

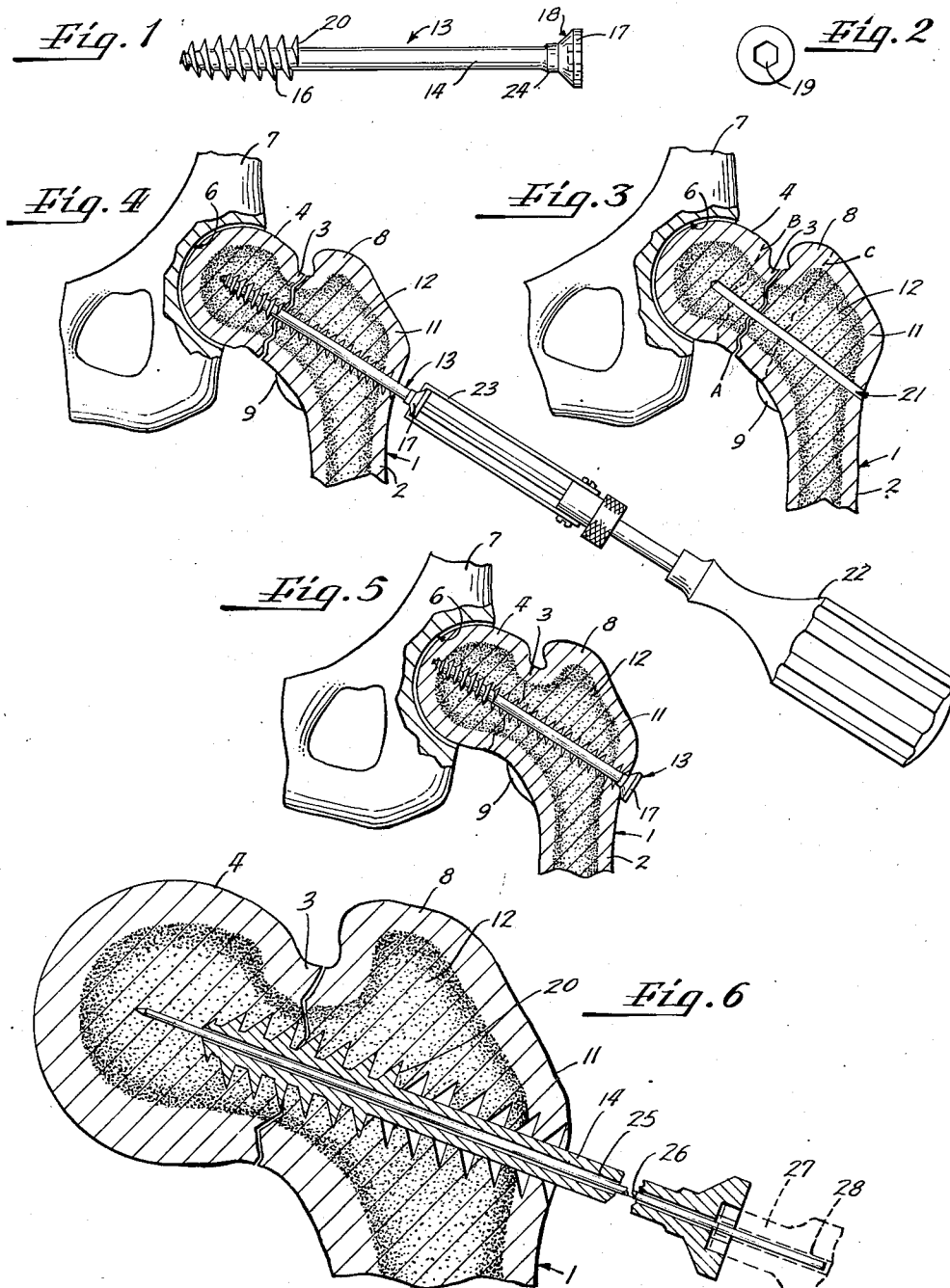
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MEANS FOR FIXATION OF HIP FRACTURES

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MEANS FOR FIXATION OF HIP FRACTURES

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This invention relates to the fixation of hip fractures and specifically to a special surgical lag screw for this purpose. This is a continuation in part of my co-pending application, Serial No. 703,253 filed October 14, 1946, now abandoned, the present application differing from the parent application in the nature of the threads and in the provision of a shoulder or collar between the head and the shank of the screw.

The human femur or thigh bone comprises a straight shaft extending upward from the knee and having an inwardly extending transverse neck portion at the top disposed at an average angle of approximately 130° with respect to the shaft. The neck terminates in a ball-shaped head which sockets in the pelvic bone. The neck of the femur and the portions immediately adjacent to it on both sides are stressed in shear by the weight of the body. Consequently, fracture of the femoral neck or of the head or shaft immediately adjacent the neck is one of the most common and at the same time most serious accidents occurring especially to elderly persons. Due to the intumed disposition of the femoral neck it is difficult to get at the fracture and fixation is usually accomplished by driving one or more nails through the shaft of the femur into the neck and head thereof. Until as late as 1925 when Smith-Petersen presented his special three-flanged nail which is still popularly used for internal fixation of the fracture, it was general practice to reduce the fracture by manually pressing the broken parts together and then immobilizing the joint in a plaster cast for a long period, in many cases months. Since these accidents usually happen to the elderly whose conditions are only too often complicated with cardiovascular disease, renal disease, hyper tension, arthritis, diabetes, or senility, the greater majority of these fractures finally terminated in death due to the required immobilization which induced circulatory stasis resulting in hypostatic pneumonia or some other condition.

The Smith-Petersen nail above mentioned is now widely employed for the fixation of these fractures, that is, for holding the fragments fixed with respect to one another while they are growing together again. It has represented a long step forward in the treatment of such fractures and has eliminated to a large degree the plaster casts formerly required; however, it has presented a certain number of disadvantages which up to this time have been considered unavoidable. Because of its very large size the large surface

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area exposed to the body fluids results in some cases in electro-chemical reactions destructive to body tissues and, furthermore, the relatively large area of cancellous bone disturbed by the nail has been believed responsible for the destruction of certain nutrient blood vessels supplying the proximal or broken-off head portion of the femur, thus delaying or preventing altogether ultimate complete knitting of the fracture surfaces. Furthermore, any nail must be pounded into place which, as in the case of elderly patients or others having very brittle bone structures, presents the danger of further splitting of the bone as well as discomfort on the part of the patient.

Accordingly, a primary object of the present invention is the provision of a surgical lag screw which exposes a minimum of surface area to electro-chemical action by the body fluids; which may be used without any danger of causing secondary fractures; which causes a minimum of injury to the nutrient blood vessels supplying the relatively small proximal fragment; and which fulfills all the following long recognized criteria of rigid fixation:

- (1) Prevents rotation of fragments by pressing the ragged fracture surfaces firmly together;
- (2) Length of the splint should be sufficient to prevent angulatory movement;
- (3) A minimum of bone displacement, and
- (4) A maximum of bone surface contact at the fracture.

Another object is the provision of a method of fixation of a fractured hip bone which may be carried out in a minimum length of time, which avoids the use of plaster casts or other immobilizing means, which allows the patient to be immediately ambulatory in bed as soon as he can tolerate it, and which permits the patient to be ambulatory on crutches, unaided, within two or three weeks.

I have discovered that in every case of a fractured femur the small or proximal fragment is never less than 1" in length; thus, it has been possible for me to standardize on a thread length at the end of my surgical lag screw of approximately 1" with the assurance that it may be satisfactorily employed in every case.

Another object of the invention is the provision of a surgical lag screw for the fixation of hip fractures in which the screw has a head with a frusto-conical surface disposed at approximately 130° to the axis of the screw so that when

the latter is emplaced in alignment with the femoral neck (which is disposed 130° with respect to the shaft) a portion of the frusto-conical head surface will engage the outer surface of the shaft in substantially flatwise abutment.

Other objects and advantages will become apparent from the following description in connection with the drawings in which—

Figure 1 is a longitudinal side view of a surgical lag screw comprising one modification of the present invention;

Fig. 2 is an end view of the head of the lag screw shown in Figure 1;

Fig. 3 is a fragmentary, partially sectioned view of the joint between the pelvic bone and the femur, showing a characteristic hip fracture in the femoral neck, and showing also the initial bore which is made in preliminarily fitting the lag screw;

Fig. 4 is a view similar to Fig. 3, showing the lag screw being tightened into position within the drilled bore;

Fig. 5 is another view similar to Fig. 3, showing the screw after it has been tightened into position to hold the fragments of the broken femur firmly together; and

Fig. 6 shows in enlarged section a second embodiment of the invention.

The human femur, or thigh bone, 1 includes a shaft 2 extending upward from the knee (not shown). Disposed at an average approximate angle of 130° with respect to the shaft is a neck portion 3 terminating in a ball-shaped head 4 seated in socket 6 in the pelvic bone 7. The femur has upper and lower prominences 8 and 9, known respectively as the upper trochanter and the lower trochanter. As in bone structure generally, the femur 1 has a strong, hard outer covering 11 called the cortex surrounding a core of cancellous or spongy structure 12 sometimes called marrow.

The majority of hip fractures occur along the line A in the femoral neck 3, as shown, or close to the neck on one side or the other as indicated by the broken lines C or B. This is because the neck itself is reduced in cross-section and is disposed transverse to the shaft 2 whereby the entire weight of the body is effective to place a high shear loading on the neck and on the intra-capital and intertrochanteric areas immediately adjacent. Thus, these parts are the first to fail when the pelvic-femur joint is overloaded as by a sudden, unexpected fall.

As a result of studying hundreds of these femoral fractures, I have discovered that the proximal fragment which is the smallest and includes the head 4 is never less than one inch long, even in cases of intra-capital fractures, that is, within the head itself, as for example, along the line B. With this discovery, I have been able to develop the present invention in which the lag screw 13 may be formed in a few standard lengths each having a thread length of approximately one inch which may be wholly contained within the proximal fragment in carrying out the fixation operation. Thus, the number of screws which a hospital is required to stock to allow for the variation in patient sizes is minimized.

To avoid the disadvantages, above-mentioned, incident to the use of a large foreign body in the bone, the lag screw 13 is made as small as possible consistent with the requisite strength. I prefer to form the shank 14 and the base of the threads 16 about $\frac{3}{16}$ " in diameter with the diameter of the threads 16 about twice that and the

head 17 somewhat larger, approximately $\frac{1}{2}$ ". The threads are preferably large, thin, coarse threads as shown in the drawings for readily gripping the cancellous bone structure 12, and in the preferred embodiment the sides of the threads facing the head 17 are disposed in substantially right angle relationship to the shank 14 as indicated at 20 while the opposite sides of the threads stop toward the shank at a substantial angle to provide adequate stock and strength in the threads; I have had good results with screws having eight threads to the inch. The screw 13 is generally inserted in axial alignment with the neck—which lies at approximately 130° with respect to the shaft 2. Therefore, to provide for the solidest possible engagement with the outer surface of the shaft, the underside of the screw head 17 is formed with a smooth frusto-conical surface 18 disposed at 130° . When assembled as shown in Fig. 5, the lower edge of this frusto-conical surface seats firmly against the beginning of the straight portion of the femur shaft 2. This is an important element of the present invention in avoiding stress concentration in the bone against a high point on the underside of the screw, thereby avoiding necrosis of the bone at that point and promoting rapid healing. The screw head is furthermore formed with a counter-sunk recess or socket 19 of the "Allen" (shown) or "Phillips" type (not shown) or the like; that further avoids irregularities in the screw head which would injure the tissues or bone structure as the screw is tightened into its final position. Adjacent the surface 18 and surrounding the shank is a collar 24 which serves a dual purpose. First, it serves to more effectively close the opening in the bone around the shank left by the entry of the threads as will be apparent from Fig. 5. Secondly, it serves as a locating and guiding means where a bone plate is employed. It is essential that the lag screw be formed of a material electro-passive in the body fluids which are highly corrosive to most metals; otherwise the electrochemical reaction incident to the corrosion of the material will be destructive to adjacent tissue and may in extreme cases prevent healing altogether. Two metals which possess both the required strength and electropassivity are "Vitalium," an alloy of cobalt, chromium and molybdenum, and "18-8-SMO" stainless steel, an alloy of roughly 18 percent nickel, 8 percent chromium, 2 to 3 percent molybdenum and the remainder iron, manganese and carbon.

In Fig. 6 I have shown a modification of the invention which is substantially similar to that shown in Figs. 1-5 and described in connection therewith with the exception that the screw has an axial bore 25 which extends from the bottom of the socket 19 through the opposite end of the screw. This bore preferably has a diameter of approximately $\frac{3}{16}$ " and has an uninterrupted annular wall concentric with the outer wall of the shank 14 and of such size that the screw may be received on a guide pin 26, the head 17, the shank 14 and the threads 16 being identical with that shown in the previous figures. When this screw is employed a handle designated generally by the numeral 27 is employed for driving the screw, the handle having a bore as shown at 28 for the passage of the pin.

The lag screw will not ordinarily be used as a structural member itself to support the weight of the body; rather, its primary purpose is to hold the bone fragments firmly together with the greatest possible fracture area in contact while

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the broken parts are knitting together. It permits the patient to be immediately ambulatory in bed and walking on crutches within two weeks or so and thereby avoids the extended plaster cast immobilization and complications arising therefrom which has previously been employed. At the same time it avoids the disadvantages attendant to the use of nails for fixation.

In applying the lag screw 13 to the fixation of a femoral neck fracture, as for example along the line A of the drawing, the procedure is as follows: The patient is brought to the operating room following the usual pre-operative medication and is placed on the ordinary operating table. I use a cassette holder to replace a part of the mattress pad to facilitate the taking of X-ray films during the progress of the operation, no other special equipment being needed. The patient is then anesthetized and reduction of the fracture accomplished by manipulating the limb. By "reduction," I refer to the procedure used to move the proximal and distal fragments of the femur into correct alignment with one another. I personally have used the method commonly known as the Leadbetter method and have had no difficulty in reducing all fractures. In this method the thigh is flexed 90° with the knee also flexed to 90°. A folded towel is passed around the upper thigh and traction is applied by an assistant holding this towel while manual traction is also applied in the axis of the flexed thigh. With traction being applied in these two directions the thigh is internally rotated and the leg is slowly circumducted into abduction and straightened out, the internal rotation being maintained. As the leg is brought down to table level the foot is over the edge of the table, and the heel-palm test is applied to confirm reduction. If reduction has been accomplished the leg will not evert itself. An assistant then holds the leg in this position throughout the operation, and X-ray pictures are taken in both the anteroposterior and lateral planes to ascertain that the fracture has been reduced.

A short incision is made through the lateral surface of the thigh extending downward from a point just distal to the greater trochanter 8. The incision is carried through the muscle beneath and it is separated down to the femur 1.

The anatomical structure and angulation of the neck of the femur must be considered in selecting the point at which to drill through the cortex 11 of the shaft 2. The femoral neck averages one inch in diameter and, as mentioned above, is disposed at an angle of 130° to the shaft; in addition it has an antetorsion angle of 15°. With this in mind, a drill (not shown) which serves as a guide pin and has a diameter somewhat less than the shank 14 of the lag screw, is drilled through the cortex at the point selected and is drilled in to produce a bore 21 (Fig. 3) having a depth estimated from measurement of the size of the femur on the X-ray pictures. X-ray pictures are again taken to ascertain if the pin is correctly placed. If so, the guide pin is then removed, the calibration noted, and the length of required lag screw is determined.

The hard cortex at the opening of bore 21 is reamed out the size of the lag screw shank 14. A tap (not shown) the size of the threads 16, is then used through the cortex to permit the wide threads of the screw to pass through it without having to drill a larger hole. The lag screw 13 is mounted on the end of an Allen head screw-driver 22 and held in place by a hinged

retaining frame 23 (Fig. 4); the screw is then inserted in bore 21, screwed through the distal fragment and into the proximal fragment until the threads 16 are wholly contained in the latter. The screw can be felt to grip into the bone of the proximal fragment as the two fragments are drawn tightly together to the final position shown in Fig. 5. As the screw head 17 is pulled down on the outer surface of the shaft 2, it turns smoothly without injuring the bone by reason of its smooth 130° frusto-conical undersurface 18.

These conditions are adverse, or where the surgeon may for some reason feel the need for positive guidance of the screw, the pin may be allowed to remain in place. A commutated tap may be employed which is passed over the pin to ream out the cortex as explained above and thereafter a screw such as shown in the modification of Fig. 6 employed, the pin being removed after the screw is seated.

The entire procedure seldom requires more than thirty to forty-five minutes, and the patient suffers little or no shock. The patient is returned to bed and the leg placed on pillows with the knee slightly flexed and the thigh moderately abducted. Routine care is given and a high backrest permitted as soon as tolerated. The patient is completely ambulatory in bed, and in five or six days is permitted up in a chair. Walking with the aid of crutches is permitted as soon as the patient is strong enough to use them, but he is advised not to put any weight on the affected leg for two months. I have had several cases, however, where this advice was disregarded, and walking unaided attempted within a few weeks with no ill effects.

I have found this lag screw equally effective in intertrochanteric fractures as well as the intracapsular types. The tension exerted by the pull of the wide threads against the screwhead placed against the cortex 11 holds the fragments firmly immobilized, which is the fundamental requirement of all fracture treatment. I have found that no additional means need be provided to prevent the fragments from rotating (such, for example, as the three longitudinal flanges on the Smith-Petersen nail); for since all fractures are ragged to a greater or lesser extent, the pressure of the lag screw forcing them together acts to prevent rotation.

While a particular lag screw and a particular method of applying it has been shown in connection with the present invention, it will be apparent that minor changes therein will readily suggest themselves to others skilled in the art without departing from the spirit and scope of the invention.

I claim:

1. A one-piece surgical lag screw for the fixation of a hip fracture wherein the proximal and distal fragments include respectively the head and shaft of the femur comprising a single piece of metal electropassive in the body fluids including a shank having a smooth cylindrical outer surface, a threaded portion approximately one inch in length at one end of said shank, the thread being continuous from end to end, the base of the thread having a diameter not greater than the diameter of the shank, the outer diameter of the thread approximating twice the diameter of the base and tapering to a lesser diameter at the extreme end of said screw, and a head at the opposite end of said shank having a frusto-conical surface adjacent the shank for rotation against the cortex of the femur shaft in

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the final tightening operation and a socket for reception of a tool for rotating the screw the perimeter of the socket being spaced inwardly from the perimeter of the head.

2. The combination recited in claim 1 wherein a cylindrical collar having a uniform diameter slightly greater than that of the shank and materially less than that of the head is disposed between the shank and said frusto-conical surface.

3. A unitary surgical lag screw comprising a head having a smooth frusto-conical circularly extending uninterrupted undersurface and a socket recess for receiving a tool, a shank having a smooth uninterrupted circular outer surface integral with the head having a diameter of approximately $\frac{3}{8}$ " and a threaded portion integral with the end of said shank having a length of approximately one inch, an outer diameter of approximately $\frac{7}{8}$ " adjacent the head and tapering to a lesser diameter at the extreme end of the screw away from the head and an inner diameter not greater than the diameter of the shank whereby said screw will expose a mini-

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mum surface area for electrochemical action by the body fluids, the thread on said threaded portion being continuous from end to end and having a side facing the head disposed at approximately right angles with respect to the longitudinal axis of the screw.

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