ARTIFICIAL HIP JOINT

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ABSTRACT

An artificial hip joint, wherein an artificial femur head is fixed in the femur and a socket having two pins is secured in the pelvis. The apparatus includes special tools for fixing the socket in the pelvis in a proper position particularly determined by bores taking up said pins, and the ball head may be located in different positions on a pin of the femur shank and is secured from unintentional twisting once it is mounted thereon in its final position.

21 Claims, 17 Drawing Figures
ARTIFICIAL HIP JOINT

BACKGROUND OF THE INVENTION

The present invention concerns an artificial hip joint. The purpose of artificial hip joints is the replacement of natural hip joints in order to return freedom of movement to a person with a diseased hip joint.

Artificial joints for the replacement of the hip joint are known. It should be noted that at first only the ball at the top of the femur was replaced. Only later were both parts of the hip joint replaced, that is to say, the socket in the pelvis and the ball at the top of the femur. Operations which require only the replacement of the ball of the joint were and still are today carried out using an artificial femur head. This artificial femur head has a Shank for insertion into the medullar cavity of the femur, the Shank being provided near one end with an enlargement having a bearing surface for abutting the upper surface of the femur and adjoining this, a pin for receiving the ball of the joint. Conventional artificial femur heads have a capitulum in contact with the acetabulum and a Shank portion intended for insertion into the medullar cavity of the femur; a demountable joint being provided between the capitulum and the Shank part.

Another known embodiment comprises a rod-like portion and an enlarged portion and a ball head which is intended to be provided on the top of the remainder femur by a supporting surface and the center of the ball head is disposed externally of the longitudinal axis of the stem. The ball head is provided on a neck part and the plane through the center of the ball head and the supporting surface, viewed in the direction of the narrow side of the artificial joint to the center plane of the flat stem, subtends an angle, and that the supporting surface on the underside of the neck member, viewed in the direction of the wide side of the artificial joint, is arranged perpendicularly to the said plane through the middle of the ball head, whilst the lower rod-like part of the Shank is approximately twice as long as its enlarged part.

In conventional artificial joints, the ball is mounted on a cylindrical part. If, for any reason, the ball does not run freely in the socket, attrition occurs on account of the friction of the ball on the pin of the Shank and is considerable because of the relatively small diameter of the pin leading rapidly to an unsteady connection.

Furthermore, in a subsequent operation for replacing the artificial joint, there are often difficulties in extracting the rooted or cemented-in artificial joint, so that the operation takes a long time, a feature which has extremely harmful consequences on the patient.

In addition to these artificial femur heads, total artificial hips are also known in which both parts of the joint, that is to say, both the ball and the socket, can be replaced. However, with such artificial joints difficulties arise which should not be neglected, since, due to the strong forces arising with the loading of the joints, the originally good joint surfaces become deformed or even damaged. The resultant bad qualities or frictional characteristics of the joint make movement difficult, causing pain and the surrounding tissues may, due to the resultant products of attrition, tend to produce corresponding reactions and this may lead to the artificial joints having to be replaced in a further operation.

These disadvantages were avoided by the feature that different materials were used for the socket and the ball. Plastics materials were used for the sockets and metals for the balls. The metal heads were fixed into the previously prepared medullar cavity of the femur. Either the artificial femur Shank had so-called windows for this purpose, through which it was possible for the bone to grow or a plain Shank was cemented into the medullar cavity.

Similarly, the plastics material socket was cemented into the pelvis. The outer radius of the plastics material socket, however, depends on the structure of the skeleton, just as its wall thickness depends on the loads to be expected. The consequence of this is that the inner radius and, therefore, the radius of the ball, are small, whereby, after a certain lapse of time the socket becomes worn out from friction, since the resultant forces exceed the resistance of the surface of the plastics material socket, and this naturally necessitates the replacement of the joint.

SUMMARY OF THE INVENTION

It is an object of the present invention to overcome the disadvantages of conventional artificial femur heads.

Another object of the present invention is to provide a total artificial hip joint having none of the disadvantages of conventional joints of this kind.

A further object of the present invention is to provide a hip joint which can be adjusted to the given conditions of the skeleton.

Yet another object of the present invention is to construct an artificial hip joint in which all the individual parts are inserted into the body in a predetermined position.

A further object to be achieved by means of the present invention is to provide an artificial hip joint which can be easily and rapidly inserted.

Another object of the present invention is to indicate a method of operating for inserting the artificial hip joint.

These objects are achieved in accordance with the present invention, on the one hand, by an artificial hip joint, comprising an artificial femur head with a femur body and ball head and a joint socket, in which the ball head is located on a pin of the femur Shank and is secured against unintentional twisting by means of pegs which engage in depressions in the collar of the femur Shank, and the joint socket has two pins which determine and secure its position in the pelvis.

A preferred embodiment of the artificial hip joint of the present invention is characterised in that the ball head has a ball neck extension on which the pegs are disposed.

The most important advantages of the present invention reside in the feature that it is possible to comply within very wide limits with the given conditions of the skeleton, since it is possible to copy the direction of the bones, medially, laterally, posteriorly and anteriorly, so that the ball head is mounted on the pins of the artificial femur head in the appropriate corresponding position.

Furthermore, the two pins of the socket are protected from small movements which could lead to subsequent loosening.

The present invention will be described further, by way of example, with reference to the accompanying drawings.
BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a section through part of a skeleton with inserted artificial joints, the right hip joint being replaced by an artificial femur head and a left hip joint by a total artificial hip according to the present invention; FIG. 2 is a side elevation of the artificial femur head with a mounted ball head of this invention; FIG. 3 is a plan view of the artificial femur shank shown in FIG. 2; FIG. 4 is a section through a joint socket of the present invention; FIG. 5 is a plan view of the socket shown in FIG. 4; FIGS. 6a, b, c, d, e and f are side views of the present ball head in the normal, lateral and medial directions and plan views in the normal, anterior and posterior directions; FIG. 7 is an alternative embodiment of the upper part of an artificial femur shank with an alternative mounting of the ball head according to the present invention; FIG. 8 shows a view of a rasp used for shaping the medullary cavity in the femur shank; FIG. 8a shows a milling cutter associated with the rasp according to FIG. 8; FIG. 9 is a section through a socket inserting device with mounted socket; FIG. 10 is a section through a drill gauge for drilling two holes in the acetabulum, in which the pins of the joint socket engage; and FIG. 10a is a plan view of the drill gauge according to FIG. 10.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 shows a pelvis 13 and two femurs 14 and 15, in which shanks 16 and 17 of artificial femur heads are inserted in the medullary cavities 56 and 57. The artificial femur heads are positioned on the surfaces 22 and 23 of the remaining part of the femurs by bearing surfaces 18 and 19 of collars 20 and 21. The left side of FIG. 1 shows a right hip joint in which a ball head 24 extends directly into the natural socket 25 of the joint and co-operates therewith. The right side of FIG. 1 shows a left hip joint which is replaced by a total artificial hip, since the natural socket is replaced by an artificial socket 26.

FIGS. 2 and 3 show in more detail how the artificial femur head is constructed. It should be noted that the length of the shank 16 can be adapted in accordance with the dimension of the skeleton and the forces involved. In order to protect the shank 16 from unintentionally sinking into the femur 14, the bearing surface 18 has been considerably enlarged on the medial side. Similarly, the lateral reinforcement 27 on the shank minimises twisting in the femur 14. The collar 20 is provided in its rear portion with a bore 28 serving to secure the possibly separated trochanter major in position again by means of an incurving. Alternatively, in the event of infection, an extracting device can be engaged in this bore. The collar 20 is provided with four depressions 29 on its side opposite to the shank 16 and the bearing surface 18, shown in plan in FIG. 3 and in a side elevation in FIG. 2. In order to receive the ball head 36, the artificial femur shank 16 has, at the point of intersection of the depressions 29, a tapered pin 30, the axis 58 of which normally forms an angle of 126° with the axis of the shank. The surface of the shank 16 is smooth or sand-blasted.

FIGS. 4 and 5 show a hip socket 26 constructed in accordance with the present invention. Its shape, which is adapted as far as possible to that of the natural socket, is clearly shown. Two pins 31 and 32 are provided which accurately secure the socket 26 in holes 60 in the acetabulum and, if may be considered as a special feature. The two pins are each provided with a groove 34 through which excess cement can flow out during the cementing-in process. Radially extending ribs 33 also serve to secure the position of the socket 26 in the pelvis 13.

Due to the fact that metal, such as a Cr-Co-Mo alloy, is used as socket material, and the ball head consists of plastics material, such as, polyethylene, the inner surface 35 of the socket 26 is not damaged in any way by the use of the hip joint. Hence any replacement of the cemented-in socket 26, with all its disadvantages is completely unnecessary, except in the case of infections.

FIG. 2 shows another ball head 36 with a symmetrical neck extension 64 and a bore 65 which is slipped on the taper pin 30 of the femur shank.

In contrast to this, FIG. 7 shows a ball head 37 with an asymmetrical neck extension 66 and a decreased bore 67, the axis 68 of which subtends, with the center line 69 of the ball head 37, an angle of between 5° and 15°.

FIGS. 6a, b, c, d, e and f show the various basic directions of the axes of the hip joint which may be considered with the same artificial femur head, and also with a single total artificial hip without replacing any cemented-in artificial part. It is sufficient if the ball head 36, shown in FIG. 2, by means of which the normal direction shown in FIGS. 6a and 6d is achieved, is replaced by the ball head 37 shown in FIG. 7, a feature which can be realised without difficulty, since both ball heads 36 and 37 are simply slipped on the taper pin 30.

The lateral direction, FIG. 6b, is obtained if the ball head 37 is slipped on the pin 30 so that the centre 61 of the ball is disposed above the axis 38 of the pin. However, the medial direction, FIG. 6c, is obtained if the same ball head 37 is slipped on the pin 30 so that the centre 61 of the ball is below the axis 58 of the pin.

The anterior and posterior directions, in turn, are obtained with the same ball head 37 if the latter, as shown in FIGS. 6e and 6f, are slipped on the taper pin 30 so that the centre 61 of the ball is disposed behind or in front of the axis 58 of the pin. These five basic directions are accurately determined by the position of the axes 38 of the ball heads 36 and 37 and the position of the corresponding depressions 29 of the collar 30, into which they fit.

The artificial femur shank 16, shown in FIG. 2, is cemented-in, as is the socket 26. However, as cementing-in involves undesirable side effects, heat development with the setting of the cement, monomer separation and also longterm effects which have not yet been completely explained, is a great advantage if the use of bone cement can be abandoned.

However, in order to fix the artificial shank in position, it must be formed as shown in FIG. 7. The shank 16 is initially rasped approximately to the thickness A. When the shank is subsequently introduced into the medullary cavity 56 of the femur 14 (FIG. 1), the residual bone material is rasped away by the teeth 39 of the
shank 40 so that this material collects in the depressions between the teeth 39, a feature which may lead to adhesion of the artificial femur shank. During the subsequent ossification the artificial shank then becomes firmly rooted in the femur.

The rest of the construction of this artificial femur shank 40 corresponds in all other requirements to that according to FIGS. 2 and 3, since otherwise the replaceability of the individual ball heads would be placed in question.

It will be easily seen that the artificial hip joint of the present invention, whether as an artificial femur head or as a total artificial hip joint, represents an artificial hip joint on a building block system, in which only the ball heads have to be replaced in order to obtain the most natural positions of the femur possible. It is obvious that extreme conditions of the bones can be further compensated by suitably adapted artificial femur shanks and sockets.

In order to insert the artificial hip of the present invention as rapidly and as easily as possible, a few special instruments or tools are necessary, as will be apparent from the following description. For example, a rasp, as shown in FIG. 8, is required, comprising a rasp member 41 and a handle slipped and fixed on a pin. The medullar cavity 56 of the femur 14 is shaped with the rasp 41. This rasp 41 should preferably have the same dimensions as the artificial femur shank 16, or thickness A of the shank 40. After the initial rasping process, the handle is removed and the rasp 60 left in the medullar cavity so that the surface B is flush with the stump of the femur neck. The pin now projects above the bone. The stump of the femur neck is milled accurately plane using a milling cutter as shown in FIG. 8c by way of this pin, and the correct angle for the bearing surface 18 of the artificial shank is also accurately obtained thereby.

FIG. 10 shows the drill gauge of the present invention for drilling the holes in the acetabulum. It has a spherical end 49, the shape of which approximately matches the shape of the socket part 26. After the introduction of the drill gauge in the initially milled acetabulum it is brought to the correct position (45° to the axis of the body and 10° to 20° anteverision) and fixed by means of the two pins 52 and 53 which are axially displaceable and have points 62 and 63, which are hammered into the acetabulum. The depth of penetration of the pin is accurately determined by the stops 54, 55. The two holes for receiving the pins 21 and 22 of the socket 26 are drilled in the acetabulum in this position by a special spiral drill through the holes C in the drill gauge. The spiral drill is also provided with a stop so that the necessary drilling depth can be accurately observed. The position of the socket 26 is thus accurately determined.

A socket inserting device 42, as shown in FIG. 9, may also be used with advantage, this device having a spherical end 43 of the shape of the inner surface 35 of the socket 26, or, in the form of the ball head 24, on which end 43 the socket 26 can be clamped. This is effected by means of an elastic holder 44 slipped over an edge 45 of the socket 26. As soon as the socket 26, the outside of which is filled with cement between the ribs 33 before the insertion in the pelvis 13, is in its final position, determined by the two bores in the acetabulum, the handle 46 is pressed in the direction of the pelvis or towards the end 43, so that the socket 26 is pressed firmly into the acetabulum, the result of which is that the two pins 31 and 32 engage in the prepared holes 60 in the acetabulum. A part 48 is then drawn towards the handle 46 against the bias of a spring 47. Thus the holder 44 is removed from the end 43 so that it releases the edge 45 of the socket 46. The socket 26 is thus inserted in the pelvis and the inserting device can be withdrawn. After the shank 16 or 40 of the artificial femur head is cemented in the medullary cavity 52 or pressed therein, the ball head 36 or 37, selected and positioned according to the condition of the skeleton, can be slipped on the taper pin 30. The actual insertion of the artificial hip joint is thus completed.

The fact that none of the cemented-in or grown-in parts is subjected to wear, has proved to be extremely advantageous if for any reason the ball head has to be replaced, since a small operative opening is sufficient for removing the ball head from the taper pin of the artificial femur and mounting a new one.

It is obvious that alterations may be made to the artificial hip joint itself, to the method of operation and the set of instruments used for the purpose without departing from the scope of the present invention.

What we claim is:

1. An artificial hip joint, comprising an artificial femur head having a femur shank and ball head mounted thereon, and a socket, said femur shank having a support pin projecting from an upper end thereof and a collar about the base of said pin, said ball head having a bore which is disposed on said pin of the femur shank and is secured from unintentional twisting by pegs projecting axially at a face of the ball head for cooperative engagement with depressions in said collar of the femur shank, said bore of the ball head having an axis offset from a diameter line of the ball head, whereby said ball head may be disposed on said pin and fixed by said pegs and depressions in various relative angular positions for selection of various positions of said ball head relative to said femur shank.

2. An artificial hip joint as claimed in claim 1, in which the ball head has a neck extension on which the pegs are disposed.

3. An artificial hip joint as claimed in claim 1, in which the ball head has a bore, the axis of which is offset between 5° and 15° from a diameter line.

4. An artificial hip joint as claimed in claim 1, in which the ball head has four axially projecting pegs arranged cross-wise.

5. An artificial hip joint as claimed in claim 1, in which the artificial femur shank has at least approximately smooth surfaces.

6. An artificial hip joint as claimed in claim 1, in which the shank has annular teeth.

7. An artificial hip joint as claimed in claim 1, in which the collar has a bore in its rear portion.

8. An artificial hip joint as claimed in claim 1, in which the collar has four depressions arranged crosswise at whose point of intersection said pin is disposed and is tapered.

9. An artificial hip joint as claimed in claim 1, in which the axis of the shaft and the axis of the pin subtend an angle of 126°.

10. An artificial hip joint as claimed in claim 1, in which the neck of the ball head is symmetrical.

11. An artificial hip joint as claimed in claim 1, in which the ball head has an asymmetrical neck.
12. An artificial hip joint as claimed in claim 1, in which the femur shank is curved and the rear part of its upper end is provided with a reinforcement.

13. An artificial hip joint as claimed in claim 1, in which the ball head consists of plastics material.

14. An artificial hip joint as claimed in claim 1, in which the shank consists of Co-Cr-Mo alloy.

15. An artificial hip joint as claimed in claim 1, in which the femur shank is sand-blasted.

16. An artificial hip joint as claimed in claim 1, in which the socket has two pins.

17. An artificial hip joint as claimed in claim 1, in which the socket is provided on its outer surface with radially extending ribs.

18. An artificial hip joint as claimed in claim 1, in which the socket is at least partially provided with a rim on its circumference.

19. An artificial hip joint as claimed in claim 1, in which the socket is chamfered on the medial side.

20. An artificial hip joint as claimed in claim 1, in which the inner radius of the socket corresponds approximately to that of the ball head.

21. An artificial hip joint as claimed in claim 1, in which the socket consists of a Co-Cr-Mo alloy.