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FRACTURE REDUCING DEVICE
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My invention relates to fracture reducing devices and has particular reference to means for reducing fractures of the neck of the femur or similar fractures wherein it is desirable to employ a fracture reducing element capable of drawing the bone fragments together and to render them sufficiently rigid to permit use of the bones for supporting weight.

In the treatment of many of the bone fractures, it has been the practice in the past to employ various devices to draw the bone fragments together and then the entire limb has been immobilized by means of casts extending beyond the joint at opposite ends of the bone. In the treatment of fractures of the neck of the femur, for example, it has long been the practice to attempt to draw the bone fragments into reasonably close juxtaposition with each other by means of “nails” driven through the bone fragments longitudinally of the neck of the femur. This lends some rigidity to the reassembled bone fragments but it has been essential that the patient maintain the entire leg substantially immobilized for a relatively long period of time extending between two to five months before it was possible to permit the patient to walk or otherwise exert force upon the affected limb.

A further disadvantage of the “nail” types of fracture reducing elements is in the manner in which such devices are inserted into the bone, such devices requiring that the nail be driven into the bone through the distal fragment and thence into the proximal fragment, the driving forces being exerted in a direction which tends to separate the bone fragments rather than to draw them together, the reaction forces of the driving of the nail or pin into the proximal fragment being depended upon for compounding the meeting ends of the fragments into close relation with each other. This method does not assure the tight engagement of the jagged ends of the bone fragments and frequently requires that the healing processes must bridge a considerable gap between the bone ends during the healing period.

It is therefore an object of my invention to provide a fracture reducing device which may be successfully employed to actually exert forces between the adjacent bone fragments to forcibly draw them together into close abutment with each other.

Another object of my invention is to provide a device of the character described which may be inserted through the distal bone fragment and into the proximal fragment and there to grip the proximal fragment and draw it and the distal fragment into abutting relation with each other and in which the device will provide a sufficient support between the fragments, as to permit the patient to immediately exert weight upon the fractured bone.

Another object of my invention is to provide a device of the character described wherein the device is readily removable from the healed bone after the termination of the healing period.

Other objects and advantages of my invention will be apparent from a study of the following specifications, read in connection with the accompanying drawing, wherein:

Fig. 1 is an elevational view of a typical femur having a fracture at the neck thereof and illustrating the manner in which my fracture reducing device may be employed therein;

Fig. 2 is a vertical sectional view taken through the fracture reducing device shown in Fig. 1 and illustrating the same in its initial position;

Fig. 3 is a vertical sectional view similar to Fig. 1 and illustrating the position of the parts when the inner end of the device has been expanded to grip the proximal fragment of the bone;

Fig. 4 is a transverse sectional view of the device illustrated in Fig. 2, taken along line IV—IV of Fig. 2;

Fig. 5 is a vertical sectional view taken through a modified form of fracture reducing device which may be substituted for the device shown in Figs. 2, 3 and 4 and illustrating the position of the parts prior to the expansion of the inner end of the device;

Fig. 6 is a fragmentary sectional view similar to Fig. 5 and illustrating the position of the parts when the inner end of the device has been expanded; and

Fig. 7 is a fragmentary sectional view similar to Fig. 6 but illustrating a still further modified form of my invention.

Referring to the drawing, I have illustrated in Fig. 1 a typical femur bone 1 having a neck 2 terminating in a head 3 and which is assumed to be fractured across the neck along the line indicated at 4. The fracture of the type illustrated in Fig. 1 is a common type of fracture and for proper treatment requires that the head portion 3 be drawn into snug engagement with the main or distal fragment 1 to permit the knitting together of the bone fragments across the break 4.

To accomplish this result, a bone indicated by the dotted line 5 is drilled through the main or distal bone fragment and through the neck 2 into
the head of the bone after the head fragment has been accurately aligned with and moved into reasonably close juxtaposition to the distal fragment. Into the bore 5 is inserted my fracture reducing device, which comprises a body member 6 preferably formed as a hollow bolt of any suitable material, such as stainless steel, provided its exterior surface with threads 7 with preferably extend continuously from one end to the other of the body 6. The body 6 is provided with an internal bore 8 through which extends a threaded rod or bolt 9 for the purpose of expanding or enlarging the inner end 10 of the body member 6.

In the form of the device illustrated in Figs. 1 through 4, the bolt 9 is illustrated as having threaded upon its inner end an expanding wedge nut 11 normally seated in a tapered recess 12 formed in the inner end of the body 6 so that as the screw or bolt 9 is turned relative to the body 6 the wedge 11 will be drawn into the body to such position that the split inner ends 10 of the body 6 will be bent or expanded radially into an enlarged head which will grip the sides of the bone 5 with sufficient pressure to effectively anchor the inner end 10 of the body in the head or proximal fragment 3 of the bone.

The body 6 now being anchored in the head 3, a nut structure 13 may be then screwed down upon the body 6 to draw the distal and proximal fragments into tight abutment with each other, interlacing any jagged edges of the fragments and positioning the two fragments in sufficiently close abutment as to permit the healing or knitting of the bone sections together with a minimum of healing time.

The nut structure 13 is preferably constructed as a tubular sleeve, the inner end of which is provided, as indicated at 14, with female threads engaging the external threads 1 of the body 6 while the outer end of the nut 13 is provided with an enlarged head or radially projecting flange 15 adapted to abut against the outer surface of the distal bone fragment 1 so that by turning the nut 13 relative to the body 6, the bone fragments may be drawn together with any desired pressure. The nut 13 is preferably constructed of any suitable material, such as stainless steel or other material which will not react chemically with the body processes during the time it is within the body, and may be provided with slots 16 upon its outer end for the purpose of receiving a suitable wrench, screwdriver or other instrument facilitating the turning of the nut on the body.

With the fracture reducing device just described inserted and the bone fragments drawn together, the device will not only hold the bone fragments together but will provide sufficient rigidity between the bone fragments as to resist displacement thereof by the exertion of the weight of the patient in normal walking or other movements. Hence the patient treated with my fracture reducing device may immediately resume normal activity, unhampered by the necessity of immobilizing splints or casts or other devices.

One of the distinct advantages of my device over the "nail" methods of reducing fractures of this character lies in the fact that there is substantially no bruising or other injury to the hip joint by the manipulation necessary to insert and fix the device in place, with the result that, except for the minor pain and soreness resulting from the incision through the muscles necessary to expose the bone for the drilling of the fracture reducing device, there is no unfavorable reaction upon the patient.

By referring particularly to Figs. 2, 3 and 4, it will be observed that the inner bolt 9 and its wedge exert relatively great expanding forces, permitting the anchoring of the body 6 within the head 3 of the bone by reason of the relatively great mechanical advantage achieved between the wedge surfaces of the nut 11 and the split ends of the body 6, the bolt 9 being preferably formed with an enlarged head 17 upon its outer end provided with a screwdriver or wrench slot 18 by which the bolt may be manipulated from the exterior of the bone. If desired, the expansion of the inner end 10 of the body 6 may be facilitated by reducing the cross sectional area of the body 6 at some point spaced inwardly from the inner end 10 thereof as by forming a recess or laterally extending bore 19 at the end of the split in the end of the body 6. While this weakening of the expanding end of the body facilitates the ready expansion of the body into gripping relation with the head 3 of the bone, it also serves additionally to permit the ready contraction of the expanded end of the body 6 when it is desired to remove the entire device at the end of the healing period.

Removal of the device is accomplished by releasing the wedge nut 11 as by reversing the rotation of the inner bolt 9 to thread the nut toward the inner end of the bolt 9. While if desired the bolt 9 may be merely turned until it has threaded itself to some extent out of the nut 11 and then the head 17 of the bolt 9 may be struck to drive the wedge inwardly, I prefer to provide means for resisting the outward movement of the bolt 9 as by providing an annular groove 20 in the bolt 9 and an annular groove 21 on the interior of the bore 8 of the body 6, between which grooves may be interposed a snap ring 22 of the construction commonly employed for interconnecting two telescopically assembled machine elements. Thus reverse rotation of the bolt 9 will positively drive the wedge 11 inwardly of the head 3, and I believe the expanding forces from the split end 10 of the body 6, permitting the split expanded end to collapse to its normal diameter and thus releasing engagement thereof with the now healed bone fragment 3. However, if after releasing the split end 10 failed to contract as the wedge 11 is removed therefrom, the removal of the entire device from the bone is by no means prevented since all that is necessary is to rotate the body 6 in a direction to unscrew it from the bone, the threads 1 which have engaged the bone surface on the interior of the drilled bore 5 acting like a screw and nut assembly to thread the device out of the bone cavity. To facilitate the unscrewing of the body 6 wherever it is necessary, I provide a cross slot 23 in the outer end of the body 6 to permit the insertion therein of a wrench or screwdriver or other suitable instrument required to rotate the body 6.

The nut structure 13 is preferably formed with a length sufficient to provide considerable longitudinal movement thereof on the body 6 before the outer end of the body 6 is exposed through the open end of the nut structure 13. Thus a single device may be employed for bones of different size, the adjustment of the device to bones of smaller size being accomplished merely by screwing the nut structure 13 further inwardly upon the body 6 or the device may be adapted to larger bones by merely screwing the nut structure 13 outwardly with respect to the body 6...
until the desired overall length of the device is achieved.

To insulate against the inadvertent disassembly of the various parts of the device from each other, a secondary feature of the inner screw

9 in such manner as to prevent its complete removal from the wedge nut 13 as by riveting over the inner end of the screw 9 as indicated at 9a, or otherwise forming an enlarged head against which the nut 11 may bear when the nut is in its normal position. Also I may provide the outer end of the body 6 with an enlarged unthreaded section 6a which constitutes an abutment against which the nut structure 13 may engage when the nut is completely unscrewed to its outermost position.

Referring to Fig. 1, it will be observed that while the device is particularly adapted for the reduction of fractures of the neck of the femur, the same may be employed also to draw together three or more bone fragments in the event a multiple fracture has occurred, a second line of fracture being indicated at 24 and the drilled bone or cavity being illustrated as extending through all three pieces of the bone.

Also I have illustrated the adaptation of my fracture reducing device to the reduction of intercondylar fractures of the lower end of the femur. Thus it will be apparent that the device is equally adaptable for the reduction of various types of fractures in which both the exertion of tensile forces drawing the bone fragments together and also the provision of lateral rigidity during the healing period is required.

While in Figs. 1 through 4 I have illustrated one form of expanding body member 6, it will be apparent that the body may be provided with other types of expanding devices; for example, in Figs. 5 and 6 I have illustrated a modified form of expanding apparatus which includes the body member 6 constructed substantially as described in the forms shown in Figs. 1 through 4 with the exception that the tapered split 25 is provided with a reverse taper from that shown in 5 and the expanding device, instead of requiring the use of a wedge nut 11, in this form of the device comprises a bolt or screw 26 threaded into the outer end of the body 6, as indicated at 27. The inner end of the screw 26 is provided with an interior threading with the reverse taper 25 and arranged in such manner that by screwing the screw 26 inwardly the tapered end 25 acts as an expanding mandrel forcing the split ends of the body 6 to their expanded bone gripping position as illustrated in Fig. 6.

In Fig. 7 I have illustrated a still further modified form of my invention wherein the inner split end of the body 6 is formed by constructing a pair of jaws 10a and 10b separate from the body member, each of the jaws having a hemispherical head 31 adapted to be received in a spherical socket 332 formed in the end of the body 6. The bore 8 through the body extends through the loose ends 10a and 10b in such fashion that when the bolt or screw 9 is inserted the ends 10a and 10b will be forced from the body member 6, thus the ends 10a and 10b form a pair of loose jaws which may readily be removed from their normally retracted position as shown in Fig. 7 to an expanded position corresponding to the position shown in Fig. 2 by the inward threading of the wedge 11 upon the screw 9 in the same manner as was described with reference to Figs. 1 through 4, the primary difference being in the fact that when the wedge is again screwed outwardly the jaws 10a and 10b are free to collapse and are not restrained by the normal inherent stiffness of the material of the body 6.

Again the removal or retraction of the screw 26 will permit the contraction or collapse of the expanded end of the body 6 to facilitate removal thereof from the bone after the healing period is complete, the failure of the ends to contract permitting the unscrewing of the body member 6 from the bone cavity in the same manner as was described with reference to Figs. 1 through 4.

In the event that the particular position along the distal bone fragment at which the bore 8 is to be made is not at right angles to the surface of the bone, it may be desirable to interpose between the head 15 and the distal bone fragment an angular washer such as is illustrated at 30 in Fig. 1, thus providing for a distribution of the pressure exerted by the head 15 over a greater area of the bone surface.

While I have shown and described the preferred embodiment of my invention, I do not desire to be limited to any of the details of construction shown or described herein, except as defined in the appended claims.

I claim:

1. In a fracture reducing device, a body member adapted to be inserted into a bore formed in the bone fragments, comprising an elongated cylindrical member having its inner end laterally expandable to engage the walls of the bone bore and having its exterior surface at said inner end provided with screw threads, means extending through said body member and adapted to be accessible from the exterior of the distal bone fragment for expanding said inner end into anchored relation in the proximal fragment, a nut member comprising a sleeve extending along and threaded upon said body member, a nut member comprising a sleeve extending along and threaded upon said body member and having a head at its outer end adapted to bear against the expanded end of said distal fragment for drawing said anchored proximal fragment into abutment with said distal fragment, and means interengaging said body member and said nut member when said nut member is unscrewed from said body member to prevent further unscrewing of said nut member, whereby further turning of said nut member will unscrew the members from the bone as a unit.

2. In a fracture reducing device, a body member adapted to be inserted into a bore formed in the bone fragments, comprising an elongated cylindrical member having its inner end laterally expandable and having its exterior surface at said inner end provided with screw threads, means extending through said body member and adapted to be accessible from the interior of the distal bone fragment for expanding said inner end into anchored relation with the proximal fragment, a nut member comprising a sleeve extending along and threaded upon said body member and having a head at its outer end thereof to engage the threads of said sleeve when said body member is unscrewed to a predetermined distance along the body member to prevent further unscrewing of
said nut member, whereby further turning of said nut member will unscrew the members from the bone as a unit.

3. In a fracture reducing device, a body member adapted to be inserted into a bore formed in the bone fragments, comprising an elongated cylindrical member having its inner end split and having the exterior surface thereof at said inner end provided with screw threads, means extending through said body member and adapted to be accessible from the exterior of the distal bone fragment for expanding said split end into anchored relation in the proximal fragment, a nut member comprising a sleeve extending along and threaded upon said body member and having a head at its outer end adapted to bear against the exterior of said distal fragment for drawing said anchored proximal fragment into abutment with said distal fragment, and means interengaging said nut member and said body member when said nut member is unscrewed to a predetermined distance along said body member to prevent unscrewing of said nut member, whereby further turning of said nut member will unscrew the members from the bone as a unit.

4. In a fracture reducing device, a body member adapted to be inserted into a bore formed in the bone fragments, comprising an elongated cylindrical member having its inner end split and having the exterior surface thereof at said inner end provided with screw threads, wedge means in said split end, a screw adapted to be accessible from the exterior of the distal bone fragment for drawing said wedge toward the outer end of said body member to expand said split end into anchored relation in the proximal fragment, a nut member comprising a sleeve extending along and threaded upon said body member and having a head at its outer end adapted to bear against the exterior of said distal fragment for drawing said anchored proximal fragment into abutment with said distal fragment, and means interengaging said nut member and said body member when said nut member is unscrewed to a predetermined distance along said body member to prevent unscrewing of said nut member, whereby further turning of said nut member will unscrew the members from the bone as a unit.

5. In a fracture reducing device, a body member adapted to be inserted into a bore formed in the bone fragments, comprising an elongated cylindrical member having its inner end split and having the exterior surface thereof at said inner end provided with screw threads, a bore extending through said body member terminating in an inwardly tapering bore adjacent said split end, and a screw extending into said bore from the outer end of said body member and adapted to be accessible from the exterior of the distal bone fragment, said screw having a tapered end disposed in the tapered portion of said bore to expand the split end of said body member when said screw is turned inwardly of said body member, a nut member comprising a sleeve extending along and threaded upon said body member and having a head at its outer end adapted to bear against the exterior of said distal fragment for drawing said anchored proximal fragment into abutment with said distal fragment, and means interengaging said nut member and said body member when said nut member is unscrewed to a predetermined distance along said body member to prevent unscrewing of said nut member, whereby further turning of said nut member will unscrew the members from the bone as a unit.

6. In a fracture reducing device, a body member adapted to be inserted into a bore formed in the bone fragments, comprising an elongated cylindrical member, a pair of semi-cylindrical members hingedly secured to the inner end of said body member and constituting an extension of said body member having screw threads thereon, a bore extending through said bore and adapted to be accessible from the exterior of the distal bone fragment, a wedge nut on said screw disposed between said semi-cylindrical members comprising the extension of said body member to expand said semi-cylindrical members into anchored relation in the proximal fragment, a nut member comprising a sleeve extending along and threaded upon said body member and having a head at its outer end adapted to bear against the exterior of said distal fragment for drawing said anchored proximal fragment into abutment with said distal fragment, and means interengaging said nut member and said body member when said nut member is unscrewed to a predetermined distance along said body member to prevent unscrewing of said nut member, whereby further turning of said nut member will unscrew the members from the bone as a unit.

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