Feb. 9, 1954 E. J. HABOUSH 2,668,531

PROSTHESIS FOR HIP JOINT

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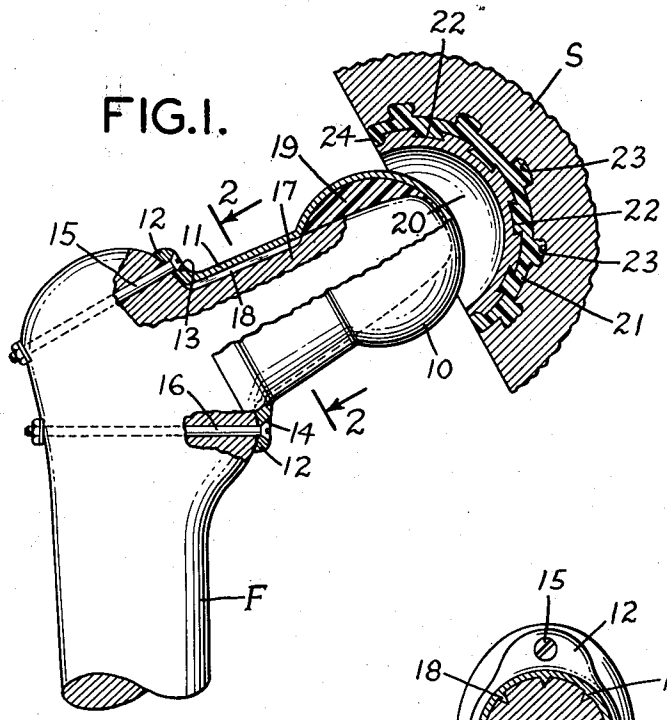
FIG.1.



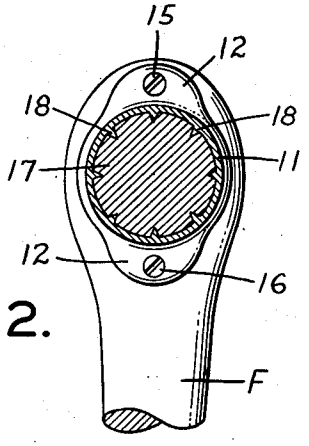


FIG.2.

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PROSTHESIS FOR HIP JOINT

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10 Claims. (Cl. 128—92)

1

This invention relates to metallic prosthesis for degenerated or damaged joints of the human body and it relates particularly to a metallic ball and socket prosthesis for replacing a degenerated or damaged head or head and neck of the femur.

In some cases of injury to the hip joint, the head of the femur or the neck and head of the femur are so badly damaged or degenerated that the common techniques for repair of the damaged parts are impractical or ineffective. For example, the relatively common practice of fixing a fractured femur or the neck thereof by means of bone nails or bone plates is impractical when the head of the femur is shattered or chipped to such a degree that it cannot move freely in the acetabulum (socket) of the hip joint.

It has been suggested that such a badly shattered or chipped head of the femur could be replaced or repaired by means of a metallic or other artificial head or covering for the head of the femur. I have proposed that the damaged femur head could be repaired by reshaping it and applying to it a hollow head formed of a chrome, cobalt, molybdenum alloy (Haynes Stellite No. 21). The hollow head is provided with a spike which is driven lengthwise of the neck of the femur to form a rigid support for the metallic head. In practice, I found it difficult to seat the hollow head properly because it is impossible to see the position of the spike as it is being driven along the neck of the femur. Because of this difficulty, I suggested a modified type of head prosthesis which includes a short metallic flange or skirt to aid in guiding the head into position. This type of head was more readily applied and seated than the earlier type but it and the earlier type were found to have disadvantages which arose after the prosthesis had been in use for a relatively short period of time. It was found that with both of these types of prosthesis that the motion of the joint decreased progressively and the patient began to experience pain at the joint. Upon reoperation to relieve the pain, it was found that the metallic head had eroded the acetabulum and the head itself had become slightly roughened thereby causing undesirable friction at the joint. Apparently, the differences in the hardness of the two relatively moving surfaces and the concentration of the stresses on areas of the bone by the denser and harder material of the prosthesis caused the erosion and deepening of the acetabulum with a consequent loss of proper fit between the ball or head and the acetabulum.

My experience with the prior types of prosthesis led me to the conclusion that the head, as well as the receiving socket, must be made of appropriate materials of similar density and resistance to erosion and corrosion and that an improved structure for seating and maintaining alignment of the prosthesis was required in order to provide a proper restoration or replacement of the damaged joint.

2

In accordance with the present invention, I have provided an improved form of prosthesis for the repair of the hip joint which includes a ball-like head member having a sleeve extending therefrom to receive and fit over the reshaped neck and head of the femur to provide a firm and solid union between them and to anchor the ball and sleeves with bolts extending through the outer cortex of the femur. I have also provided for cooperation with the ball-like head a complementary socket formed of a similar material which is precision fitted to the ball to minimize friction between them and prevent the concentration of stresses at limited areas of the head and the socket. I have also found it highly desirable to secure the head or ball in position on the femur by means of a quick-setting resinous material, such as, a quick-hardening acrylic resin and also to secure the socket in position in the pelvic arch, by means of a similar quick-setting resin which serves not only to bond the elements together but to afford a cushioning action which absorbs and distributes the shock throughout a greater area of the bone structure and this minimizes wear, erosion and pain. By providing a precision fitted head and socket, lubrication of the surfaces can be accomplished with a minimum of the body fluids, such as lymph or the like, so that the ball to all intents and purposes floats in the socket and thereby is subjected to a minimum of wear. To obtain this effect, the surfaces preferably should be fitted to within $1/100,000$ of an inch, although somewhat greater tolerances are possible.

The provision of a separate metallic socket has the advantage that it overcomes the need to fit the acetabulum closely to the head of the ball, such practice being practically impossible, in any event, during an operation of the nature required. Through the use of the resinous bonding material, irregularities which are produced during the enlargement of the acetabulum to receive the metallic socket are obviated and an accurate and precise location and fitting of the socket of my new prosthesis is readily obtained.

For a better understanding of the present in-

vention, reference may be had to the accompanying drawing in which:

Fig. 1 illustrates my new prosthesis shown partly in elevation and partly in section as applied to the femur and to the pelvic bone at the zone of the acetabulum; and

Fig. 2 is a view in section taken on line 2—2 of Fig. 1.

Referring to Fig. 1, the prosthesis is shown as applied to a femur F and to the pelvic bone S to repair a damaged femur head in which the neck of the femur has not been fractured. The ball member of the prosthesis consists of a hollow ball-like head 10 formed of a corrosion-resistant alloy of chromium, cobalt and molybdenum (Haynes Stellite No. 21) or a wrought sheet alloy such as Haynes Stellite No. 25. The ball-like head has a tapered or frusto-conical hollow skirt or collar 11 projecting from one side thereof. The collar 11 may be symmetrical with respect to an axis passing through the center of the ball-like head 10 for it has been found that with such a skirt construction, the same type of ball and skirt construction can be used for repair of either the right or left hip joint.

The outer end of the skirt 11 is provided with a flared or laterally extending flange 12 having two or more apertures 13 and 14 for the reception of the bolts 15 and 16 to secure the ball and skirt to the femur F. The use of bolts to secure the ball and sleeve to the femur contributes greatly to the strength thereof. In particular, the bolts keep the prosthesis from working off the portion 17 and relieve it of almost all of its loading. The portion 17 merely provides resistance to shearing forces while the binding load is taken by the bolts.

In applying the ball and skirt to the head and neck of the femur, the head and a portion of the neck are carved or chiseled to the generally conical form 17 illustrated in Fig. 1. The over-all length of the conical portion 17 will, of course, vary depending upon the extent of damage to the head and neck of the femur. The conical portion 17 should be reduced in size so that it fits tightly within the skirt 11 when the latter is seated firmly on the portion 17. The inner surface of the skirt 11 may be provided with a plurality of small sharp-edged ridges or knife edges 18 which penetrate into the bone and retain the head and skirt against rotation relative to the portion 17. Also, to prevent distortion of the head 10 and reinforce the connection with the conical portion 17 of the bone, the head may be filled with a quick-setting resin such as an acrylic resin 19 which hardens by polymerization, or evaporation of a solvent after application and thereby produces a solid filling within the head.

In some cases, the neck of the femur may be fractured or may be severely damaged so that it cannot be fitted tightly within the skirt 11. In such case, a bone nail may be driven through the femur along the axis of the neck and the nail itself together with the resinous material 19 will form a strong support for the ball and skirt.

The ball portion 10 does not cooperate directly with the acetabulum or the normal socket. A metallic socket 20 formed of the same material as the ball 10 or a similar material is provided to receive the ball 10. The socket 20 and the ball 10 are precision fitted to each other by a grinding and lapping operation which makes their surfaces complementary. The closer the fit of the socket 20 to the ball 10, the better the operation of the joint. Preferably these elements should be

fitted within about $\frac{1}{100,000}$ of an inch to assure best operation. However, somewhat greater tolerances may be used in the manufacture of the prosthesis, but in any event, the motion of the ball in the socket should be smooth and capable of almost frictionless movement in the presence of only a small amount of the lubricating fluid, such as body lymph.

In most cases, the socket 20, although formed of material on the order of 0.125 inch in thickness, will not fit within the normal acetabulum so that it is necessary to chisel or otherwise form a recess of somewhat larger than natural dimensions in the bone. Because of the fact that it is not possible to produce a recess which precisely fits the back of the socket 20, and, in fact, it may not be desirable to do so, the socket 20 is secured in the bone S by means of a thin layer 21 of quick-setting hesin, such as the acrylic resin referred to above. The layer of resin 21 is shown greatly exaggerated in Fig. 1 as is the thickness of the socket 20. To assure a firm bond between the socket 20, the resin 21 and the bone S, the back of the socket may be provided with a series of small undercut or dovetailed recesses or grooves 22 into which the resin may flow and harden. Also a series of small undercut recesses 23 may be formed in the bone S to receive the resin. In this way, a strong mechanical bond is obtained between the metallic socket 20 and the bone S. Further, the outer edge of the socket may be cut back to form an outwardly facing shoulder 24 over which the resin can flow to key the socket 20 to the resin and retain it against outward movement. Also, the resin will flow smoothly up to the edge of the socket 20 and thereby form a joint which is free of sharp edges which might cut or lacerate the adjacent tissues.

It has been found that joints including my prosthesis are capable of withstanding loads comparable to those which an undamaged femur can support without a substantial concentration of stresses at restricted areas of the joint. Moreover, the surface tension between the closely fitted ball and socket is such that the smallest drop of body fluid becomes a thin lubricating film between the opposed surfaces of the ball and socket. Due to the presence of such a lubricating film, very little wear can occur on the ball and socket. Moreover, because of the presence of the acrylic resin or the like, vibrations or shock are absorbed to a degree that pain-like sensations are largely eliminated. Another important feature of the closely fitted surfaces is that air pressure will tend to hold them together so that, while they can be moved readily, they cannot be separated without the application of a very substantial force.

It has also been found that the smooth juncture of the metallic prosthesis with the bone structure permits the body tissues to grow over the joints between the prosthesis and the bone and thereby form natural covering for the edges of the metallic elements. It also provides for a more extended range of movement and distributes the weight over a larger area.

It will be understood that the prosthesis disclosed herein may be made in several sizes depending upon requirements and they may be made of various types of corrosion-resistant metals or materials. Therefore, the form of the invention disclosed herein should be considered as illustrative and not as limiting the scope of the following claims.

I claim:

1. A hip-joint prosthesis comprising a hollow ball member of corrosion-resistant metal, a hollow tapered sleeve extending from one side of said ball member to receive the reshaped head and neck of a femur, said sleeve having its smaller end fixed to said ball member, a socket member of corrosion-resistant metal fitted to said ball member for free rocking movement relative thereto, and means forming recesses on the back of said socket member to secure said socket member in position with respect to the pelvic arch.

2. The prosthesis set forth in claim 1, comprising a plurality of sharp-edged ribs extending lengthwise, and on the inside, of said sleeve.

3. The prosthesis set forth in claim 1 in which the ball and socket have opposed lapped surfaces fitted to each other within a tolerance of about 0.00001 of an inch.

4. A hip-joint prosthesis comprising a hollow ball member corresponding to the head of the femur, a hollow sleeve extending from one side of said ball member and communicating with the interior thereof to receive the neck of the femur, and a flange extending laterally from the outer end of said sleeve and having apertures therein to receive fasteners to secure the ball and sleeve to the shaft of the femur, said ball, sleeve and flange being integral and formed of corrosion-resistant metal.

5. The hip-joint prosthesis set forth in claim 4, in which said sleeve tapers inwardly from said flange to said ball and is substantially symmetrical about an axis passing through the sleeve and the center of said ball.

6. The hip-joint prosthesis set forth in claim 4 comprising a plurality of sharp edged ridges on the inner surface of said sleeve and extending lengthwise thereof.

7. The hip-joint prosthesis set forth in claim 4 comprising a thin metal socket member having a cavity in the front thereof to receive and fit the outer face of the ball, said socket having recesses in its back to receive and interlock with a bonding material to secure the socket member in position.

8. The hip-joint prosthesis set forth in claim 4 comprising a thin metal socket member having an outwardly facing substantially hemispherical cavity therein to receive and fit said ball and a substantially circular outer edge, said socket member having a laterally extending shoulder extending circumferentially around it behind and outwardly of said circular edge and facing in substantially the same direction as said cavity to receive bonding material behind and in front of said shoulder to secure said socket member in position.

9. A hip-joint prosthesis for a damaged head or neck and head of the femur, comprising a hollow ball member of corrosion-resistant material adapted to receive the reshaped head of a femur, a sleeve integral with said ball member adapted to receive the reshaped neck of the femur in tightly fitted relation, said head and sleeve being adapted to receive a quick-setting resin to fill any space in said ball and sleeve not occupied by the reshaped neck or neck and head of the femur, a flange on the outer end of said sleeve, means to secure said flange to the shaft of the femur, a socket member formed of thin corrosion-resistant metal having a substantially hemispherical cavity therein receiving and fitted to said ball member with capacity for relatively frictionless rocking movement relative thereto, said socket member being adapted to be mounted in the pelvic bone with a layer of a quick-setting resin.

10. A hip-joint prosthesis comprising a hollow ball member corresponding to the head of the femur, a hollow, tapered sleeve extending from one side of said ball member and communicating with the interior thereof to receive the neck of the femur, said sleeve having its smaller end adjacent to said ball member, and means at the outer end of said sleeve to receive fasteners to secure the ball and sleeve to the shaft of the femur, said ball and sleeve being integral and formed of corrosion-resistant metal.

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(Copies of these publications in Div. 55.)