THE TREATMENT OF FRACTURES OF THE NECK OF THE FEMUR

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According to Per Linton (1944) in his admirable survey of the literature of fractures of the neck of the femur, the first 'nailing' operation was performed by von Langenbeck in 1850. Smith-Petersen in 1931 and Sven Johansson in 1932, however, really introduced nailing as it is now understood. Since then the subject has been investigated and reported in innumerable articles. The percentage of failures in nailing operations on the femoral neck has been reported as low as 5 per cent. and at the other extreme as high as 55 per cent. Probably a figure of 30 per cent. would be accepted as a fair average of failure in this country. Many theories have been advanced in explanation of non-union. This paper puts forward a theory and a technique, which when acted upon by the author, considerably increased the percentage of bony union in subcapital and trans-cervical fractures.

A Theory of Non-union

Presupposing that the cause of failure was a poor blood supply, fibular grafts were used in the hope that these would encourage vascularization. Later, because it was thought that the grafts were not strong enough (one patient broke the graft crossing her knees and another turning in bed), they were reinforced by special nails made to fit the lumen of the fibula (Fitzgerald, 1942). Twenty-five cases were treated in this way and in due course the results were investigated. There was no increase in the percentage of bony union. In those fractures which united, however, no case of aseptic necrosis of the head of the femur was recorded, but the number of cases was too small to make this an observation of much value.

Later on, during a nailing operation, it was noticed that when a guide wire was inserted, the head of the femur was rotated by its point; a second wire rotated it again and a guide and nail were inserted in a fairly central position only with difficulty. The fracture failed to unite and led to a closer examination of the anatomy of the femoral neck. This revealed one well-known but perhaps not fully appreciated fact, that the tendon of obturator externus lies very close to the femoral

neck and actually grooves its under surface. It was possible, therefore, that if this tendon slipped in between the fragments or invaginated the capsule, the head would be rendered mobile and thus bony union would be discouraged. The tendon might slip in between the bone ends either at the time of fracture, when the lower fragment moves upwards, or during the usual Leadbetter method of reduction when the hip is forcibly internally rotated and abducted. Here then might be one cause of failure.

Again Bankart and others have mentioned the fragmentation and compression of cancellous bone which occur on the back of the femoral neck as a result of the external rotation element of the injury. (This resembles the dorsal compression seen in a Colles' fracture.) Bankart's finding was verified and it was noted also that when the femur was forcibly internally rotated, a wide transverse gap developed on the posterior surface of the neck. A nail inserted after forced internal rotation, therefore, would have a grip in the outer fragment and in the head of the bone, but would be uncovered posteriorly while traversing this 'gap' area.

With these two points in mind a large number of cases was reviewed, including the cases reported by Eyre-Brooke and Pridie in 1941. It was found that a very large number had failed to unite when operated upon after forced internal rotation, as shown by the reduced profile of the lesser trochanter seen on the antero-posterior radiograph taken on the operating table. On the other hand, when some external rotation deformity was accepted, the percentage of success was much higher.

A large number of patients have now been treated, taking into consideration these two points, gentle reduction and nailing in slight external rotation, and the rate of failure has been greatly diminished.

Types of Fracture and their Treatment

Fractures of the neck of the femur are divided into two large groups, impacted and non-impacted, and the latter are subdivided into subcapital,

transcervical and basal. Basal fractures do not come within the province of this article.

1. IMPACTED FRACTURES

These are usually the result of a fall on to the greater trochanter. The neck breaks and the lower fragment is impacted into the upper. In the great majority of these cases, the force of the violence abducts the lower fragment on the upper, leading to a *coxa valga* deformity (Fig. 1). Very occasionally adduction takes place, and *coxa vara* with impaction results (Figs. 3 and 4).

Treatment

A. *Coxa Valga with Impaction.* It is possible to allow the patient to walk from the first without any splintage, and in the majority of these cases, an uneventful recovery follows. Fig. 2 shows such a case treated without a splint. Two years later she fractured the other side and this was nailed. In a small percentage of cases, however, the impaction is not strong enough and the fragments may separate. It is wise therefore to immobilize the hip in a closely-fitting plaster spica. After a few days the patient is allowed to walk and the plaster is retained for two months.

B. *Coxa Vara with Impaction.* Two lines of treatment are available, conservative and operative.

(a) *Conservative.* The patient is kept in bed on a Braun's splint with 7 to 10 lbs. traction, depending upon the weight of the patient. After three months she is allowed up with great care. Fig. 3 illustrates a case treated deliberately in this way. The patient was not old and she has been back at her full strenuous employment for the past five years without further trouble. Fig. 4 shows a much worse fracture which could not be nailed for medical reasons.

(b) *Operative.* This is probably the better method of treating an adducted impacted fracture. It is nailed *without attempting reduction of any kind*; traction at the time of operation is strictly forbidden. In this way impaction is maintained and the prognosis is very much improved, since impacted fractures nearly always unite. In addition, the risk inherent in the unstable adduction deformity is avoided by the presence of the nail. The best advice for adducted impacted fractures therefore is to 'nail them as they lie.'

2. NON-IMPACTED FRACTURES

In these cases operative treatment is the method of choice. It is proposed to describe in detail only two operative procedures, nailing and a modified form of Leadbetter's osteotomy.

Selection of Cases. In the author's view almost every fresh case should be nailed providing the patient will stand the operation; osteotomy should

be reserved for old cases and for those in which nailing has failed.

The Nailing Operation

Pre-operative Treatment. Most patients who fracture the neck of the femur are old and are very liable to develop pulmonary complications if their movements and respiratory excursions are impeded. The pain of the fracture prevents the patient from moving about in bed, every movement being resented even those for nursing purposes. If skeletal traction is used, however, the pain ceases and the patient can move with relative freedom.

A Steinmann's pin is driven through the crest of the tibia. The limb is placed on a Braun's splint and 10 to 12 lbs. traction applied. The foot of the bed is raised on 10 to 12 in. blocks and the patient is supplied with an overhead sling and a foot rest for the affected limb. In this way she is rendered more independent and is encouraged to move about in bed. Operation is postponed for at least a week.

Reduction. Skates are fitted to the patient's feet, and she is then placed upon the orthopaedic table. The perineum is in contact with a special perineal upright (see below) and the skate on the good side is fixed to the foot rest. The hip on the affected side is then flexed to 30 degrees, and the operator's forearm is placed in the bend of the knee (Fig. 5). Firm but not forcible traction is then exerted on the limb, while very slight internal and external rotatory movements are carried out. This simple manoeuvre is sufficient to effect reduction. For reasons which have already been stated, Leadbetter's method with its full forced flexion and internal rotation should never be used.

Position of Fixation on the Table. The firm traction is maintained by the operator while an assistant fixes the skate to the foot rest. The traction is then transferred to the screw or windlass (Fig. 6). The limb is abducted 30 degrees, and fixed in a few degrees of *external rotation*. For reasons already mentioned internal rotation is contraindicated.

X-rays. Antero-posterior and lateral pictures are now taken. This is best done by means of a special pelvic rest (Fig. 7) which has two advantages. It allows the X-ray plates to be moved in and out without disturbing the patient or the surgeon. It also avoids the dangerous, potentially unsterile and inaccurate method of having a cassette held by an assistant. Fig. 6 shows the rest and the X-ray sets in position. For taking a lateral view, special malleable screens are packed into the X-ray envelope so that it may be bent to fit the slot in the curved perineal upright (Fig. 7).

FIG. 1.—Impacted fracture of abduction type with *coxa valga* deformity.

FIG. 2.—The right hip shows an old untreated abduction fracture.

FIG. 3.—An impacted adduction type of fracture with *coxa vara* deformity, treated successfully by traction only.

FIG. 4.—Radiographs from another case of impacted adduction fracture showing union obtained from traction only.

FIG. 5.

FIG. 7.

FIG. 6.

A portable dark room and specially heated developer are invaluable.

Towelling. The towels are so arranged that the operator's side is completely towelled off from the radiographer on the sound side (Fig. 8). This gives that freedom of movement to the radiographer which is so essential for rapid work.

Instruments. Apart from the usual set of instruments, two specially designed by the author need description.

The Guide. This consists of a curved piece of metal (Fig. 9). It grips the anterior and lateral aspects of the upper end of the shaft of the femur (Fig. 10). Two vertical struts (a) are fixed to the lateral metal piece and the hollow moveable tube (b) can therefore be fixed in any one of a large series of positions. The position in the coronal plane is constant, having been worked out experimentally. It presupposes accurate reduction of the fracture.

Setting the Guide. A guide wire is placed in the small moveable tube and the instrument superimposed upon the antero-posterior radiograph of the reduced fracture. The guide wire is then moved until it is exactly along the middle of the femoral neck on the X-ray plate. The guide (b) is locked in this position by the wing nuts and the instrument is then ready for use.

'Pan's Pipes.' These are simply a series of hollow tubes fixed together (Fig. 11). If the first guide wire is not exactly correct, one of these is threaded over it and another guide is inserted in the desired position.

The Operation. The skin is sterilized with pure Dettol. A 5-in. incision is made exactly along the lateral side of the upper end of the femoral shaft, extending downwards from the tip of the greater trochanter. Any bleeding points are caught and cauterized by diathermy. Skin towels are fixed by means of large Michel clips. With a clean knife the incision is deepened to bone, and bone spikes are passed around the femur. Further bleeding is controlled and the spikes replaced by self-retaining retractors.

Fixing the Guide to the Bone. Two points must be verified, firstly the lower border of the greater trochanter and secondly the gluteal ridge. The sharp point of the guide is pushed into a small prominence on the lower border of the greater trochanter (sometimes called the third trochanter), and the guide is rotated so that its posterior metal edge lies against the gluteal ridge. The point is then driven home with a hammer and punch, and the instrument is fixed firmly to the femur (Fig. 12).

Inserting the Guide Wire. The guide wire, attached to a handle, is passed through the guide tube until the point of the wire is in contact with the bone. With a small chisel, the cortex is

notched at this site to prevent the point from skidding. The wire is then pushed through the femoral neck as far as the acetabulum. Antero-posterior and lateral films are taken and the position and length of the guide checked.

The Length of the Nail. The guide wire should be central and its tip in the acetabulum. The length of wire which protrudes is then measured and subtracted from the total length, giving the distance from the cortex to the acetabulum. In choosing the length of nail, two factors must be taken in consideration. Firstly, that later on the bone fragments must be impacted and secondly, that the joint surface has been traversed. This distance is allowed for and a nail chosen accordingly.

Inserting the Nail. The three-flanged starter is passed over the guide wire and tapped gently into the cortex. It is then withdrawn and the nail is threaded over the wire, its flanges passing into the grooves already made. A hollow punch which fits over the guide and encloses the head of the nail is used to drive the nail inwards. When it has been driven in about two-thirds of its length, two more films are taken. If both are satisfactory the nail is driven home.

Impaction. The traction is released and the bone ends are impacted. The author uses a wooden impactor which fits against the bone just below the nail. The guide is removed and the nail again driven home. A small cross pin (Pidcock's) is passed through the hole in the head of the nail into the bone to prevent it from slipping outwards. The wound is then sutured without drainage.

Dressing. The incision is painted with Dettol, and gauze and wool are held by means of elastoplast. The latter is applied so as to seal the junction of wool and skin and prevent infection from without.

After-care. The limb is placed on a Braun's splint again. The patient is measured for a weight-relieving caliper, and when this is ready (which takes about six weeks), she is allowed to get up. The caliper by day and the Braun's splint or caliper by night are used for a least six months.

With this method of treatment and after-care, the percentage of failure in a large number of cases was greatly reduced.

Delay in Bony Union

Despite this rather elaborate care the rate at which bony union took place remained slow. In an attempt to overcome this, a series of cases was operated upon, using bone chips as well as a nail.

Method of Obtaining Iliac Bone Chips. A 4-in. incision is made below the anterior end of the iliac crest. A thin layer of bone is raised upwards

FIG. 8.

FIG. 9.

FIG. 12.

FIG. 10.

FIG. 11.

FIG. 13.—The chip-graft gun. (a) The cannulated drill. (b) Brace or handle to fit the drill. (c) The cannula with hopper for iliac chips. (d) The blunt-ended trochar to fit the cannula.

and inwards from the upper surface of the crest ; the muscles attached to the lateral surface of the blade are stripped off with a rougine. The cortex is then incised as far anteriorly, posteriorly and inferiorly as possible, and the incision deepened as far as the deep cortex. A thin osteotome is then inserted between the inner cortex and the cancellous bone from above, and the mapped out piece of bone is removed. The muscles are then reattached and the wound sewn.

The cortex is carefully separated from the piece of bone removed and the remaining cancellous bone is cut up into very fine chips.

Chip Grafts in the Femoral Neck. Two guide wires are inserted into the neck of the femur, the first below, by means of the guide, and the other above and parallel, by means of the set of little parallel tubes ('Pan's pipes'). A nail is inserted over the upper guide as described above and the chip graft gun is directed by the lower one.

Chip Graft Gun. This consists of a cannula

with a special hollow drill to fit (Fig. 13). The hollow drill, which is turned with either a brace or a handle, is passed into the cannula. It is threaded over the lower guide wire, and is bored into the femoral neck across the fracture. The drill is then removed, leaving the cannula *in situ*. At the outer end of the cannula is a small funnel or hopper placed at an angle.

Inserting the Chips. The blunt-ended trochar is inserted almost to the hopper level. The chips are now 'poured' into the hopper, and reach the cannula, whence they are driven into the femoral neck by the trochar. As the chips are packed home, the gun is gradually withdrawn, leaving in its place a solid tube of chips which may possibly spread out at the fracture level. The fracture is then impacted and the wound treated as before.

Theoretically, this method should shorten the time for bony union and perhaps discourage aseptic necrosis of the head of the femur. In the author's series the results are promising, but it is too early yet to assess them finally.

FIG. 14.

Old-Standing Fractures of the Neck of the Femur

In these cases nailing or grafting is not advisable on account of sclerosis of the bone ends. Also many of these cases have failed to unite after nailing. An osteotomy is the method of choice, and the one to be described here is a modification of the one by Leadbetter. This operation resembles McMurray's osteotomy, but it has some features which seem to be an improvement on the older method.

Modified Leadbetter's Osteotomy. The fracture is reduced and the patient fixed to the orthopaedic table as before. The lateral surface of the femur is exposed as above. (Leadbetter employs an anterior approach and cuts the bone under direct vision.)

Level of Osteotomy. A guide wire is inserted into the femoral neck as far as the fracture and at the junction of the upper two-thirds with the lower one-third of the neck (Fig. 14a). An osteotome is then used to divide the *outer fragment* only at this level. The new lower fragment is then pushed firmly inwards and rotates the head until the freshly-cut upper surface lies in contact with the lower fracture surface of the head. The greater trochanter is displaced laterally; this preserves

the length of the gluteus medius and thus prevents a dip or positive Trendelenburg's sign. The cut surface of the lower fragment opposes the broken area of the head in its new position (Fig. 14b).

A double plaster spica is then applied. Care is taken not to move the patient from the orthopaedic table until the plaster has set, as the bones are very easily displaced. The results in the few cases treated by this method have been excellent.

Summary

Some causes of non-union in fractures of the neck of the femur are mentioned and means discussed for obviating them. These methods have decreased the percentage of non-union.

A method of chip grafting in an effort to increase the rate of bony union is described.

Finally, a modification of Leadbetter's osteotomy for cases of established non-union is described.

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