requisite for complete consolidation to take place. This has been shown in a series of fractured femora measured at subsequent dates after the patient had been allowed to walk. In each case a certain amount of telescoping had occurred. It is also a fact that one can frequently refracture a bone by manual manipulation after eight to twelve weeks.

For the prevention of deformity during the period of after-treatment it is necessary to take a large amount of weight-bearing strain from the fracture. It is a good working rule to fit all fractures of the femur with walking callipers for at least eight weeks after the bone is considered sound enough to let the patient up. Corresponding fractures of the upper third of the tibia should be similarly treated. Patients who have had fractures of the middle and lower thirds of both bones and Pott's fractures should be allowed to walk with a light outside iron extending from the heel of the boot to two inches below the knee-joint, and the inner side of the sole and heel of the boot should be built up a third of an inch in order to prevent the valgoid deformity that is otherwise so apt to manifest itself.

NON-UNION.

Some fractures are slower than others in beginning to unite, and here the surgeon must possess his soul in patience and leave the fracture alone. Too much interference in the way of constantly taking splints off and moving the fragments to see if union is occurring is apt to end in non-union.

Treatment by what Thomas called damming and hammering is of assistance. Passive congestion by means of rubber tubes tied above and below the fracture, sufficiently tightly to impede venous return, should be carried out for increasing periods of time every day until two to three hours is borne without undue discomfort. The ends are hammered by a small leather-covered wooden mallet twice a week to produce subperiosteal stimulation, and thus acts in the same way as the method of rubbing the ununited ends of the bone. Where non-union is definitely established, and where conservative means as outlined above have failed, the question of operation arises. In fractures of the lower extremity operation should be postponed until the effect of the patient getting about with the aid of an appliance has been tried without success. The number of stubborn non-unions that respond to this simple procedure is surprising. The need for operation having arisen, the question whether this should consist of freshening the fractured ends and bone-plating or bone-grafting is one which depends on personal choice. For myself I invariably use a bone graft; it is preferable to get the graft from the tibia rather than to use a slide inlay of the involved bone, as this is invariably porous as a result of prolonged disuse. Plating is obviously preferable to wiring for immobilizing the freshened ends where bone-grafting is not resorted to, but a circular wire loop is often of advantage where the non-union is merely due to the interposition of muscle or fascia.

If comminuted fractures appear to require operative interference, it is advisable to leave all splintered bone in position, even in the presence of sepsis. This was impressed on us all during the war. The wholesale removal of bone fragments is apt to result in non-union.

The Signs of Faulty and Delayed Union.

If there be pain over the site of a fracture of old standing, especially on digital pressure, unsound union may be suspected, and if this pain be accompanied by an exuberant callus formation the diagnosis is absolute. If malunion be present in addition, manual manipulation with the aid of a wedge will be sufficient to correct the deformity, and the irritation so caused may expedite firm union; congestion and hammering may also be used with advantage.

Operation or Splinting.

The question what fractures should be treated at once by operation, and which by splinting, must be answered by each individual surgeon according to his mechanical or operative aptitude.

I generally operate on spiral fractures of the lower third of the leg by means of inlay grafts, but plating is equally satisfactory in skilled hands. Fractures of the patella in the transverse axis I treat by wiring, as also fractures of the olecranon, where there is a large gap with rotation of the fragment. I also operate on scaphoid fractures where the proximal fragment prevents full hyper-extension of the wrist and where there is palmar dislocation of the semilunar. Removal of the proximal portion of the scaphoid is generally sufficient.

All other fractures I endeavour to treat by means of splinting or posture, or both, combined in some cases with rigid extension and counter-extension.

FRACTURES OF THE LOWER EXTREMITY.

Fractures of the neck of the femur and of the upper fourth of the shaft are best treated in the double Thomas frame with extension straps on both legs, the affected limb being widely abducted. The groin strap round the groin on the sound side gives adequate counter-extension (Fig. 2).

The exception is in cases of old people, where prolonged recumbency is contraindicated on account of the risk of pulmonary congestion. One must judge by general appearances; the plethoric type of old age fares badly on a

frame. In these cases it is advisable to fit a walking caliper made half an inch too long and allow the patient up on crutches. The American school uses a plaster

FIG. 2.—Double Thomas's frame for abduction of the affected limb in fracture of the neck and upper fourth of the femur.

spica in wide abduction—the so-called Whitman position—instead of the Thomas frame.

The question of separating impacted fractures of the neck depends on the amount of deformity: unless there is extreme rotation outwards of the whole leg the condition is best left alone in old people.

Careful nursing is essential in cases treated on a frame; the back must be carefully rubbed with talcum powder twice daily, the flat of the hand being carefully interposed between the skin of the back and the pad of the frame. An alcohol rub twice weekly

is also necessary. With these rules strictly obeyed no skin trouble need be feared.

Fractures of the middle and lower portions of the shaft of the femur, fractures of condyles, and fractures of tibial tuberosities and shaft in the upper three-fourths, are all treated in the Thomas knee-bed splint. I have heard it said by men who are not conversant with this splint that pressure sores are common with it, and for that reason they carry on with the long Liston splint. With proper nursing precautions pressure sores under the ring of the splint should be unknown, despite the tremendous pressure to which the skin in the region of the tuber ischii is subjected when heavy traction is required. Here again the skin round and under the ring must be carefully rubbed with talcum several times a day; the patient usually does it himself under supervision; rubbings with alcohol are also required to harden the skin. The skin in the region is so movable, that a fresh area can be subjected to pressure by merely pulling or pushing it under the ring; the same effect can be produced by slightly altering the position of the limb into various degrees of flexion, abduction, and adduction. Where it is difficult during the first two or three days to reduce the shortening of the limb (the dangerous period for pressure necrosis of the skin under the ring), it is advisable to tilt the foot of the bed, and fasten the lower end of the splint to the lower bars of the bed. The body weight thus keeps up and tends to increase traction, and at the same time reduces pressure on the skin of the buttock.

I use adhesive straps made of coarse holland, which I find last longer than Sinclair's glue, and I do not bend the splint either at the knee or at the site of fracture in

FIG. 3.—Use of malleable iron posterior splint in fracture of the middle third of the femur.

femoral cases. To preserve the antero-posterior convexity of the femur and to prevent hyperextension of the knee I use big pads interposed between the leg and the malleable iron splint which is slung beneath. This fracture-splint should run from a point two inches below the gluteal fold to the lower third of the leg (Fig. 3).

In fractures of the lower third of the femur a big pad is required beneath the site of fracture; if despite firm traction the backward distortion of the lower fragment remains, it may be necessary to divide the tendo Achillis; this, however, is very seldom required. Angulation is prevented by the application of laterally applied bandages fixed to the side bar of the bed-splint.

The use of callipers, ice-tongs and Steinmann's pins to produce traction are complications which are only applicable in hospital and in the hands of experts, and in a large percentage of cases are unnecessary.

Fractures of the tibia, with the exception of Pott's fracture, are treated on the same lines, and fractures involving the knee-joint require adequate restoration of fragments by manual pressure combined with traction. The fragments are easily controlled by a broad ring of adhesive strapping around the leg.

The reduction of a Pott's fracture is of greater importance than the splinting. forcible traction with the foot in extreme extension combined with a downward pull on the leg and an upward pull on the heel to reduce the backward displacement of the foot should reduce the deformity, but occasionally it is necessary to divide the tendo Achillis. The foot is then forcibly inverted into an over-corrected position. Side-splints of metal extending from the knee-joint, the outer one projecting three inches beyond the heel, are suitably padded to keep up the inversion and bandaged into position. The projecting portion of the outer splint is now bent inwards to meet the inferior extremity of the inner splint. A box is thus formed which, when duly bandaged, keeps the foot at a right angle and prevents the dropping back of the heel. In fractures of the tarsus, when reduction is complete, all that is necessary is for the foot to be kept at a right angle.

FRACTURES OF THE UPPER EXTREMITY.

Fractures of the humerus in the region of the shoulder-joint, if inefficiently treated, may become malunited with, as a result, limitation of abduction and external rotation. Fractures in the region of the elbow-joint are apt to result in defects of flexion and supination. Supination is often deficient in fractures of both bones of the forearm, and the deformity of a malunited Colles's fracture, with limitation of wrist movement, of pronation and supination, and of finger flexion is well known.

Fractures of the anatomical neck of the humerus are best treated by a wrist sling which allows the weight of the arm to act as an extension—a pad in the axilla to produce slight abduction of the upper arm, and an encircling bandage round arm and trunk to fix the humerus.

Separation of the upper humeral epiphysis in childhood or adolescence may produce marked abduction and external rotation of the upper fragment, which, if unreduced, will result in inability to raise the arm above the head. In treating this condition it is advisable to abduct the arm to a right angle and to rotate it outwards till the hand is level with the mouth, and to immobilize the arm in this position either by one of the humerus abduction splints or in plaster (Fig. 4). Sometimes the amount of abduction and rotation are so extreme that it is necessary to fix the arm in plaster above the head in what may be termed the "Kamerad" position.

FIG. 4.—Humerus abduction splint.

Fractures of the surgical neck are often impacted, and the question of disimpaction depends on the abduction deformity of the upper extremity. Should it be found necessary, the method of Thomas (Fig. 5) is excellent. The patient is seated on a chair near the wall and a roller towel is passed under the axilla and fastened to a coat-hook or nail. A wrist sling is fastened round the neck and a clove hitch is made fast to the elbow with a long loop which comes to within a foot of the floor and which acts as a stirrup for the operator's foot. Extension is thus obtained, leaving both hands free for manipulation. The axis of the pull is brought to the abducted position, and when reduction appears complete the arm is forced upwards and reimpacted. Treatment is now carried on as for fractures

of the anatomical neck except that a larger axillary pad is indicated.

Fractures of the shaft are treated by malleable iron fracture splints, which can be bent to cover in the shoulder-joint and thus produce fixation.

All fractures in the region of the elbow-joint, with the exception of the olecranon, are treated, after adequate and

FIG. 5.—Thomas's method for reduction of impaction in fracture of the surgical neck of the humerus.

complete reduction, in the Jones or fully-flexed position. This position cannot be obtained unless reduction is complete. Whether the fracture is supracondylar, T-shaped, or intercondylar, one must reduce by traction-extension, supination, and hyperflexion, and, if the latter cannot be obtained, the routine must be repeated until it is, and the arm must then be kept in this position at rest for at least three to four weeks. A warning must be given against passive movements after the arm is being gradually brought down, otherwise traumatic arthritis and consequent stiffness of the elbow ensues. As an empiricism it is advisable to let the wrist sling down a little every week until the arm is at a right angle at the end of the sixth week. After the fourth week the patient can use the arm in the sling with moderation, and massage may be given as an adjunct to treatment, but forcible passive movement is absolutely contraindicated. For this type of fracture the rectangular internal splint should be abolished.

Fractures of the head and neck of the radius must be fixed in full supination, otherwise limitation of this movement will certainly result. Fractures of the shaft of both bones require consideration of two important points: first, the shaft of the ulna must be kept straight, and secondly, the curve of the radius must be conserved as the

FIG. 6.—Splints twisted for the treatment of Colles's fracture.

whole length of the posterior border of the ulna is straight, and on this the curved radius rotates like a bucket handle. There must be no lateral pressure on the middle of the radius, otherwise synostosis may ensue. In the position of supination the bones are farthest from each other, and so we should treat all our shaft fractures in this position. Nearly all neglected fractures of the forearm show limitation of supination, whereas pronation is not defective.

Colles's fracture requires complete and adequate reduction before splinting takes place. The Jones method is preferable to the hand-shaking plan, because

the force is applied directly to the bone instead of working through the carpal bones. Twisted fracture splints (Fig. 6), adequately padded to keep the replaced fragments in an over-corrected position and the hand in ulnar deviation, are applied and remain for four weeks, movements of fingers and thumb being allowed from the first.

REFERENCE.

¹ BRITISH MEDICAL JOURNAL, 1912, II, p. 1505.

Further Observations

ON

THE ETIOLOGY OF ECLAMPSIA AND THE PRE-ECLAMPTIC STATE.

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THIS paper* contains confirmation of an explanation of eclampsia which one of us published in 1914. It is based on a study, carried out at the Royal Maternity Hospital, Edinburgh, of 40 cases of toxæmia and associated conditions. The original investigations professed to show that the eclamptic and the pre-eclamptic toxæmia is dependent on a placental necrosis and they culminated in the experimental reproduction in animals of a disease closely simulating the classical picture of eclampsia. The first observations were concerned with a study of the pathology and with experiment. We propose now to give a third link of proof—the clinical.

Eclampsia and the pre-eclamptic state of toxæmia are due to the circulation in the mother's blood of a specific substance or specific substances, that have, as their dominating effects, (1) degenerative changes in the kidney and albuminuria, (2) characteristic necrotic lesions in the liver, and (3) convulsions. The symptom-pathological complex is found only in pregnancy, and it is therefore dependent, in some way or other, on the child or placenta or both, and its occurrence in cases of hydatid mole, where there is no foetus, points to the placental elements as the source of the poison.

Placental disease of the nature of infarction is common in eclampsia and pre-eclampsia. In fact, the typical case of long-standing albuminuria of pregnancy shows multiple pale areas of necrosis in the placenta. On the other hand, many cases of fulminating eclampsia show no obvious change in the placenta, and the natural inference for long was that, where infarction is present, it is only of secondary importance. If related to the toxæmic state at all—and related it must be, everyone who has studied the subject admits—it is considered as more the result of the toxæmia than the cause.

What first directed our attention to the subject was the discovery that, although obvious placental disease might be absent in the placenta of fulminating eclampsia, which ends in rapid labour or death, in the other, less virulent type, in which some days or even weeks elapse between the seizure and the birth of the placenta, there is always massive necrosis visible to the naked eye. We have seen no exception to this. Its recognition threw a flood of new light on the subject. It showed that the degenerative change is always present in the placenta, but that it requires some days before it evolves into the form of ordinary naked-eye infarction. As a matter of fact, the recognition of the real character of the change has made it possible of detection at an earlier period if it is looked for.

If these observations are correct they have a double significance. In the first place, they provide us with a tangible focus for the origin of a placental poison. If we except Veit's discarded theory of the deportation of chorionic villi into the blood stream, they offer such a focus for the first time. In the second place, they

* Read before the Section of Obstetrics and Gynaecology of the Royal Society of Medicine.