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THE TREATMENT OF FRACTURES OF THE NECK OF THE FEMUR BY COMPRESSION

By

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It is probable that immediate prosthetic replacement of the femoral head after subcapital fractures of the neck of the femur, in senile patients, will be used more commonly in the future in preference to internal fixation. In senile patients there is much in favour of this policy, but we must not abandon attempts to improve internal fixation in the case of patients with an expectation of ten or more years of life. It is unfortunate that surgeons do not appear to have an agreed opinion on the frequency of failure of simple forms of internal fixation such as the Smith-Petersen nail. There is a tendency for surgeons who were using the Smith-Petersen nail before the outbreak of the Second World War to remain faithful to it, though biomechanical studies of this fracture indicate dissatisfaction with the simple Smith-Petersen nail. Because ischaemic necrosis in the femoral head is a matter outside the surgeon's control, some surgeons have adopted a reactionary policy and returned to the simple Smith-Petersen nail with early weight-bearing. Past experience has shown, however, that many failures with the simple Smith-Petersen nail occur *in the presence of a viable head*, and it would therefore seem justifiable to employ complicated methods of internal fixation if thereby it were possible to eliminate failure when the femoral head possessed a reasonable blood-supply.

Those who attempt to belittle the efforts of the perfectionist in developing methods of internal fixation for subcapital fractures of the neck of the femur often use the argument that, even if union of the fracture is obtained in the presence of ischaemia of the femoral head, the result will still be a failure because collapse of the pressure-bearing surface of the head will occur in the subsequent two or three years. But ischaemic necrosis of the femoral head is not always a totally disabling complication, and it has still to be proved that two years after a prosthetic replacement a hip is more comfortable than a head showing ischaemic collapse. The development of ischaemic collapse of the pressure surface of the head, following successful union at the fracture site, in younger patients is a condition which can be successfully treated by methods suitable for osteoarthritis of the hip, and after union of the fracture the problem of ischaemic necrosis of the head is less difficult to treat than an un-united fracture of the neck of the femur.

It is obvious that successful results after subcapital fractures of the neck of the femur will never be obtained in 100 % of cases, but it would seem reasonable to suggest that if successful union could be obtained in 80 % to 85 % of patients some mechanical elaboration of the technique would be justifiable, because many surgeons believe that for subcapital fractures simple methods of internal fixation are successful in only 60 % to 70 % of patients.

An attempt is made in this paper to evaluate the mechanical efficacy of different methods of internal fixation of intracapsular fractures of the neck of the femur and to advance reasons for the use of a spring-loaded compression screw. Certain technical details in the use of the author's compression screw are emphasised and some new ideas introduced as a result of further experience.

MECHANICS OF FIXATION METHODS

Smith-Petersen Nail: The design of the Smith-Petersen tri-fin nail was dominated by the desire to prevent rotation in the axis of the neck. While successful in this, we now know that the mechanical weakness of this nail lies in its failure to resist external rotation of the distal fragment, and varus displacement of the head. The failure to resist a recurrence of the initial deformity is frequently the result of comminution of the posterior surface of the femoral neck which is often more extensive than might be imagined from the X-ray. When a fracture of the femoral neck is reduced by internal rotation of the distal fragment, the anterior cortex of the femur is compressed while the posterior cortex is under tension. When the force holding internal rotation is removed the shattered posterior cortex of the femoral neck is unable to act as a compression strut to resist the tendency of the distal fragment to fall again into external rotation (Fig. 1). In the reduced position a comminuted fracture of the femoral neck is therefore in an unstable position, and the whole of the force tending to cause recurrence of the deformity will fall on the Smith-Petersen nail. If the fracture is not comminuted, the reduced position will have inherent stability and in these cases the simple Smith-Petersen nail will be adequate to maintain the immobilisation.

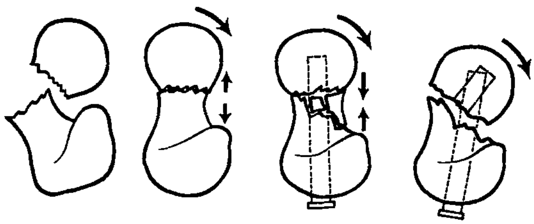

Fig. 1.

Mechanical weakness of Smith-Petersen nail. When the fracture is *not* comminuted, 1 and 2, the reduced position is stable and the Smith-Petersen nail is likely to be successful. When the fracture is comminuted on the posterior surface, the reduced position, 3, is an unstable position and the nail is exposed to forces tending to make it cut out as the head falls back into the position of original deformity, 4.

Shaft-Fixation: To ensure rigidity against forces causing varus deformity we are now familiar with the various forms of 'blade-plate' in which shaft-fixation was added to Smith-Petersen's tri-fin nail. The addition of shaft-fixation to the Smith-Petersen nail in the treatment of subcapital fractures makes it difficult to estimate the exact length of nail which will be required. The correct length of the nail in subcapital fractures is critical if the maximum hold on the small medial fragment is to be obtained without penetration into the joint. A further disadvantage of this type of shaft-fixation is that it prevents extrusion of the nail and, if collapse of the fracture occurs during healing, the point of the nail will penetrate the joint.

Sliding Nails: Several new patterns of nail which combine shaft-fixation with the ability of the nail to extrude are undergoing clinical trials at the present moment, notably that described by Pugh (1955). These devices utilise a component of the body-weight to generate a compression force at the fracture line and encourage collapse of the fracture without a tendency for the head to shear in a varus direction. It will be noted that in these devices the maximum compression force is obtained with a valgus position of the nail.

In the Pugh nail resistance to rotation is obtained by a mechanical device, consisting of a peg engaging in a groove, in the sliding apparatus (Fig. 2). This is a weak point in design because a perceptible clearance must be allowed to guarantee free sliding and this allows slight rotary play at the fracture. It is true this play will only operate when muscle-tone is abolished, but a slight rotary play in the apparatus will be magnified on the greater radius at the circumference of the fracture.

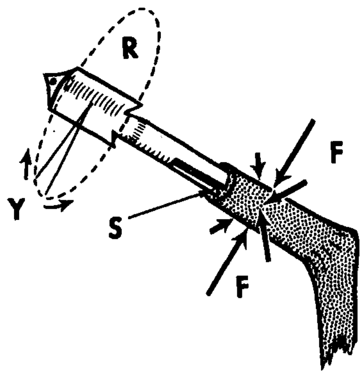

Fig. 2.

Schematic representation of the Pugh Sliding Nail. A device is incorporated in the sleeve to exert frictional resistance, F, against free extrusion; this is in effect a distracting force which has to be neutralised by weight-bearing or the action of muscle tone. Y indicates the movement, expressed as linear at the surface of the femoral head, which results from the slight rotational "play" of the slot, S, on the peg which is integral with the sleeve.

A further technical difficulty in designing a nail to facilitate extrusion is the tendency which all nails possess for spontaneous extrusion. Various devices have been used to stop this tendency in the Smith-Petersen nail, such as the Pidcock 'check' or the use of serrations on the flanges of the nail. To offer a nail a free pathway for extrusion is to invite the nail to fail out of the capital fragment. In the Pugh nail this tendency has been countered by using a 'friction ring' in the sliding sleeve which presents frictional resistance to extrusion. Any resistance offered to extrusion is theoretically objectionable because it constitutes a distraction force and will neutralise part of the compressive force of muscle-tone.

The Valgus Nail: The valgus or low-angle nail resists forces displacing it into varus by utilising support from the calcar femorale. Theoretically this is sound, but the technique is not as simple as it sounds because the final position of the nail depends on the exact point

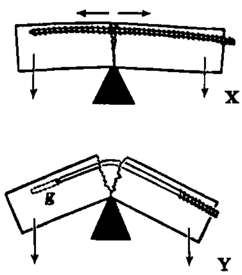

Fig. 3.
Beam of reinforced concrete breaking under a bending stress, X; the tension surface is reinforced by a steel bar bonded to the concrete throughout its whole length. The Austin Moore wire is smooth in the greater part of its length; it will be unable to reinforce the object in which it is buried because tension will avulse the point, g.

of entry through the lateral cortex of the femur. After the point of the nail has penetrated the lateral cortex of the shaft of the femur, it encounters the calcar which acts like a gutter which takes charge of the direction without the surgeon having further control.

Multiple Pins: Austin Moore (1953) advocated the use of four wires, attempting to liken the fixation of a fractured femoral neck to the technique of reinforced concrete. In structural engineering it is a first principle that a steel reinforcement should never be placed in the central axis of a concrete beam if maximum stiffness against a bending strain is desired. To strengthen a beam composed of a substance as brittle as concrete, steel wires are incorporated on that aspect of the beam which will be convex under a bending load, but none are needed in the central axis or on the concave side. This was Austin Moore's argument against using a Smith-Petersen nail in the centre of the femoral neck.

In reinforced concrete the iron rods bond themselves, by rust or chemical action, to the concrete in which they are embedded and tension in the concrete is therefore immediately communicated to the metal. Wires with smooth polished surfaces would pull out of the concrete and could not act as a reinforcement unless they were specially anchored at both ends, as is the case in the special instance of 'prestressed' concrete. The Moore pin is threaded only on its outer extremity and the medial part is smooth, so that it is incapable of resisting tension (Fig. 3).

The final criticism of multiple wires is that the neck of the femur is a thin-walled tube and multiple wires must inevitably pass inside or outside the cortex. In the theory of reinforced concrete the reinforcing wires would have to be totally embedded in the walls of the tube in their whole length.

The mechanical theory of multiple wires therefore does not stand serious analysis.

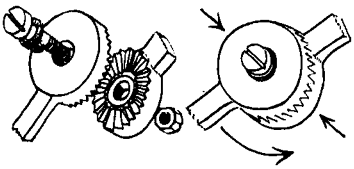

Fig. 4.
Well-known mechanical device to resist rotation. The interdigitating teeth are the elements which resist rotation; the screw is not exposed to rotatory stress. The screw acts by compressing the teeth together.

Screws: There have been many attempts in the past to treat fractures of the neck of the femur by means of screws or bolts, but without any greater success than the simple Smith-Petersen nail. The reason for failure in many cases has been that the screws have been used incorrectly so that they have functioned merely as nails.

When a fracture is held together by a single screw the strength of the junction to resist shear and rotation depends on the frictional resistance between the opposed surfaces of the fracture. If the frictional resistance is high a shearing force will be neutralised by this frictional resistance, and the amount of shearing force reaching the nail or the screw will be small. If no frictional resistance is present the screw, or nail, will be exposed to the full force of shear which will eventually cause it to cut through the bone and the fixation will become loose.

The amount of frictional resistance between two objects is proportional to the force which compresses the two objects together. It is obvious that a screw can compress two objects together more effectively than a nail, but if a simple screw is used the compressive force resides in the elasticity of the two objects to be fixed together. If a fracture is held together by a simple screw and is then subjected to violence which deflects the bone beyond its elastic limit, the compressive force will not be restored when the external force is removed because the bone will have been crushed. The fixation will therefore be loosened and in these circumstances a simple screw will be no more efficacious than a nail.

By using 'spring-loading' in combination with a screw, it is possible for the opposed surfaces still to remain under compression even though the union has been subjected to an external stress which has caused slight crushing of the bone.

To illustrate the action of compression in achieving fixation, a mechanical analogy is helpful. The mechanical device ilustrated in Fig. 4 is designed to resist a rotary force. The rotary force will be diffused over all the interdigitating serrations and the greater the radius of the device the smaller will be the pressure on each individual serration. It is important to observe that the spring-loaded nut and bolt which compresses the two serrated surfaces together is not itself exposed to any rotary force because it is loose to turn in the device. If a model of this device were to be constructed in bone we realise how futile it would be to try to hold these serrated surfaces together with a nail!

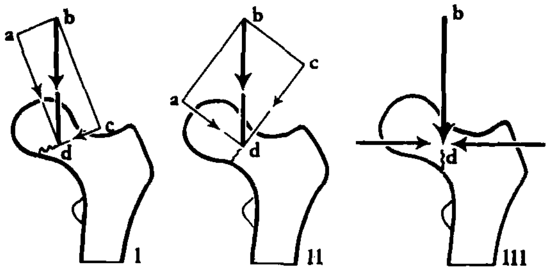

Fig. 5.
Pauwels Grade I: Vertical force of body-weight, bd, produces small shear force, cd, but large compression force ad.—Pauwels Grade II: Beneficial compression force, ad, is diminished while harmful, shearing, force, ed, is increased to comparison with Grade I.—Pauwels Grade III: Vertical force of body-weight, bd, is now entirely the evil force of shear. The Charnley compression screw is arranged at the most varus angle possible, 120°, so that the compression spring can introduce a horizontal component.

MECHANICS OF SPRING-LOADED COMPRESSION

The Charnley Compression Screw: In this device a spring-loaded compression screw is combined with a 'sleeve-plate'. The angle of the sleeve-plate has been purposely set at 120° and this has been criticised by surgeons who would prefer a more valgus direction of 130° or 135°. The angle of 120° was chosen because it is the most varus which can conveniently be inserted into the average patient. To explain the reason for choosing this varus angle it is necessary to refer to the forces acting on a fracture of the femoral neck as was first described by Pauwels. In Pauwels Grade I fractures the vertical force of weight-bearing generates only a small component in the harmful direction of shear (parallel to the plane of the fracture) but a large component in the beneficial direction (perpendicular to the plane of the fracture) which is the force which compresses the fragments together (Fig. 5). In the Pauwels Grade II fracture the beneficial component is less and the harmful shear component greater. In the Grade III fracture the beneficial force compressing the fracture together is small, or even non-existent, and the shearing force is high. It is therefore obvious that if an artificial force with a large horizontal component could be introduced into Grade II and Grade III fractures this would increase the pressure between the fragments. This is what the spring-loading of the compression screw is intended to do. If the screw were to be directed in a valgus direction (135° shaft-neck angle) its beneficial horizontal component would be lessened and it would generate a shearing component which would increase the shearing force already present in a Grade III fracture. Therefore the idea was to keep the direction as horizontal as could be conveniently inserted in order to increase coaptation in the Grade II and Grade III fractures.

One of the objectives in using this compression screw which I have not previously emphasised sufficiently is to produce extreme mechanical impaction. One of the commonest errors in the use of this screw, perhaps fostered by the original description, is to tighten the nut to the tension of the fully-compressed spring (25 lbs.) and no more. I now consider that at the time of operation a much greater impacting force than this is necessary so that in the post-operative period the fracture is under a compression force of 25 lbs. after it has been fully impacted with a force much greater than this. In this process of extreme impaction the idea is to break down any projecting spikes of bone so that the fracture is rendered stable as a result of intimate bone contact over the full area of the cross-section of the neck. The head of the femur is thus driven forcibly towards the blood-supply existing in the base of the femoral neck.

An interesting new light on the importance of intimate coaptation over the whole area of the fracture is suggested in work recently reported by Harrold (1959) which renews interest in one of the oldest theories of non-union in fractures of the femoral neck. It has been proved that synovial fluid inhibits the clotting of blood; Harrold suggests that this could explain the failure of subcapital fractures to unite. Whether or not this is the essential feature in non-union of this fracture is open to argument, but there is no doubt that it must be an important contributory factor. If a fracture of the femoral neck can be reduced and impacted to such a degree of intimacy that synovial fluid cannot reach the fracture and cannot wash over exposed bone fragments, this would seem a highly desirable objective in treatment.

To achieve this extreme impaction it is essential to strain and shake the fracture while the nut is being tightened in order to make sure that the head of the femur is not perched in an unstable position on the summit of projecting bone spikes. This is a technical detail of the ut-

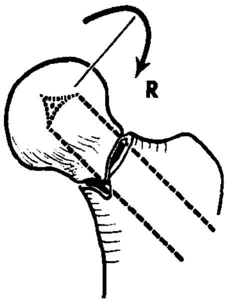

Fig. 6.

The ability of the tri-flanged nail to resist rotation can, occasionally, be the cause of defective coaptation. If this head were free to rotate 5° in the direction R, the fracture would sink into perfect coaptation.

most importance which I find is rarely adopted by many who use this device.

In the mechanism of coaptation it is important to note that the essential feature of the tri-flanged nail, namely its ability to resist rotation of the medial fragment, is a mechanical factor which can obstruct impaction. Any fracture which needs to rotate in order to sink into full coaptation will be held in an unstable position by a tri-flanged nail (Fig. 6).

When using the spring-loaded compression screw it is necessary that a sense of finality should be obtained when the nut has been fully tightened. It is futile to desist from further tightening if the sensation is received that the screw is about to pull out of the femoral head. The possibility of the screw pulling out of the femoral head, during impaction by tightening of the nut, is always present if poor resistance was encountered when the screw was inserted into the head. In order to obtain a clear 'end-point' to the tightening of the nut when the femoral head is very soft, a special screw has been designed with an extra-large helical thread. The total area of cancellous bone gripped by the thread of this screw (the 'life-saver') is six times larger than that of the 'standard' screw (Fig. 7).

In order to make full use of this extra-large screw, the following technical procedure is advised:–

(1) In every case start by inserting the standard screw in order to test the density of the bone of the femoral head and in order to establish the direction of the screw.

(2) Delay fixation of the sleeve-plate to the shaft of the femur until the very end of the operation and insert the standard screw into the femoral head with the sleeve-plate held against the shaft of the femur by an assistant.

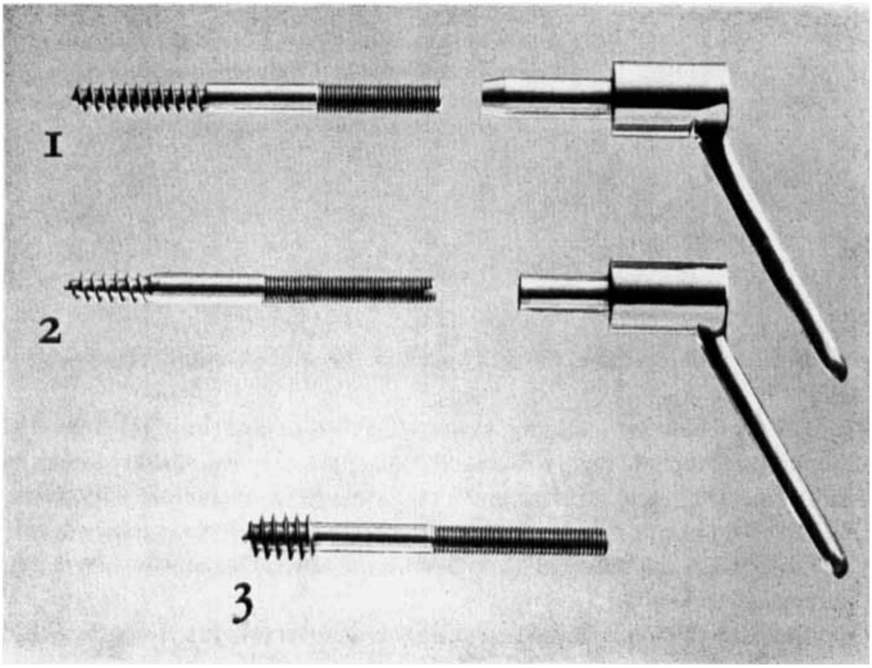

Fig. 7.

Showing the differences in dimensions of the original screw and sliding sleeve, 1, and the final pattern, 2. The special large-diameter screw, 3, (the "life-saver") is used if the femoral head is so soft that no resistance to insertion is encountered when the "standard" screw, 2, is used.

(3) If a positive 'end-point' is obtained when the nut is tightened, which holds after the fracture has been shaken and strained, nothing more need be done and the operation can be completed by fixing the plate to the shaft of the femur.

(4) If a positive 'end-point' is not obtained when the nut is tightened, continue tightening until the standard screw is completely avulsed from the head of the femur. Extract the sleeve-plate (which has not been screwed to the femoral shaft) and insert the extra-large screw into the track left by avulsion of the standard screw. This track will conduct the screw into the head without the need for any mechanical guide. The sleeve-plate is now threaded over the projecting end of the 'life-saver' screw and the spring and nut applied. The nut is now tightened to compress the spring and impact the fracture as before. Again it is necessary to achieve a sense of finality in tightening the nut. The plate is then anchored to the shaft of the femur to complete the operation.

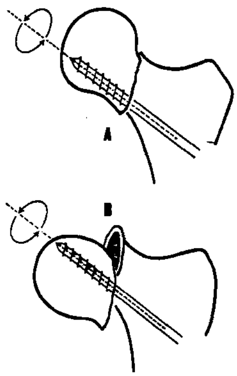

Fig. 8.
A central position of the screw in the head is to be preferred, but the only really bad position is a very low screw, A. In this position it is possible for the screw to rotate through 180° to give the appearance, B.

(5) If a sense of finality is not obtained when tightening the nut on the 'life-saver' screw, then the procedure should be abandoned and a prosthesis inserted without any attempt at conservative treatment.

Ideal Position in Head: In the original description it was stated that it did not matter whether the screw be sited centrally or eccentrically in the head. Experience has shown that it is worth taking the trouble to get a centrally placed screw. A screw centrally placed in the head enters a greater thickness of cancellous bone than a screw on the periphery of the head where all the helical thread may not get a purchase.

An eccentric position which it is especially necessary to avoid is that which is very low in the head, because this may encourage the head to rotate into a varus position with immediate loss of all spring pressure (Fig. 8). The change in radiological position as a result of this rotation can be mistaken for cutting out of the screw. Treatment should be immediate re-tightening of the nut of compress the head in the new position.

Recent Modifications of Design: Since the original description there have been four small alterations in the screw to eliminate defects which tended to obstruct extrusion and so defeat the action of continuous spring-loading on the healing fracture. It is important to describe these alterations so that obsolete patterns can be recognised (Fig. 7):

(1) *Helical Thread:* In early models the root diameter of the screw was parallel, and was long and narrow; the result was that the screw tended to bend and obstruct in the sleeve, so preventing extrusion. The present design has a short screw with a root diameter which becomes thicker towards the base.

Fig. 9.

(2) *Length of Sleeve:* In early models the medial end of the sleeve was long and, in a short neck, sometimes reached the line of the fracture and this theoretically could prevent extrusion. The sleeve has therefore been shortened to eliminate this possibility.

(3) *Length of Machine Thread:* In small patients the nut would occasionally reach the bottom of the machine thread before the fracture was completely impacted. The length of the machine thread has been increased to prevent this occurrence.

(4) *The Medial end of the Sleeve:* This originally was tapered in order to present a fine edge to the femoral head. This often became dented and obstructed extrusion of the screw by cathing the helical thread.

An important feature of the design is that only one length of screw should be needed for all sizes of patients. In small patients this policy may cause excessive projection of the outer end of the screw and surgeons have sometimes requested a second screw of shorter length. It is undesirable to change a screw once it has been inserted to full depth, because this may impair the grip of the second screw in the femoral head. For this reason it is recommended that the same size of screw should be used for all patients and any excessive projection of the outer end be cut off with small fine-tooth hack-saw (i.e. 'Eclipse' Junior). It is surprising what projection is possible without being easily palpable in patients of normal build, and cutting off the projecting end is necessary only in very thin patients.

Post-operative Conduct: The post-operative conduct is as important as the details of the operation and some bad results with this method have been due to ignoring the warning of failure as manifested by extrusion of the screw. By measuring the projection of the outer end of the nut above the level of the outer surface of the sleeve-plate an indication of the state of union is available which is more sensitive than any radiographic study of the bone itself (Figs. 9 and 10). A radiograph should be taken every month after operation but it is unnecessary to repeat lateral films after the original post-operative examination. It is

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Fig. 9.

A. original deformity. B. position after operation. C. 12 months after operation—showing osseous union and the emergence of the outer surface of the nut by only 1 or 2 mm. (i.e. less than the distance between two threads of the coarse screw which is about 3 mm.).

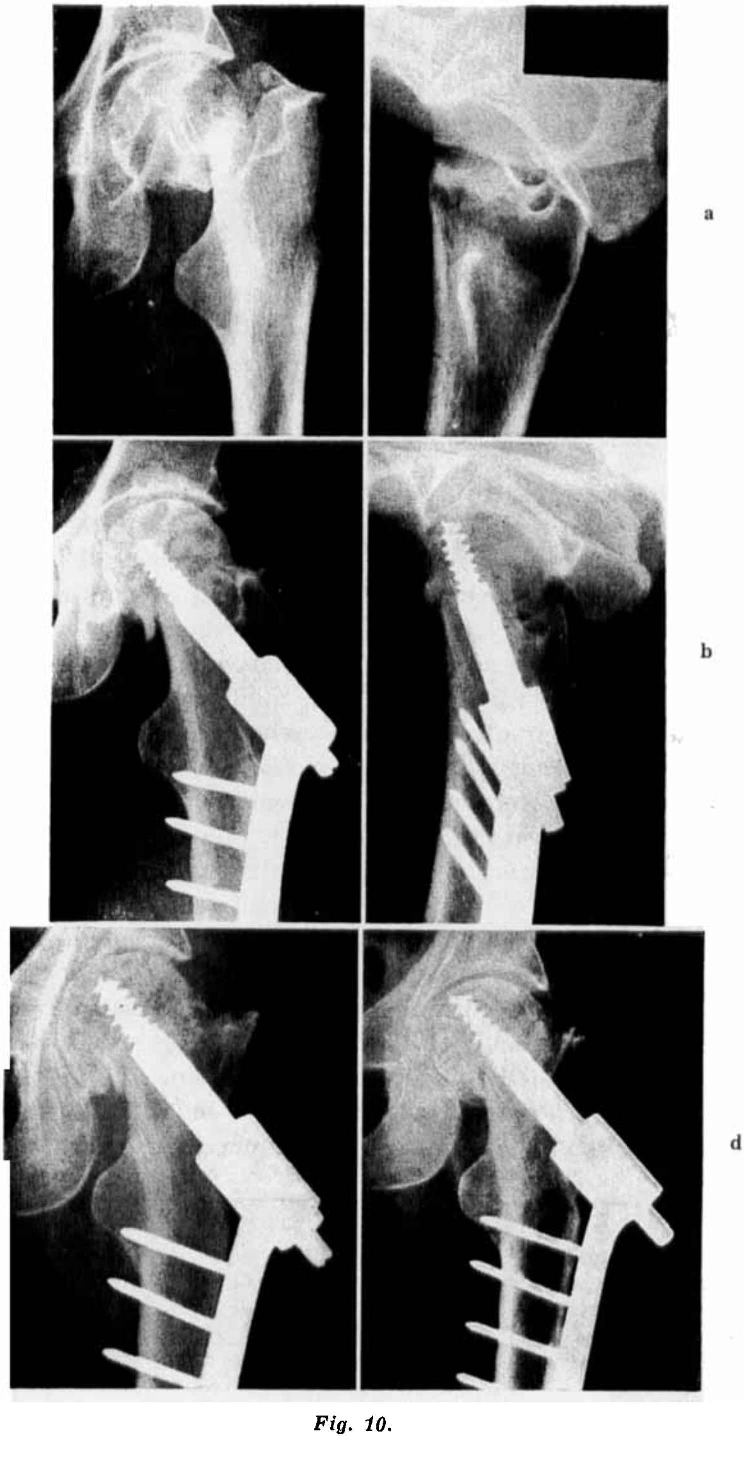

Fig. 10.

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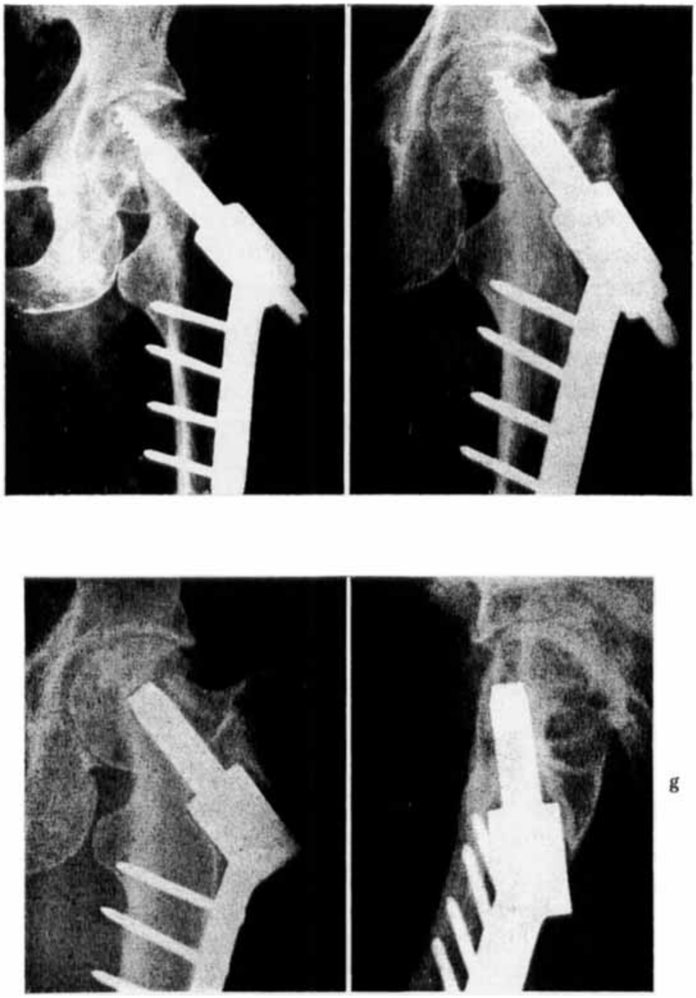

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Fig. 10.

A. original deformity of subcapital fracture. B. Immediate post-operative position—firm grip of screw so defective lateral position acceptable. C. Rapid extrusion of screw one month after operation. D. One week after re-tightening of nut. E. Slight extrusion three months after re-tightening, but not more than about 1 mm. F. Screw has cut out of head but fracture appears radiologically united six months after re-tightening. G. Screw was extracted under local anaesthesia. Film shows perfect radiological union 18 months after original injury.

important that the antero-posterior film should be centred to show the screw in true profile and not in external rotation with the shadow of the sleeve-plate markedly foreshortened.

In the original description (1957) it was proved that emergence of the outer end of the nut above the level of the sleeve-plate indicates absorption at the fracture line and does not mean that the screw is being avulsed from its position in the femoral head; unless this is fully appreciated the whole rationale of this device cannot be understood. Obviously the fracture cannot be united unless extrusion of the nut has become stationary during several monthly examinations.

If *three months* after the operation the nut has not extruded *more than 3 mm.* (i.e. the distance between two threads of the helical screw as measured directly on the X-ray film) it can be considered that the fracture is united and full weight-bearing can be permitted. This type of case has a fully viable head and first-intention osseous union has taken place (Fig. 9).

If *three months* after the operation there is extrusion of *more than 3 mm.* it is necessary to wait for the fourth or fifth-month film to decide whether extrusion is progressive before weight-bearing is permitted.

If here has been *2 or 3 mm.* extrusion *one or two months* after operation, re-tightening of the nut should be considered (Fig. 10).

Re-Tightening: A subject for future clinical research is the possibility of improving results by re-tightening the compression spring when early extrusion indicates that pressure is being lost very rapidly. In a small series where this has been done there has been no further extrusion after the second tightening and it is tempting to think that osseous union has been obtained in cases which otherwise might have failed. There is no doubt that many ischaemic femoral heads are ischaemic only in parts, while in other parts a blood supply is still present. I visualise re-tightening as encouraging the removal of defective bone until a part of living cancellous bone in the head is brought into contact with living bone on the neck.

The operation of re-tightening is a trivial procedure which can be done through a stab wound using local anaesthesia.

Bending and Breakage of Screws: Bending of the screw is not a sign of mechanical defect in the apparatus. Austenitic stainless steel is essentially a soft alloy and not capable of being hardened. Bending of a screw indicates that the fracture must have been in a potentially unstable position at the conclusion of the operation, probably as a result of comminution of the posterior cortex, and thereafter the head collapsed into a stable position. It must be remembered that, as a result of leverage, a screw in the femoral neck is exposed to a shearing force of the order of 100 lbs. during the simple bed-exercise of "straight-leg raising". If coaptation of the fracture surfaces is complete over the whole area of the fracture the screw will be shielded from shearing forces, but if coaptation is incomplete the screw will bend.

It is to be noted that no attempt has been made to design a screw strong enough to carry the whole weight of the body; the purpose of the screw is to encourage osseous union of the fracture, and if the screw breaks in service this means that the patient was permitted to walk on it before the fracture was united.

It is inevitable that as the fracture falls together, as a result of the screw bending, the screw will also extrude and spring-loading will be lost (Fig. 11). When beinding and extrusion occurs it is necessary to consider re-tightening of the nut.

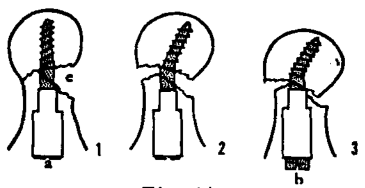

Fig. 11.

Bending of the screw when fracture is fixed in an unstable position with a comminuted posterior cortex. Bending of the screw, without a mechanism for extrusion, would result in distraction of the fragments as in 2. It is important therefore to re-tighten if projection of the nut, 3, accompanies bending.

Fracture of the screw has occasionally been encountered. In some cases there is no doubt that the surgeon has neglected the evidence of extrusion, indicating that the fracture was still un-united, at the time weight-bearing was permitted. In other cases it seems possible that ischaemia of the femoral head has been absolute, unlike the more common state of patchy ischaemia. When ischaemia of the femoral head is total it seems probable that failure by any form of internal fixation is inevitable, but it would seem that total ischaemia is rather rare.

RESULTS

In our original report (1957) the one-year results in 33 cases were available for study. Twenty-seven were clinically successful and six were failures (82 %). A study of a more recent series of 49 one-year results has now revealed a very similar figure indicating that it is possible to cause the fracture to unite in 85 % of cases, though it is admitted that many of these cases will later show ischaemic collapse of the femoral head. It is possible that ischaemic collapse of the pressure-bearing area of the head may appear to be more common after this method than after the Smith-Petersen nail because by use of the screw more cases proceed to union of the fracture when the head is partially ischaemic.

CONCLUSIONS

(1) The post-operative management of the patient, according to evidence deduced from the behaviour of screw extrusion, is more important than technical detail in the operation itself.

(2) Emphasis is placed on powerful mechanical compression at the time of operation to crush the fracture until the maximum area of contact is reached.

(3) Ischaemic necrosis of the femoral head after fracture of the neck of the femur is more commonly patchy in distribution than absolute. Progressive collapse, as demonstrated by extrusion of the screw, is a process which should be encouraged, in an endeavour to bring the living parts of the femoral head within range of the living bone in the neck fragment.

(4) The possibility of re-tightening the nut, in cases where rapid extrusion has occurred between the first and second months, offers scope for further investigation.

SUMMARY

The mechanical efficiency of some of the methods of internal fixation in current use for the treatment of intracapsular fractures of the neck of the femur are compared with the Charnley, spring-loaded, compression screw. This screw is intended to encourage union of the fracture by exerting a continuous compressive force in a constant direction in the absence of shearing force. It is not intended that the patient should walk on this screw before the fracture is united. Union of the fracture can be predicted by the cessation of extrusion of the screw.

It is believed that early extrusion of the screw indicates partial ischaemia of the femoral head and that by encouraging collapse, if necessary by re-tightening the screw, it is often possible to get contact between areas of living bone which originally were separated by a

volume of partially ischaemic bone on the capital side of the line of the fracture.

It is considered that the compression screw eliminates failure of union when the capital fragment is alive.

A number of technical details are described which are important in minimising failure with this device.

RESUME

L'efficience mécanique de certaines des méthodes de fixation interne couramment en usage pour le traitement des fractures intracapsulaires du col du fémur sont comparées à la vis de compression Charnley, avec charge-ressort. Cette vis tend à encourager la soudure de la fracture en exerçant une force compressive continue dans une direction constante et dans l'absence d'une force poussée à l'extrême. Il n'est pas prévu que le malade doit pouvoir marcher avec cette vis avant la soudure de la fracture. La soudure de la fracture peut être indiquée par l'arrêt de l'expulsion de la vis. On croit que l'expulsion précoce de la vis indique une ischémie partielle de la tête fémorale et qu'en encourageant l'affaissement ou si nécessaire en resserrant la vis, il est souvent possible de remettre en contact les surfaces osseuses vivantes qui étaient séparées par un volume d'os partiellement ischémique du côté de la ligne de la fracture qui se trouve vers la tête fémorale.

Il est considéré que la vis de compression élimine l'insuccès de la soudure lorsque le fragment de la tête est en vie.

Il est donné la description d'un certain nombre de détails techniques qui sont importants si l'on veut par cette méthode obtenir les meilleurs résultats possibles et minimiser les chances d'insuccès.

ZUSAMMENFASSUNG

Die mechanische Leistungsfähigkeit von einigen der gebräuchlichen Methoden zur inneren Feststellung der intrakapsulären Schenkelhalsbrüche wird mit der, mit einer Feder versehenen, Druckschraube von Charnley verglichen. Diese Schraube hat den Zweck die Vereinigung des Bruches mittels einer dauernden komprimierenden Kraft in einer unveränderlichen Richtung unter Ausschaltung scherender Kräfte zu befördern. Man beabsichtigt nicht, dass der Patient auf dieser Schraube gehen soll ehe der Bruch geheilt ist. Die Vereinigung des Bruches kann angenommen werden, sobald die Austreibung der Schraube aufhört.

Es ist wahrscheinlich, dass die frühzeitige Austreibung der Schraube eine teilweise Ischämie des Schenkelhalses anzeigt, und dass es oft möglich ist mittels Förderung des Kollapses, wenn notwendig durch erneute Anstrammung der Schraube, Berührungsflächen von lebendem Knochen, der ursprünglich durch teilweise ischämische Knochensubstanz an der Kopfseite der Bruchlinie abgeschieden war, herzustellen.

Man meint, dass die Druckschraube das Fehlschlagen der Wiedervereinigung ausschaltet, wenn das Kopffragment lebensfähig ist.

Eine Anzahl technischer Einzelheiten werden beschrieben, die wichtig sind, um die Möglichkeit des Misserfolges mit dieser Vorrichtung auf ein Minimum herabzusetzen.

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