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An Address ON STATURE AND POSE THE PROBLEM OF UNEQUAL LEGS*

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"Which of you, by taking thought, can add one cubit unto his stature?"

I suppose that if this question was propounded for our answer to-day we should devote ourselves almost entirely to a consideration of the possibility of provoking endocrine stimulation of the pituitary gland. A cubit is the distance from the tip of the elbow to the tip of the middle finger, and is about 18 inches in a full-grown adult. The true acromegalic giants, such as Charles Byrne, John Hunter's famous trophy, may be more

than two feet taller than an average adult, and if we knew how to add to the bulk or to increase the activity of a normal pituitary gland such an addition to the stature of a growing adult might easily be made.

FIG. 1.—Shortening of the leg due to infantile paralysis. A. Outline of the limbs showing intrinsic shortening of right femur. B. Method of lengthening femur; step-cut and grafts. C. Method of shortening femur. D. Shortened femur after impaction. (In the diagram the peg is made from the lateral half of the femur, whereas in practice it is formed from the posterior half.)

A man's height depends chiefly on the length of the spine, the femora, and tibiae. The length of the spine is made up of the thickness of twenty-four vertebral bodies

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(cervical, dorsal, and lumbar) and of twenty-three intervertebral disks, but the total length of the vertebral column will vary with its curvature. Any marked variation from the normal affecting the stature is always

FIG. 2.

FIG. 3.

FIG. 2.—Congenital dislocation of the hip in an adult.

FIG. 3.—Coxa vara with characteristic adduction deformity.

in the direction of shortening. Thus in the classical case of Sir James Paget's first patient with osteitis deformans, the man, who had been an officer in the Guards, 6 feet 2 inches in height, became so bent and bowed in later life that he measured only 5 feet 8 inches. It is commonly believed that a young adult can actually, but temporarily, increase his height by about a half to three-quarters of an inch simply by remaining recumbent for about a week. This attitude is supposed to allow each intervertebral disk to increase in thickness by a fluid accommodation in its nucleus pulposus. This half-inch may be of vital importance to a man measuring 5 feet 11½ inches, if he wishes to enter a regiment of the Guards.

I do not propose, however, to discuss these rather fascinating questions of general skeletal growth or of spinal length, but to devote myself to the very important and practical problems of the balancing of a patient on legs of unequal length, or alternatively of making those legs equal.

This problem presents itself in four common groups of cases—namely, malunion of fractures (usually of the femur); faulty ankylosis of the hip-joint after infective arthritis; poliomyelitis; and congenital dislocation of the hips. In these cases there may be actual shortening of a bone such as the femur. It may have been broken and then united with several inches of overlap, or in the paralytic cases (Fig. 1, A) the femur may have failed in its normal growth. The shortening may be due to the dislocation of the hip—congenital (Fig. 2), traumatic, or pathological—the head of the femur lying one or more inches above the level of the acetabulum. Again, shortening may be caused by the adduction or varoid angulation (Fig. 3) in the shaft or neck of the femur or actually in

the hip-joint. The shortening effect of this deformity is due chiefly to the fact that in order to achieve parallelism of the legs, the pelvis must be tilted up on the affected side.

Before discussing the best way of treating a case in which the legs are of very unequal length, it may be

FIG. 4.

FIG. 5.

FIG. 4.—Ankylosis of hip in marked adduction.

FIG. 5.—Bifurcation osteotomy, which, by correcting the adduction deformity, effectually lengthens the leg in condition shown in Figs. 2, 3, and 4.

useful perhaps to say a word about prophylaxis. There is no pious precept so often repeated, and yet so often ignored, as that "prevention is better than cure." Probably gross deformity could have been prevented by timely treatment in more than half the cases which present themselves. At the present day there is no justification for allowing a fracture of the femur to unite in such a way as to cause an appreciable shortening. In this connexion it should be borne in mind that callus union is soft and plastic, and that if a femur is half an inch short at the end of six weeks, it will probably be an inch shorter at the end of six months, owing to the yielding of callus to pressure or to the increase of an angular deformity if insufficiently splinted. The greatest crippling deformity, however, is produced by the slow, insidious, infective arthritis of the hip if vigilance is relaxed in the early days. The thigh becomes flexed and adducted, and, when fixed in this position, the effective length of the leg is reduced many inches by the tilting of the pelvis necessary to get one leg in the same line as the other (Fig. 4). All that is required is to fit the child on to a proper frame in the early months in order to secure a much smoother and less painful course for the disease, and to prevent any crippling deformity.

TECHNIQUE OF DIRECT LENGTHENING OF BONES

While it may be unnecessary to dwell at length on the technical details of methods of bone lengthening, I should like to give a short review of commonly advocated methods in order to indicate their relative advantages and disadvantages.

The Use of Transfixion Pins

The use of rigid transfixion pins seems to me to be almost an essential element for any effective method of skeletal traction. I use only two sizes ($3/16$ inch by 6 inches, and $1/8$ inch by 4 inches), and in rare cases when I have to deal with a child's olecranon or a phalanx I improvise a small pin from a steel knitting needle. I would always carry out the transfixion under a general

anaesthetic, not because the pain of perforating the limb cannot be abolished by local injection, but because under a general anaesthetic a strong traction of 200 lb. or more can be used for a few moments; another reason is that during the first hours of traction (by 40 or 50 lb.) the muscles will be fully relaxed. When the pin has perforated the limb a pulley-bearing clamp is fixed on it; with a pulley block at the foot of the bed this allows a strong and steady traction to be exercised by a weight which may be multiplied up to four times according to the number of pulleys used. Thus with a 10 or 15 lb. weight, a 40 or 60 lb. pull is obtained. Such a powerful traction will, of course, necessitate raising the foot of the bed and also fixing a counter-extension perineal band round the opposite thigh, this being tied to the bed head.

I would urge that this use of the transfixion pins affords the maximum of simplicity combined with efficiency. The so-called ice-tongs callipers, which have rightly been discarded, gave no advantage which compensated for the real danger of their slipping or dragging if used for any effective weight extension.

Hawley's Table

Transfixion pins, however, can be utilized in other ways. Hawley's table, of which there have been many modifications, is in my opinion a necessary part of most of the traction operations or fracture methods, enabling one or both legs to be fixed at any angle and pulled upon by a very powerful screw appliance. The efficacy of this screw traction will be greatly increased if one or more transfixion pins have been passed through the limb and the screw pull applied directly to the pin. The desired amount of traction and lengthening can be fully maintained by a plaster bandage, applied while the patient is still on the table. Thus in a neglected or mal-united fracture of the femur, with 3 inches of shortening and angulation, a pin was passed through the supra-condylar region of the femur, and the leg, pulled out to full length on a

Hawley's table, put in plaster; the transfixion pin being left in place three weeks and then removed without disturbing the plaster. The possibility of combining the use of a Hawley's table with transfixion pins opens up very great chances of rapidly and completely correcting certain deformities and of lengthening shortened legs. In many cases of malunited fracture with much shortening

FIG. 6.—Case of ankylosis of the hip in adduction. A. Before bifurcation operation. B. After bifurcation operation. C. Five-inch-raised shoe worn before operation.

a careful choice will have to be made between the two methods of (1) full or immediate lengthening done by a Hawley's table and fixation by plaster over transfixion pins, and (2) gradual traction by weight and pulleys. Probably in a difficult case the maximum of efficiency and accuracy will be obtained by first breaking down the malunited fracture, then applying skeletal traction for

six to ten days, and lastly giving a final adjustment on the Hawley's table and fixing in plaster.

Double Transfixion Apparatus

Another appliance for lengthening bones is the double transfixion apparatus, which I designed, and used frequently in 1914 and succeeding years. Its principle depends on the transfixion of the broken bone at two points near the extremities. The projecting ends of the

FIG. 7.—Gross curvature of the femora due to rickets, treated by multiple osteotomy.

rigid steel pins are engaged in a frame, consisting of side bars and a circular band, which allows distraction to be made by a screw action and fixation in any relative position of rotation of one fragment upon another. This apparatus, or one similar to it in principle, has been invented independently and described by many surgeons, and it appears in most of the large works dealing with the treatment of fractures. I never use the apparatus now, because I find that the combination of skeletal traction

it is held in a collapsible concertina clamp. When the steel wire has traversed the limb, including the bone, its two projecting ends are engaged in a very strong steel horse-shoe clamp, one end being screwed tightly and the other remaining loose. The loose end is then pulled as tight as possible by a special steel screw, which is fixed in this taut position. Weight is now attached to the horse-shoe and traction carried out in the ordinary way. It is claimed for this method that it is never followed by a septic bone sinus. But there are two arguments against it: one is that if it is used for the application of a heavy weight, it is likely to be dragged through the bone, especially if this is at all decalcified; the other is that the technical difficulties of the method hardly justify its use in any except very large fracture clinics. In the method of its application it complicates the use of skeletal traction.

THE LENGTHENING OF AN UNBROKEN BONE

So far I have considered only the question of increasing the length of a broken bone, which usually consists in restoring it to its original measurement; but in many cases of marked inequality of the legs, especially in poliomyelitis and tuberculous hip disease, there may be a possibility of lengthening the short leg. This problem involves several considerations beyond the merely mechanical one of bone lengthening. The short leg in these cases is nearly always under-nourished, with poor blood supply, weak muscles, and slender bones. As the limb is therefore ill adapted to plastic operations, it is much wiser, in my opinion, to shorten the sound leg rather than attempt to lengthen the weak one. The patient, however, may readily consent to any operation on the "bad leg," but will be very reluctant to have the good leg interfered with. In such circumstances what are the possibilities of the method? Various ingenious appliances have been designed for bone lengthening, all of

FIG. 8.—Contracture of the knee causing shortening, treated by curved osteotomy.

with the Hawley's table, followed by plaster fixation, gives just as good results with much less pain to the patient.

The Wire Method

The modern vogue for skeletal traction now rather favours the use of taut steel wire, generally known as Kirschner's wire, though many surgeons have suggested its use and invented a technique for its application. The essentials of the wire method are as follows: A rigid piece of hard, rustless steel wire, 1 to 2 mm. thick and about 30 cm. long, sharpened at one end, is held in a motor or other mechanical drill stock, and is made to pierce the leg; this it does with great ease and rapidity. To prevent the wire from bending under the pressure,

FIG. 9.—Ambulatory abduction splint to be worn for six months after bifurcation osteotomy.

them having the essential design of a double transfixion apparatus with external screw distraction rods. I am not convinced that there is any apparatus that will produce more favourable results than can be obtained by immediate traction on a Hawley's table, or, better still, by skeletal traction making a steady pull on the divided bone. The femur must be divided either by a long oblique division or by a shaped osteotomy. If immediate lengthening is made, suitable bone wedges are placed in position and the bone united by a band (Fig. 1, B). If continuous traction is used, a transfixion pin is passed through the lower end of the femur and weight traction carried out while the knee is kept flexed. The actual limit of such lengthening of the bone is about 10 per cent.

—that is, about one and a half inches to a fifteen-inch femur, so that at the end of a rather difficult and hazardous procedure the maximum gain is not very great.

THE LENGTHENING OF A CURVED BONE

Apart from bones which have been shortened by mal-united fractures, there are many cases of legs shortened and deformed by curving of the bones or by contracture of the knee. Such conditions result from various types of rickets and also from infection or paralytic conditions of the knee with flexion contracture. A grossly distorted femur usually has two pronounced curves (Fig. 7), one outward just below the trochanters, and the other forwards, below the middle of the shaft. The best operative correction of this double deformity is a double or triple osteotomy followed by continuous weight traction. The osteotomy should aim at splintering the bone obliquely at the points of maximum curvature, and is best done by a hammer and chisel. When both femora are affected, as in the case depicted, I think it is wiser to deal with one leg at a time, allowing sufficient interval (about six months) for the first leg to become firm and sound before touching its fellow. In the case of a contracted knee-joint which is free from intrinsic adhesions and allows of flexion but cannot be fully extended (perhaps by 20 degrees), it is easy to restore complete extension to the joint without interfering with its mechanism (Fig. 8). A curved osteotomy is performed just above the condyles, the curved cut being as nearly as possible parallel to, and concentric with, the curve of the condyles. This is done by means of a band-saw or a fretsaw through two lateral incisions just behind the quadriceps muscle. When the bone has been divided, the knee can be fully straightened and put up in this position in plaster.

SLIPPED FEMORAL EPIPHYSIS AND EARLY COXA VARA

There is, I think, a mistaken notion held by students and practitioners that coxa vara, resulting from a slipped epiphysis of the head of the femur, is a condition that should be left alone until growth is at an end, and then corrected by an osteotomy. This view is certainly quite wrong. The slipped epiphysis can be corrected by manipulation within several weeks of the onset of the deformity, and, at a later date, when the neck of the femur is being remoulded to form a coxa vara, it can still be fully corrected by a single operation which will result in a perfect hip, six months only being required for the correction treatment. If full growth is allowed to occur, with the establishment of coxa vara, the patient is incapacitated by a crippled condition for years, and operative correction is merely palliative. Within a few weeks of the occurrence of slipping of the epiphysis, correction can be done by forcible manipulation, the leg being put up in full abduction with internal rotation in a plaster spica. At a later stage an operation is necessary to divide the femoral neck, and then, when complete restitution has been carried out, the head of the bone is fixed by a bone nail driven into it from the trochanter.

THE BIFURCATION SUBTROCHANTERIC OSTEOTOMY

The shortening and deformity in many unequal legs are due to a faulty relation of the bones at the hip-joint, either actual dislocation or more often adduction with flexion deformity by which the pelvis has to be tilted up on the diseased side in order that the legs may be parallel. It is the general rule that in dislocation, arthritis, or ankylosis of the hip, the limb becomes fixed in adduction and flexion, so that to the real deficiency is added a much greater functional shortening—unfortunately called "apparent." Thus the affected limb in cases of faulty ankylosis of the hip and in congenital dislocation is often 4 to 6 inches off the ground in the standing position

(Figs. 2 and 4). This apparent, or as it should be called, functional shortening, is measured by taking the length from the upper border of the symphysis pubis to the tip of the internal malleolus. It has always been recognized that this great functional shortening due to adduction and flexion of the hip should be corrected by a subtrochanteric osteotomy. In recent years Lorenz has elaborated the idea that this osteotomy should aim, not merely at altering the angle of the femur, but at making a sort of fork at its point of contact with the pelvis. This is known as the bifurcation osteotomy (Fig. 5). I have done this operation many times, but I am doubtful if the making of a fork at the top of the femur really achieves much more than the old-fashioned simple osteotomy. Three things are gained by a subtrochanteric osteotomy in these cases of adduction deformity of the legs. In the first place, by abducting the femur and fixing it in this position the pelvis will come to be tilted down on the diseased side when the legs are parallel. Thus functional lengthening will be made to counteract real shortening. In a typical case (Fig. 6) the diseased leg is $1\frac{1}{2}$ inches shorter than the sound one, and the adduction deformity makes the pelvis 2 inches higher on that side than on the other; there are therefore $3\frac{1}{2}$ inches of functional shortening. After osteotomy and abduction the anterior superior iliac spine is brought down to a level $1\frac{1}{2}$ inches below its fellow, and this exactly counterbalances the $1\frac{1}{2}$ inches of real shortening, so that, as the patient stands, the two legs are apparently of the same length, the pelvis being inclined downwards on the side of the diseased limb. In the second place, the axis of the femur comes to lie under the line of weight of the body, instead of lying quite outside it. In other words, the weight of the body is transmitted direct to the femur instead of hanging on to its side. Thirdly, there is provided a wide area of contact between the pelvis and the upper end of the femur by which the body weight is transmitted. The operation is a very simple one. The femur is cut down upon through an internal incision over the base of the great trochanter, and the bone is divided by an oblique saw-cut, which runs downwards and backwards. When it has been completely divided, the shaft of the femur is forcibly abducted and then pushed in towards the symphysis. The degree of abduction in which the leg is fixed must be decided upon beforehand, and is determined by the amount of tilting of the pelvis which has to be corrected or over-corrected. The body and leg are fixed in a plaster spica, which is maintained for six weeks and is then renewed as a short spica down to the knee for another six weeks. Then for six months the patient must use either a walking calliper splint or some form of ambulatory abduction splint. For the latter I have found the appliance illustrated by Fig. 9 very useful. It is very light and can be worn outside the underclothes concealed by the dress or trousers. It is very important to provide in this way against the occurrence of adduction, which is liable to be brought about by the excessive pull of the adductor group of muscles acting on the bone while it is still soft.

LENGTHENING THE LEG BY THE EQUINUS POSITION

One of the most natural attempts to make good a shortened leg is by walking on tip-toe, and this attitude is therefore assumed by every patient who has a short leg. How far should this practice be allowed or encouraged? It is quite certain that it is unsatisfactory for a patient always to walk on tip-toe with the heel off the ground. The attitude involves constant strain on the calf muscles with consequent fatigue, and this will be all the greater as the muscles are already weakened by partial paralysis. The heel, therefore, must be supported by raising that part of the boot. In an adult foot measuring 7 inches from the heel to the ball of the great toe, the following

angles of tilting will be associated with the corresponding raising of the heel—namely, 15 degrees tilting with $1\frac{1}{2}$ -inch heel ; 30 degrees with $3\frac{1}{2}$ -inch heel ; and 45 degrees tilting with 5-inch heel. But even if the heel of the foot is supported by a raised heel of the boot, the pose of the foot is not very satisfactory, because the calf muscles are thrown out of action to an extent measured by the degree of tilting of the foot, and the patient loses spring and resiliency of step. Probably 15 degrees of tilting is the maximum advisable, representing a gain in height of about an inch, since the other shoe must have a heel of at least three-quarters of an inch. Both instrument makers and surgeons, however, have gone much beyond this limit, and have tried to convert the foot into an extreme equinus position. A special type of boot is widely advertised in which the heel is 5 or 6 inches off the ground, the equinus position being masked by making this elevation of the heel inside the boot. Such an appliance does disguise the deformity, but it does so at the expense of the muscular balance of the leg. In the same way the Mikulicz operation, by which the os calcis and astragalus are removed and the rest of the tarsus and metatarsus brought into a straight line with the tibia, results in a gain of about 5 inches in the length of the leg, but the limb, in consequence, is much less useful for walking than an artificial limb would be. There is an interesting specimen in the Museum of the Royal College of Surgeons representing the leg and foot of a girl, aged 18, on which the Mikulicz operation had been performed by Sir William MacCormac. The patient had infantile paralysis with paralytic equinus, and the leg was amputated by Sir John Bland-Sutton owing to the pain and uselessness of the limb, in spite of the fact that perfect bone union had occurred in good line. It may therefore be laid down as a definite rule in dealing with a weak, short leg, that a plantigrade position of the foot should be preserved, or certainly not departed from by more than 15 degrees of tilting.

SHORTENING OF THE SOUND LEG

For equalizing the length of legs another valuable device, which I think is not resorted to as often as it might be, is the shortening of the longer leg. In the majority of cases we are considering, whether tuberculous hip disease, infantile paralysis, or congenital dislocation of the hip, the long leg is strong and has good sound bones with perfect muscular and vascular supply. In such a leg the femur may be shortened with perfect impunity by 25 per cent. of its total length—that is, in the adult about 4 inches. I have done this operation in various ways, by taking a piece right out and uniting the shaft over a peg, or by a "step-cut" operation, but I now use an impaction method, which is much simpler than either of these (Fig. 1, C and D). If, for example, 4 inches is to be taken from the femur, the bone is exposed by a lateral longitudinal incision in its lower part about 6 inches long. The muscles are divided between the rectus and the vastus externus, and the bone is sawn through about 2 inches above the condyles. The shaft is brought out of the wound and 2 inches are cut off. The remainder is removed by a longitudinal saw-cut 2 inches in length, passing from side to side, the anterior part being cut away, leaving the posterior part of the femur, including the linea aspera, sticking out. This is trimmed by the saw and chisel into a peg about half an inch thick. The lower fragment of the femur is bored by a twist drill of suitable diameter, and the upper fragment is then impacted into it, and fixed in place by a single transverse ivory nail. It is very remarkable how the slack of 4 inches of muscle is taken up within a few months and the full muscular power of the leg regained.

Two examples will suffice to illustrate the possibilities of this method.

CASE I

A woman, aged 25, had a long-standing infantile paralysis with dislocation of the hip on the same side. When she came to me the left leg was $5\frac{1}{2}$ inches off the ground, caused partly by tilting of the pelvis and partly by insufficient growth of the leg, which was encumbered by a heavy apparatus consisting of a calliper splint and high boot. I did three operations. First, the left flail foot was stabilized by a partial tarsectomy (Naughton Dunn's operation), so that she could get firm plantigrade stance without irons ; secondly, an osteotomy was performed below the left trochanter, so as to bring down the pelvis on the left side, lengthening the leg by $1\frac{1}{2}$ inches and allowing her to support her body weight direct on the femur, instead of hanging it on to the capsule of the dislocated joint ; thirdly, six months later, the right femur was shortened by 4 inches, thus bringing her two legs to the same length. She can now walk on limbs of the same length, and for the first time in her life she can wear an ordinary pair of shoes.

CASE II

A man, aged 30, who must have had osteomyelitis of the upper end of the right femur in childhood, came to me wearing the largest "surgical" boot I have ever seen. It was 9 inches high at the heel and weighed 7 lb. He was sent to me for amputation, and it was obvious that an artificial limb would have been much more serviceable to him than the horrid boot. He had, however, an adduction and flexion deformity of the hip-joint, and this would have had to be corrected even if an amputation had been done. He gladly consented to a series of reconstructive operations, by which his own foot and leg have been preserved. An osteotomy was performed below the neck of the left femur, and the leg put up in abduction. This gained 2 inches for the functional use of the leg. The right leg was shortened by 4 inches, and his two legs are now within 3 inches of the same length. He was so pleased with this result that he is now trying a boot raised 3 inches at the heel and $1\frac{1}{2}$ inches in the sole, postponing for the present a possible bone-lengthening operation on the left femur.

As the result of the active campaign that is being carried out to-day for the treatment of crippled children there are fewer of these cases of adult gross deformity than formerly ; but there will always be a sufficient number to make the problems involved of great practical importance.

A CASE OF PERNICIOUS ANAEMIA RESISTANT TO TREATMENT

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A civil servant, who had always lived a temperate life in this country, at the age of 52 noticed that he was becoming pale and rather easily tired, and a year later, on account of these symptoms having become worse, he spent a month at a convalescent home on the South Coast. Shortness of breath and palpitation on exertion began to trouble him ; sleep did not come easily at night ; and six months after returning home his doctor told him that he was suffering from pernicious anaemia, and prescribed from a quarter to half a pound of liver daily. He did not seem to make any progress, however, either for better or for worse ; and after six months' treatment with liver daily he was admitted to hospital under my care.

He was then 54 years of age, a well-nourished man, 11 st. 10 lb. in weight, with fairly considerable subcutaneous fat. His skin and mucous membranes were pale, the former possessing the slight lemon tint so typical of pernicious anaemia. He had been treated for an appendix abscess at the age of 48, but had had no other illness before the onset of the complaint from which he was now suffering. His appetite had always been good, and he had not suffered from vomiting, diarrhoea, or from troublesome constipation.